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Evaluation of waterlily genotypes under pot conditions

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Abstract
The growth performance of important commercial cultivars and hybrids of water lily (*Nymphaea* sp.) was evaluated by maintaining plants in pots. The design of the experiments was Completely Randomised Design (CRD) with three replications. The study focused on evaluating the vegetative parameters of 10 water lily genotypes. Data on leaf length, leaf width, plant height, and the number of flowers produced were statistically analysed by ANOVA. The results show a clear picture of the performance of waterlily under pot conditions (stress). The genotypes include hardy and tropical waterlilies from which *Nymphaea* "Rudraksha" produced larger leaves which is a hardy type, while *Nymphaea* "Bull's eye" produced a comparatively large number of flowers under pot conditions. With the proper ratio of water and soil depth in the pot, waterlily can be a good ornamental plant that can be recommended for indoor gardening and aqua-scaping.

Keywords: Waterlily, pot plants, ornamental plants, flowering ornaments, flowering plants for landscape

Introduction
Water is an important element of a garden which represents the flow of life. The aquatic garden may have the form of bogs, ponds, streams, fountains, cascades, and water containers. Since aquatic plants create oxygen (O_2), remove and recycle nutrients, and offer shade and hiding places for the residents, water plants are the most crucial element in the ecology of water gardens (Masser, 2010; Sharma, 2001) [3, 4]. The addition of water plants to the urban environment will improve the aesthetic value (Al-Menaie, Zalzaleh, Mathew, & Suresh, 2011) [1]. Water gardening can be utilized to supplement the traditional terrestrial gardens to expand the green surface in landscape projects. Nymphaeaceae commonly Waterlilies are aquatic flowering plants widely spread across tropics and temperate regions in every continent except Antarctica and vast Dessert (Fischer & Rodriguez, 2010) [2]. The widely used flowering aquatic landscape plants are Lotus (*Nelumbo*) and Waterlily (*Nymphaea*) for their aesthetic value and propagation methods. In comparison with Lotus, Water lilies were diverse in nature and morphology. This can be used as an advantage for selecting plants for landscape purposes by maintaining harmony and variation by color (Lima *et al*., 2012). The option to make gardens on small scale can be achieved by pot plantings. This can also provide an opportunity to maintain aqua plants in indoor conditions. The selection of plants for different location and environment that suits the region becomes a new confusion. Even-though, aquatic plants are suited for the wide climate, the classification of plants is important for providing information and options for better decisions in aquascape & landscape projects. Hence a study was conducted at the Department of Floriculture & Landscape Architecture, Tamil Nadu Agricultural University (TNAU), Coimbatore using 10 commercial cultivars and hybrids to assess their growth and performance under pot conditions.

Materials and Methods
The evaluation of different Nymphaea genotypes was conducted at the Botanical Garden, Tamil Nadu Agricultural University, Coimbatore in pot conditions. The genotypes include cultivars and hybrids which are tropical and hardy types. Uniform rhizomes of each weighing 10 g without any sprouts were maintained under open sunlight conditions in the water container with dimensions of 10 vi height, 8 cm diameter wide at the top, and 6 cm diameter wide at the bottom. The water containers were tagged and observed daily for sprouting. The treatments were listed in Table 1. After 10 days, the sprouted rhizomes were planted in ambal pots (Ambal thotti in Malayalam) having dimensions of 27.94 cm in height, 27.94 cm in diameter wide at the bottom, and 50.80 cm diameter wide at the top. The containers are filled with a planting mixture of clay and red soil in the ratio of 2:1 that covers 70% of the pot i.e.,

19 to 20 cm from the bottom of the pot so that the sprouted rhizomes were visible above the surface. The top of the soil was covered with fine gravel to ensure that the filled water need to be transparent and to prevent the rhizomes from snails and birds. After planting, the containers were irrigated. Water criteria is an essential element for the vegetative development of water lily while it can tolerate up to 2 m depth of water, the recommended level is between 30 to 67 cm (Richard *et al.*, 2011). The research was carried out using Completely Randomized Block Design (CRD) with three replications.

Table 1: List of commercial cultivars of *Nymphaea* planted in pots

Treatment	Cultivars
T_1	*Nymphaea* "Albert green-berg"
T_2	*Nymphaea* "Red ruby"
T_3	*Nymphaea* "Rudraksha:"
T_4	*Nymphaea alba*
T_5	*Nymphaea "*After glow"
T_6	*Nymphaea* "Bull's eye"
T_7	*Nymphaea colorata*
T_8	*Nymphaea colorado*
T_9	*Nymphaea* "Fox fire"
T_{10}	*Nymphaea* "King of siam"

After planting, the rhizomes were periodically examined for their growth and development. Irrigated water was monitored for its quality and quantity parameters such as pH values and depth of the water in the container. As the aquatic plants need slightly alkaline or neutral water for their growth and development, the pH of the irrigation water was maintained at 6.9. The containers were irrigated with fresh water at three days intervals. *Poecilia reticulata*, a freshwater aquatic fish which are smaller in size was introduced into each container to control the mosquito larvae. Decayed leaves were removed periodically. The observations recorded were the number of leaves, leaf width, petiole length, and the number of flowers at monthly intervals.

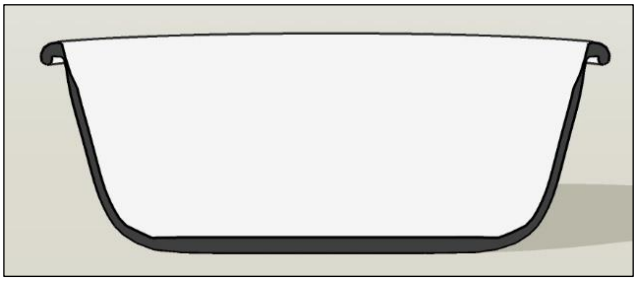


Fig 1: Horizontal cross-section of Ambal pot.

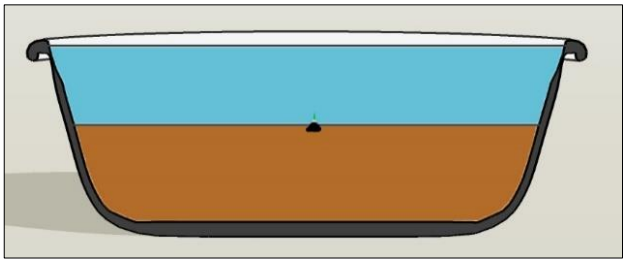


Fig 2: Illustration of planting rhizomes in Ambal pot.

Results and Discussion

The plants begin to produce leaves within a week after planting. The highest average leaf length was recorded in T_7 (*Nymphaea colorata* - 6.9 cm) in 1st Month after Planting while the lowest was recorded on T_9 (*Nymphaea* "Fox fire"- 3.00 cm). Table 3 shows the highest leaf width which was recorded on T_3 (*Nymphaea* "Rudraksha:"- 33.69 cm) at 10th MAP while the lowest was recorded on T_1 (*Nymphaea* "Albert green-berg"- 28.48 cm) at 10th MAP. The difference in leaf length shows that the Hardy Waterlilies produce more leaf production (vegetative production) in comparison with the Tropical Waterlilies.

Table 4 shows that the highest plant height (from the crown to the top bud) was recorded in T_5 (*Nymphaea "*After glow" - 75.76 cm). The lowest plant height was recorded on T_2 (*Nymphaea* "*R*ed ruby" - 73.16 cm). The plant height from 1 MAP to 10 MAP was gradually increased when they are maintained in pots. The vegetative growth of plants mainly focused on the plant spread instead of its height which is unique to the pot conditions. This can be observed from the leaf width (Table 3) and leaf length (Table 4) data, compared with plant height (Table 5). All 10 genotypes were similar in flower production (number of flowers). The plant heights for each treatment were significant at $P < 0.05$ (**) except for T_5 (*Nymphaea* "After glow").

The average number of flowers produced were ~2 per month. In the 1st MAP, there were no flowers produced in most of the plants. But T_7, T_8, and T_{10} (*Nymphaea colorata*, *Nymphaea colorado*, *Nymphaea* "King of siam") flowered within one month after planting. In each genotype, two to three flowers bloomed, but the size of the flower was small compared to the flowers observed during the 10th MAP. At 10th MAP, all the treatments bloomed approximately 3 flowers with good quality and size. The highest number of flowers were observed during the 10th MAP in the petaloid flower – T_6 (*Nymphaea* "Bull's eye" ~2 numbers). The hardy types bloomed a lower number of flowers than tropical water lily types. The number of flowers produced varied both within the treatments even after maintaining the water levels uniformly. Thus, for pot conditions, the number of flowers produced was not influenced by the maintained water depth (Vijay, Aruna, Rajamani, & Vanitha, 2021). For pot conditions, except T_4 and T_9, all other examined genotypes performed well.

Table 2: Average Leaf Length in cm

Treatments	1MAP	2MAP	3MAP	4MAP	5MAP	6MAP	7MAP	8MAP	9MAP	10MAP	Significance	SEM
T1	6.00	6.8	8.56	9.96	10.78	12.25	15.79	19.45	24.88	30.48	**	2.49
T2	5.5	6.45	7.45	8.79	10.43	12.78	14.93	19.68	23.29	30.9	**	2.47
T3	5.35	6.84	7.96	9.17	10.8	13.01	16.56	19.3	24.05	35.69	**	2.45
T4	5.87	7.01	8.04	9.05	11.43	13.56	15.9	19	25.09	32.97	**	2.65
T5	6.31	7.21	8.67	9.86	8.05	13.71	16.2	20.68	24.6	31.79	**	2.65
T6	5.9	7.72	8.96	9.79	11.05	14.07	16.89	19.7	24.85	33.85	**	2.67
T7	6.9	7.96	9.12	9.83	11.69	13.6	16.02	20.57	24.89	32.68	**	2.69
T8	6.1	7.83	9.04	10.16	12.38	13.84	16.94	19.63	23.05	33.00	**	2.44
T9	3.0	6.03	7.20	8.80	10.10	11.40	13.60	16.47	19.57	24.40	NS	1.85
T10	4.3	6.58	8.89	10.02	12.4	14.68	17.24	20.55	25.06	32.59	**	2.59

Table 3: Average Leaf Width in cm

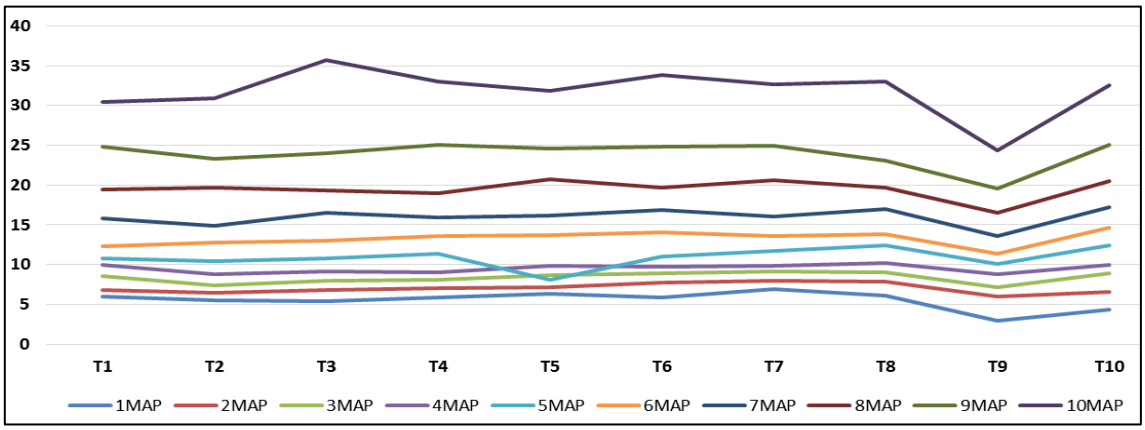
Treatments	1MAP	2MAP	3MAP	4MAP	5MAP	6MAP	7MAP	8MAP	9MAP	10MAP	Significance	SEM
T1	4.00	4.80	6.56	7.96	8.78	10.25	13.79	17.45	22.88	28.48	**	2.56
T2	3.50	4.45	5.45	6.79	8.43	10.78	12.93	17.68	21.29	28.90	**	2.34
T3	3.35	4.84	5.96	7.17	8.80	11.01	14.56	17.30	22.05	33.69	**	2.33
T4	3.87	5.01	6.04	7.05	9.43	11.56	13.90	17.00	23.09	30.97	**	2.53
T5	4.31	5.21	6.67	7.86	8.89	11.71	14.20	18.68	22.60	29.79	**	2.45
T6	3.90	5.72	6.96	7.79	9.05	12.07	14.89	17.70	22.85	31.85	**	2.43
T7	4.90	5.96	7.12	7.83	9.69	11.60	14.02	18.57	22.89	30.68	**	2.38
T8	4.10	5.83	7.04	8.16	10.38	11.84	14.94	17.63	21.05	31.00	**	2.33
T9	2.90	4.76	7.00	8.34	9.97	12.96	14.80	17.49	22.80	29.40	**	2.56
T10	2.30	4.58	6.89	8.02	10.40	12.68	15.24	18.55	23.06	30.59	**	2.44

Table 4: Average Plant Height in cm

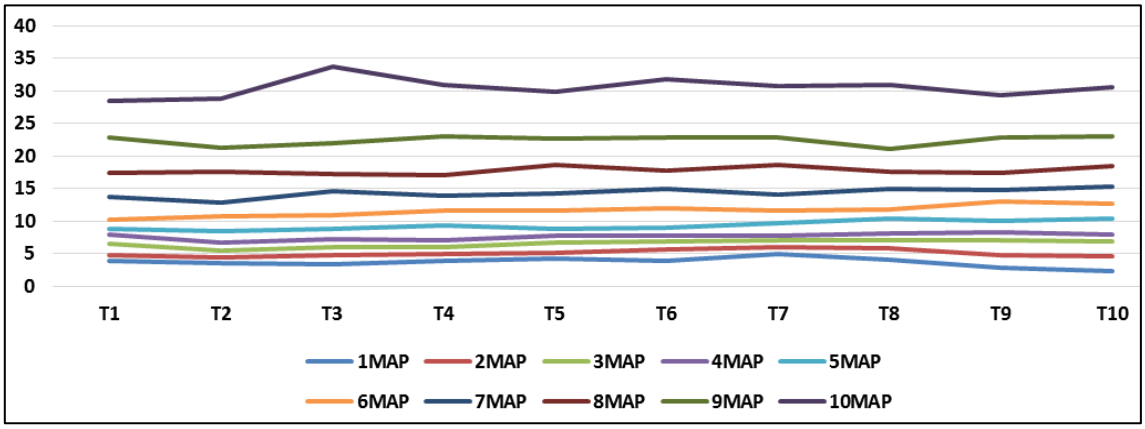
Treatments	1MAP	2MAP	3MAP	4MAP	5MAP	6MAP	7MAP	8MAP	9MAP	10MAP	Significance	SEM
T1	11.48	20.96	28.96	36.96	43.96	50.96	57.96	63.96	69.96	74.96	**	7.65
T2	10.58	19.16	27.16	35.16	42.16	49.16	56.16	62.16	68.16	73.16	**	7.50
T3	10.69	19.38	27.38	35.38	42.38	49.38	56.38	62.38	68.38	74.38	**	7.5
T4	11.14	20.28	28.28	36.28	43.28	50.28	57.28	63.28	69.28	74.28	**	7.38
T5	11.38	20.76	28.76	36.76	43.76	50.76	57.76	63.76	69.76	75.76	**	7.4
T6	10.97	19.94	27.94	35.94	42.94	49.94	56.94	62.94	68.94	74.94	**	7.27
T7	11.04	20.08	28.08	36.08	43.08	50.08	57.08	63.08	69.08	74.08	**	7.34
T8	10.59	19.18	27.18	35.18	42.18	49.18	56.18	62.18	68.18	74.18	**	7.3
T9	11.45	20.92	28.90	36.90	43.90	50.90	57.90	63.90	69.90	74.90	**	7.35
T10	11.59	21.18	29.18	37.18	44.18	51.18	58.18	64.18	70.18	75.18	**	7.70

Table 5: Average number of Flowers Produced in numbers

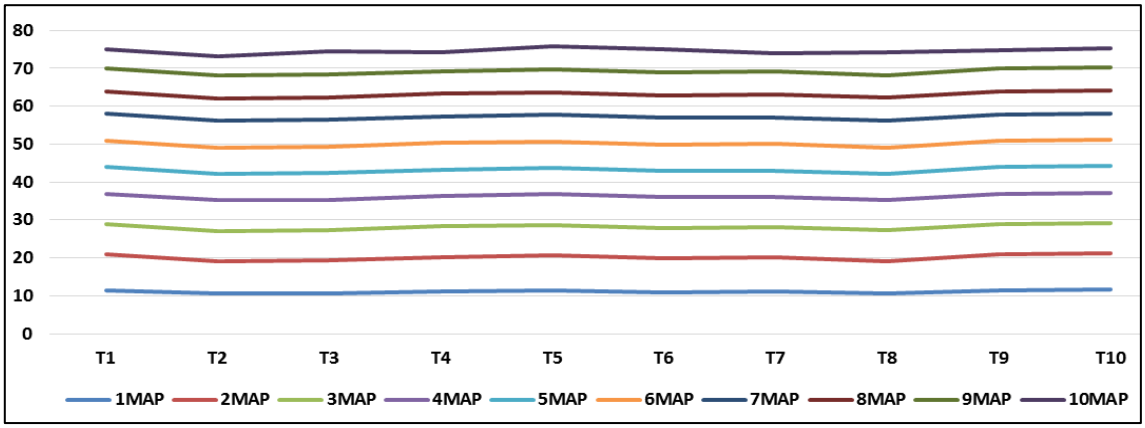
Treatments	1MAP	2MAP	3MAP	4MAP	5MAP	6MAP	7MAP	8MAP	9MAP	10MAP	Significance	SEM
T1	0	1.63	0.61	0.52	0.64	1.03	0.94	1.52	0.8	1.17	**	0.02
T2	0	1.36	0.82	0.59	0.59	1.02	0.81	1.25	0.89	1.38	**	0.03
T3	0	1.58	0.65	0.61	0.64	0.88	0.51	1.51	0.73	1.19	**	0.025
T4	0	0.4	0.6	0.2	0.34	0.36	0.38	0.58	0.66	0.74	NS	0.001
T5	0	0.78	1.22	0.49	0.6	0.99	0.5	1.03	0.85	1.38	**	0.016
T6	0	0.82	0.97	0.66	0.76	0.92	1.02	0.88	1.02	1.58	**	0.021
T7	0.11	1.61	0.91	0.68	0.48	0.78	0.87	1.43	0.77	1.51	**	0.021
T8	0.09	1.69	0.59	0.56	0.87	0.99	0.86	0.85	0.94	1.44	**	0.030
T9	0	1.47	0.64	0.48	0.69	0.79	0.73	1.34	1.02	1.28	**	0.030
T10	0.1	1.28	1.15	0.43	0.79	0.96	0.51	1.53	0.93	1.06	**	0.024



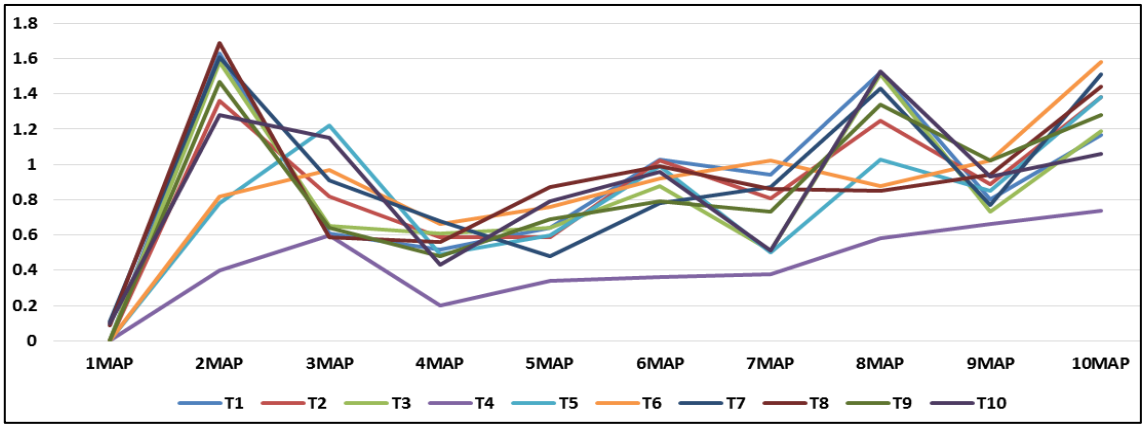
Leaf Length



Leaf Width



Plant Height



Average Number of Flower Blooms

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