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MORPHOLOGY AND FLORAL BIOLOGY OF TWELVE WATER LILY GENOTYPES

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Abstract

An experiment was conducted at the east nursery of Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur from July 2020 to June 2021 with a view to characterizing twelve water lily (*Nymphaea nouchali*) germplasm for cultivation in Bangladesh. The experiment was set up in a Randomized Complete Block Design with three replications. Rhizomes of each germplasm were planted in earthen tub of around 95 cm upper diameter and 40 cm depth was half filled with heavy clay soils. Characterization of the germplasm was then started at vegetative stage after 30 days of planting on the basis of flower color and thirty other traits. Results indicated that the number of leaves/plant at different days after planting varied significantly and counted the highest in NN 002 (26.0 at 30 DAP, 32.0 at 60 DAP and 29.7 at 90 DAP) and the lowest in NN 012 at 30 DAP (3.0) and 60 DAP (12.7); while at 90 DAP, the lowest was recorded in NN 010 (7.3). Leaf length varied from 8.2 cm (NN 007) to 31.4 cm (NN 008); while, leaf width varied from 7.5 cm (NN 007) to 28.6 cm (NN 002). The shortest time (36 days) to flowering was found in NN 008, conversely NN 011 took the maximum number of days (46) to flowering. Flower diameter ranged from 7.1 to 16.7 cm with the minimum in NN 007 and the maximum in NN 002. In NN 001, flowers were opened at night and closed in the morning; while in others, flower were opened in the early morning and closed either in the afternoon or in the evening. The duration of flowering in the genotypes ranged from 3-4 days. The genotypes NN 007 produced the maximum suckers per plant (13.3); and NN 003, NN 005, NN 008 and NN 009 did not produce any sucker. Flowers with shorter stalk from the base (< 30 cm) in NN 006, NN 007, NN 010, NN 011 and NN 012 can be used for producing flowers in small tub or urn. The genotypes NN 001, NN 002, NN 003, NN 004, NN 007, NN 008, NN 009 and NN 001 produced abundant pollen and they can be used in breeding program for developing more variation through crossing. All the genotypes should be maintained for further evaluation and next year use.

Keywords: Water lily, genotypes, characterization, evaluation, floral biology.

Introduction

Water lily (*Nymphaea nouchali*), commonly known as Shapla in Bengali is an aquatic herbs that grows in wetlands like ponds, beels, haors and lakes all over Bangladesh. There are about 70 species of water lilies around the world (Kamal, 2017). In Bangladesh, we can see only 2-3 Colors of water lilies - white, red

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and blue. The white water lily is the national flower and state symbol of Bangladesh. The crowns of water lilies grow beneath the water, while their leaves and flowers float on the surface. The long, flexible stems allow them to move with water currents and extend out to maximize exposure to sunlight. Water lilies can be divided into two groups: (a) hardy and (b) tropical. Hardy types enter dormancy during cold conditions, but the rootstock survive as long as the water does not freeze solid. They bloom during the day, opening in the morning and closing mid to late afternoon. Tropical water lilies, on the other hand, can not tolerate cold temperatures. They enter dormancy with the onset of winter. They are also distinguishable from hardy water lilies by their leaf morphologies. Tropical flowers can be divided into day blooming or night blooming. Day blooming species will open in the morning and close in the afternoon and have a diverse pallet of colors. Many are also fragrant. Night-blooming water lilies open at dusk and remain open until noon the next day (Anon, 2021).

Although, floriculture has an immense scope and its demand is always rising in Bangladesh but a lots of problems are identified. Among them, the most important are- a) Production technology is still primitive and for this reason it is not possible to obtain high yield and export quality products, b) Present varieties have low demand in export markets and low yield also compared to other neighboring countries, c) Lack of quality planting materials and other inputs and d) Lack of proper post-harvest technologies. Now, if we want to address these problems then we shall have to take research work from initial stages. A genotypes pool will be helpful for developing varieties, standardization of proper production and post-harvest technologies. Presently, the Floriculture Division of BARI is conducting research on flowers and ornamental plants and has been developed 19 varieties of different flower and other ornamental crops (Ara *et al.,* 2010) but no variety of water lily. Selection of better plant type from the collected genotypes can be of immense value for further improvement of this crop. At present, water lily is not cultivated commercially for vegetables as well as for ornamental purposes. There is no suitable variety in our country that can be cultivated in homestead area in a tub or urn; although, some amateur growers are growing in their homestead importing from other countries. It is, therefore considered indispensable to understand variation among genotypes for breeding programs and further research. Hence, the present study on water lily was undertaken.

Materials and Methods

The experiment was conducted at the east nursery of Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Gazipur from July 2020 to June 2021. The experiment was set up in a Randomized Complete Block Design (RCBD) with 3 replications. Rhizomes of genotypes were collected from home and abroad. Six were from different parts of the country, three from Thailand and the rest from China. The collected genotypes were then numbered as: NN 001, NN 002, NN 003, NN 004, NN 005, NN 006, NN 007, NN 008, NN 009, NN 010, NN 011 and NN 012. Earthen tub of around 95 cm upper diameter and 40 cm depth was half filled with heavy clay soils. Then the tub was filled with tap water leaving 5 cm from

the top. Rhizomes of genotypes were planted at a depth of around 5-7 cm on July 10, 2020 by pressing inside the soil so that no part of rhizome was visible from the top. For each genotype, there were 3 rhizomes. One rhizome was planted in one tub and each tub was treated as a single replication. Equal amount of urea, TSP and MoP (each 0.7 g) were mixed with clay soil and a marble like ball was made by pressing with palm. Initially, after emergence of leaves, one ball was applied for each plant by pressing them inside the soil. When the plant growth was vigourous, then 2-3 fertilizer balls were applied in the rhizosphere at 30 days intervals. Additional water was added when the water level was lowered from 5 cm of the top. Algae and snails were removed regularly from the tub as and when needed. Dead leaves and withered flowers along with its stalk were also removed from the bottom. Caterpillars were controlled mechanically. Application of fertilizer was ceased from October to April as the water lily plants underwent dormant in the winter months (Anon, 2021). Different data were collected to characterize the genotypes using knowledge from botany as no descriptor is available for water lily, so far. A panel of 7 member judges (students of BSMRAU) were used to evaluate the fragrance of flowers. The collected data were statistically analyzed and mean separation was done by Duncan's Multiple Range Test (DMRT).

Results and Discussion

Number of leaves per plant at 30 DAP and onwards was found to be varied significantly among the genotypes (Table 1). The highest number of leaves per plant upto 60 DAP was recorded in NN 002 (26.0 at 30 DAP and 32.0 at 60 DAP) and the lowest in NN 012 (3.0 at 30 DAP and 12.7 at 60 DAP). At 90 DAP, although, the highest number of leaves was

Table 1. Comparison of leaf morphology of different water lily genotypes at 30 days interval

Genotypes	Source	No. of leaves		
		30 DAP	60 DAP	90 DAP
NN 001	Local	16.7 c	25.0 bc	24.0 b
NN 002	Local	26.0 a	32.0 a	29.7 a
NN 003	Local	21.3 b	21.3 cd	17.7 c
NN 004	Local	16.3 c	28.0 b	21.7 b
NN 005	Local	15.3 c	23.3 c	17.3 c
NN 006	Local	10.7 d	14.3 fg	13.0 de
NN 007	Thailand	10.7 d	17.3 def	23.7 b
NN 008	Thailand	11.0 d	15.0 efg	14.7 d
NN 009	Thailand	7.3 e	15.7 efg	13.0 de
NN 010	China	5.3 ef	13.0 g	7.3 g
NN 011	China	4.7 f	19.0 de	9.0 fg
NN 012	China	3.0 f	12.7 g	10.7 ef
CV (%)	-	11.4	11.7	9.03

Means followed by same letter(s) in a column do not differ significantly at 5% level by DMRT.

produced in NN 002 (29.7) but the lowest was produced in NN 010 (7.3). Al-Menaie *et al*. (2011) in an earlier study reported to have variation in leaf number per plant in 15 water lily genotypes.

The length of the largest leaf ranged from 8.2 to 31.4 cm and it was the highest in NN 008. While, the lowest length was recorded in NN 007 which was identical to that of NN 006. The diameter of the largest leaf ranged from 7.5 to 28.6 cm being the highest in NN 002, which was identical to that of NN 008 (27.8 cm) (Table 2). Leaf size in the genotypes NN 007 was the smallest (61.5 cm^2), which was similar to that of 75.7 cm^2 in NN 006. Al-Menaie *et. al*. (2011) reported to have the leaf width that ranged from 3.8-10.8 cm in 15 genotypes of water lily. This might be due to the variation in genotypes. Length of the petiole at 60 DAP in the studied genotypes was found to be varied significantly. Petiole length in the locally collected genotypes was comparatively higher than those of exotic genotypes. Length of petiole in a crop like water lily is important as it indicates the habitat of the plant. Water lily with a long petiole can be planted in deep water condition and with short petiole can be reared in shallow water sources like pots, tubs, urns etc. However, the genotypes NN 004 produced the longest petiole and NN 007 produced the shortest (Table 2). Al-Menaie *et. al*. (2011) reported to have the shortest petiole length of 33.7 cm and the longest petiole length of 66.3 cm in 15 studied water lily genotypes which were much more than the studied genotypes. Range of diameter of petiole was 2.3 cm (NN 006) to 7.1 cm (NN 002 and NN 003). The lowest and

Table 2. Comparison of leaf morphology in different water lily genotypes at 60 days after planting

Genotypes	Largest leaf (cm)		Length of petiole (cm)	Diameter of petiole (mm)
	Length	Diameter		
NN 001	28.7 b	18.2 cd	87.7 b	4.7 cd
NN 002	28.9 b	28.6 a	72.6 c	7.1 a
NN 003	21.9 cd	21.6 b	66.0 c	7.1 a
NN 004	22.9 c	20.5 bc	95.2 a	4.5 cd
NN 005	20.3 d	15.7 de	83.2 b	4.4 d
NN 006	9.7 f	7.8 f	48.6 d	2.3 e
NN 007	8.2 f	7.5 f	33.1 f	2.6 e
NN 008	31.4 a	27.8 a	69.7 c	6.6 ab
NN 009	23.6 c	22.6 b	67.3 c	6.7 ab
NN 010	19.6 d	18.2 cd	50.6 d	5.8 bc
NN 011	15.8 e	15.1 e	46.4 de	4.9 cd
NN 012	17.3 e	16.1 de	39.8 ef	5.3 cd
CV%	6.36	8.54	6.74	12.98

Means followed by same letter(s) in a column do not differ significantly at 5% level by DMRT.

identical diameters were recorded in NN 006 and NN 007.

Color of petiole, leaf edge, shape and color of leaf blade in different water lily genotypes are presented in Table 3. Variable petiole color in different genotypes was observed. In five genotypes (NN 001, NN 003, NN 004, NN 008 and NN 011), brown petiole color was observed. Others were either green (NN 007 and NN 009) or grayish brown NN 002 and NN 012) or dark olive green (NN 005) or light olive green (NN 006) or dark brown (NN 010). Leaf edge was either entire (NN 010, NN 011 and NN 012) or dentate or spiny or crenate or wavy. Leaf shape was oval (NN 002, NN 004, NN 005, NN 007, NN 008, NN 009 and NN 010) or ovate (NN 001), round (NN 003 and NN 011) or heart (NN 006 and NN 012) shaped. Chesser and Sink (2020) observed oval shaped leaves in different water lily varieties. Color of upper side of leaf blade was dark green (NN 001, NN 003, NN 004, NN 010 and NN 012) or green (NN 005 and NN 007) or light green (NN 006 and NN 008) or olive green (NN 002). Color of upper side of leaf blade in NN 009 was green with chocolate spot; while in NN 011, color was green with blackish purple spots (Fig. 1). Guruge (2014) recorded light green color in upper side of leaf blade in *Nymphaea nouchali*. Color of lower side of leaf blade was also variable. In most genotypes, color was uniform but in NN 001, NN 004 and NN 011, black or purple spots were observed in lower side of leaf blade (Table 3).

While studying the characteristics of floral bud in different collected genotypes, it was observed that color of flower stalk was green in most genotypes (NN 001, NN 003, NN 005, NN 006, NN 007 and NN 010) deep green in NN 008 and NN 009, pinkish in NN 004 and NN 012, light green in NN 011 and brown in NN 002 (Table 4). Flower bud color was deep green in 5 genotypes (NN 003, NN 005, NN 006, NN 008 and NN 010). Others had either brown (NN 002) or green (NN 009) or light green (NN 004 and NN 012) or light yellow (NN 007) or blackish (NN 011). Although, the flower bud color in NN 001 was green but there were some white streak observed on the buds. Length of flower bud in the genotypes was significantly varied and ranged from 3.2-7.5 cm. The genotype NN 002 produced the longest flower bud (7.5 cm), which was statistically similar to NN 003 (6.8 cm), NN 004 (5.8 cm), NN 008 (6.7 cm), NN 009 (7.0 cm) and significantly differed from other genotypes. Similarly, diameter of flower bud also varied significantly. Flower bud diameter was recorded the highest in NN 009 (2.4 cm) and the lowest in NN 006 (1.1 cm) and NN 007 (1.1 cm).

Flower characteristics of the genotypes are presented in Table 5a and 5b. The genotype NN 011 took the maximum days to flower initiation (46.0 days) followed by NN 002 (43 days), NN 007 (43 days), NN 012 (43 days) and NN 006 (42 days). The genotype NN 008 took the minimum days (36.0). Length of flower stalk from the base in the genotypes also found to be varied significantly. The longest stalk of flower was recorded in NN 002 (47.1 cm), which was statistically similar to NN 003 (44.6 cm), NN 004 (42.3 cm), NN 008 (43.2 cm) and NN 009 (41.8 cm). The shortest flower stalk was measured in NN 012 (18.0 cm), which was collected from China. Generally, it was observed that the Chinese genotypes produced the shortest stalk compared to local

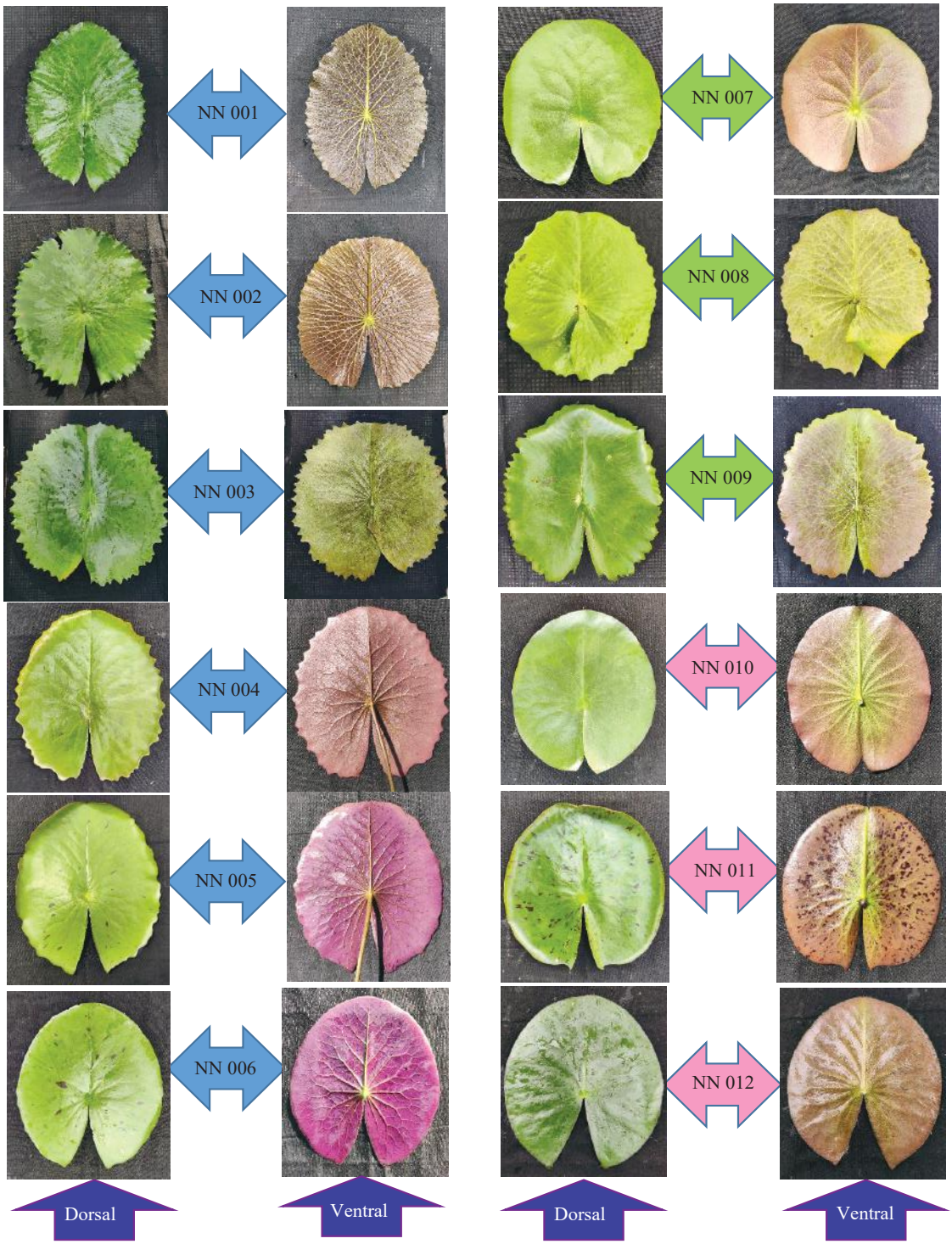

Fig. 1. Leaves of different water lily genotypes.

Table 3. Color of petiole, leaf edge, shape and color of leaf blade in different water lily genotypes

Genotypes	Color of petiole	Leaf edge*	Leaf shape	Color of leaf blade	
				Upper side	Lower side
NN 001	Brown	D	Ovate	Dark green	Olive green with purple spots
NN 002	Grayish brown	D-S-W	Oval	Olive green	Grayish brown
NN 003	Brown	C-D	Round	Dark green	Dark olive
NN 004	Brown	C-W	Oval	Dark green	Greenish chocolate with black spots
NN 005	Dark olive green	C	Oval	Green	Purple
NN 006	Light olive green	E-C	Heart	Light green	Dark purple
NN 007	Green	E-C	Oval	Green	Coffee
NN 008	Brown	C-D	Oval	Light green	Light green
NN 009	Green	C	Oval	Green with chocolate spot	Brown
NN 010	Dark brown	E	Oval	Dark green	Olive green
NN 011	Brown	E	Round	Green with blackish purple spots	Bright olive green with blackish spots
NN 012	Grayish brown	E	Heart	Dark green	Olive green

*E=Entire, D=Dentate, S= Spiny, C= Crenate, W= Wavy.

Table 4. Flower bud characteristics in different water lily genotypes

Genotypes	Color of flower stalk	Color of flower bud	Length of flower bud (cm)	Diameter of flower bud (cm)
NN 001	Green	Green with white streak	5.4 cde	2.3 ab
NN 002	Brown	Brown	7.5 a	2.2 abc
NN 003	Green	Deep green	6.8 abc	2.3 ab
NN 004	Pinkish	Light green	5.8 a-d	1.9 bc
NN 005	Green	Deep green	5.7 bcd	1.9 bc
NN 006	Green	Deep green	3.9 ef	1.1 d
NN 007	Green	Light yellow	3.2 f	1.1 d
NN 008	Deep green	Deep green	6.7 abc	2.2 abc
NN 009	Deep green	Green	7.0 ab	2.4 a
NN 010	Green	Deep green	5.5 bcd	1.9 bc
NN 011	Light green	Blackish	5.6 bcd	2.1 abc
NN 012	Pinkish	Light green	4.8 de	1.8 c
CV%	-	-	11.2	10.1

Means followed by same letter(s) in a column do not differ significantly at 5% level by DMRT.

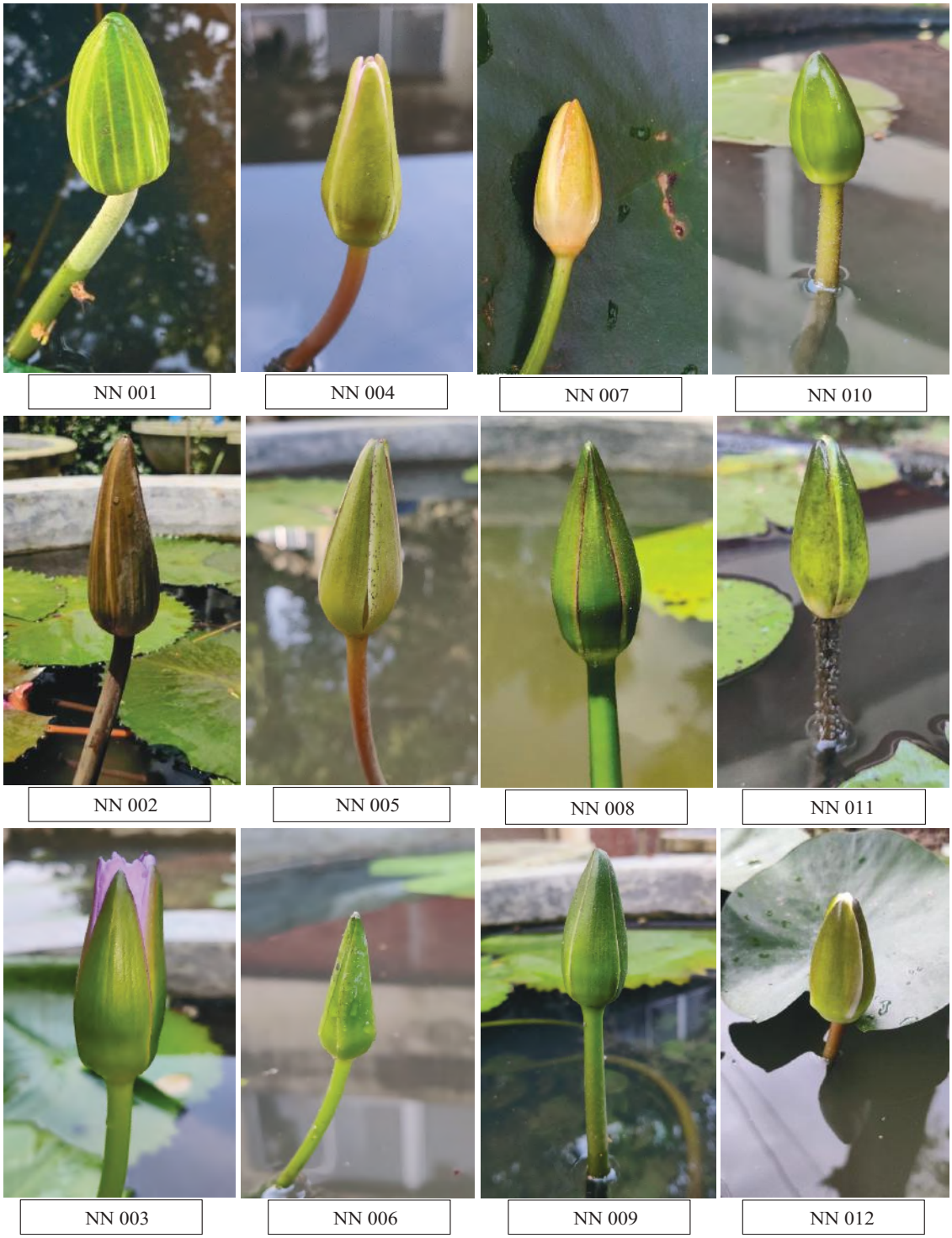

Fig. 2. Flower buds of different water lily genotypes.

and Thai genotypes. Length of flower stalk is important for water lily that depends on use. When the stalk is used for consumption or will be grown in deep water, then the longest stalk is expected. When grown in pots, then shorter stalk is expected. Likewise, length of flower stalk above the water level was also found to be varied in the genotypes. Length of flower stalk above the water level was the highest in NN 002 (22.5 cm), similar to NN 003 (22.4 cm) but significantly differed with rest of the genotypes. Rhizomes collected from China produced flowers very close to water level (3.5 cm from water level in NN 010, 3.9 cm in NN 011 and 1.0 cm in NN 012). Length of flower stalk above the water level is important for visibility of flowers. Flowers, away from water level is more visible than that of closed to the water level. But far away from the water level may be lodged due to strong wind blows. Therefore, about 10-15 cm from the water level may be a good characteristic of flowers in water lily. Although, number of sepal in all genotypes were same (4.0) but number of petals in the genotypes were significantly different (Table 5a). Number of petal in NN 003 was the highest (27.3) and it was statistically similar to NN 010 (26.7) and NN 011 (25.3). The lowest number of petal was counted in NN 006 (9.0). Chesser and Sink (2020) reported to have 8-27 petals in different varieties of water lily, which was in line with present findings. Whereas, Begum *et al.,* (2010) counted petal number in different *Nymphaea* species that ranged from 16.8-22.0. Puripunyavanich *et al*. (2014) reported to have petal number that ranged from 12-24 in 4 species of water lily and in another species, it ranged from 80-181. These inconsistencies might be due to genotypic or environmental variations. Diameter of flowers in the genotypes were also varied significantly

Table 5a. Flower characteristics in different water lily genotypes

Genotypes	Days taken to flowering	Length of flower stalk from the base (cm)	Length of flower stalk above the water level (cm)	No. of sepal	No. of petal	Diameter of flower (cm)
NN 001	41 bc	33.6 c	14.2 bc	4.0	17.7 de	12.0 d
NN 002	43 ab	47.1 a	22.5 a	4.0	16.3 ef	17.6 a
NN 003	39 bcd	44.6 a	22.4 a	4.0	27.3 a	15.7 b
NN 004	40 bcd	42.3 ab	9.8 de	4.0	15.0 f	13.4 cd
NN 005	38 cd	38.7 b	11.7 cd	4.0	14.0 f	10.2 e
NN 006	42 abc	29.7 c	8.3 e	4.0	9.0 g	8.1 fg
NN 007	43 ab	21.8 d	7.6 e	4.0	19.7 cd	7.1 g
NN 008	36 d	43.2 ab	14.4 b	4.0	20.0 cd	14.1 c
NN 009	38 cd	41.8 ab	12.9 bc	4.0	21.3 bc	12.7 cd
NN 010	41 bc	21.9 d	3.5 f	4.0	26.7 a	12.9 cd
NN 011	46 a	23.0 d	3.9 f	4.0	25.3 a	11.8 d
NN 012	43 ab	18.0 d	1.0 g	4.0	22.7 b	9.5 ef
CV%	9.83	8.79	12.92	-	7.17	7.06

Means followed by same letter(s) in a column do not differ significantly at 5% level by DMRT.

that ranged from 7.1- 17.6 cm being the largest in NN 002 (17.6 cm) and significantly differed from rest of the genotypes. Flower diameter was more than 10.0 cm in most genotypes (Table 5a). Begum *et al*., (2010) reported a range of 8.6-19.9 cm flower diameter while studying with 3 *Nymphaea* species. Chesser and Sink (2020) reported to have 6-20 cm diameter in flowers of different water lily varieties. Puripunyavanich *et al*. (2014) measured 7-20 cm bloom diameter in 5 different water lily species; while, Guruge (2014) measured 20-30 cm flower diameter in *Nymphaea nouchalli*.

Diameter of flower stalk significantly differed in different genotypes which ranged from 3.6-9.0 mm. Akkarakultron *et al.* (2014) recorded a range of 13.1-15.6 mm flower stalk diameter while studying with 3 cultivars of water lily. Techapinyawat (2001) stated that different species and even in the same environment might have the ability to produce a different size of flower which depends on the plant itself and external factors also contribute to the promotion and inhibition of flowering. All the genotypes had different flower color. Both genotypes NN 005 and NN 006 had flower color of light lavender blue (Middle blue-purple) but they only differed in flower size (Table 5a). Variation in flower color was reported by many other authors (Puripunyavanich *et al*., 2014; Anonymous,

Table 5b. Characteristics of flower and pollen in different water lily genotypes

Genotypes	Diameter of flower stalk (mm)	Color of flower	Color of anther	Color of pollen	Abundance of pollen	Fragrance of flower
NN 001	6.4 b	White	Off-white with yellow tip	White	Abundant	Light
NN 002	8.6 a	Brick red	Dark red	Off-white	Abundant	Medium
NN 003	9.0 a	Lavender blue	Yellow with blue tip	Yellow	Abundant	Very strong
NN 004	5.8 bc	White with light purple tip	Yellow	Yellow	Abundant	Light
NN 005	4.9 bcd	Light lavender blue (Middle blue-purple)	Yellow with purple tip	Light yellow	Medium	Light
NN 006	4.0 cd	Light lavender blue (Middle blue-purple)	Brown with purple tip	Light Yellow	Less	No
NN 007	3.6 d	Yellow	Dark yellow	Yellow	Abundant	No
NN 008	6.5 b	Pink	Yellow with purple tip	Yellow	Abundant	Strong
NN 009	8.7 a	Deep pink	Yellow with white tip	Yellow	Abundant	Strong
NN 010	5.1 bcd	Whitish magenta	Light brown with yellow tip	Yellow	Abundant	Medium
NN 011	5.3 bcd	Cream	Dark yellow	Yellow	Medium	No
NN 012	6.0 bd	Bright white	Yellow	Yellow	Medium	No
CV%	11.2	-	-	-	-	-

Means followed by same letter(s) in a column do not differ significantly at 5% level by DMRT.

Fig. 3. Flowers of different water lily genotypes.

2020; Chesser and Sink, 2020; Begum *et al*., 2010; Cavett, 2011). Similarly, color of anther in different genotypes was varied. Some was yellow with purple tip (NN 005 and NN 008), some was yellow (NN 004 and NN 012), some was dark yellow (NN 007 and NN 011) and others were variable in color. Color of pollen in most of the genotypes were yellow (NN 003, NN 004, NN 007, NN 008, NN 009, NN 011, NN 011 and NN 012) and others were either white (NN 001) or off-white (NN 002), or light yellow (NN 005 and NN 006). Abundant pollen was observed in most of the genotypes. In three genotypes (NN 005, NN 011 and NN 012) pollen abundance was medium; while, in one genotype (NN 006), the pollen was not abundant. Regarding fragrance of flower, only four genotypes (NN 006, NN 007, NN 011 and NN 012) produced flowers with no fragrance. Very strong fragrance was recorded in NN 003; while, strong fragrance was recorded in NN 008 and NN 009. Flowers in other genotypes had light or medium fragrance (Table 5b). Puripunyavanich *et al*. (2014) reported to have fragrant flowers in four *Nymphaea* species out of five studied species; whereas, Cavett (2011) reported to have fragrance in tropical type water lilies.

Time of flower opening, closing and duration of flowering in different water lily genotypes are presented in Table 6. Flowers in all the genotypes except NN 001 started to open in the morning between 4-30 am to 10-30 am. Flowers of the genotypes NN 001 opened fully at 8-40 pm and it remains fully open till 8-30 am. Then it started to close and within an hour closed fully. Flowers in all genotypes except NN 001 opened fully between 6-30 am to 11-45 am. These flowers started to close between 12-30 pm to 4-15 pm and closed

Table 6. Time of flower opening, closing and duration of flowering in different water lily genotypes

Genotypes	Time to start open flower	Time to full opening of flower	Time to start closing of flower	Time to full closing of flower	Duration of flowering (days)
NN 001	7-30 pm	8-40 pm	8-30 am	9-30 am	4
NN 002	6-45 am	7-35 am	2-30 pm	3-15 pm	4
NN 003	10-30 am	11-45 am	4-15 pm	6-15 pm	3
NN 004	8-35 am	9-25 am	2-30 pm	3-20 pm	4
NN 005	5-45 am	6-50 am	2-40 pm	3-35 pm	4
NN 006	5-30 am	6-35 am	3-00 pm	4-15 pm	4
NN 007	7-30 am	8-15 am	3-30 pm	4-40 pm	3
NN 008	9-30 am	11-00 am	4-00 pm	6-00 pm	3
NN 009	6-30 am	9-00 am	2-00 pm	4-30 pm	3
NN 010	6-30 am	7-30 am	2-00 pm	3-00 pm	3
NN 011	9-35 am	10-50 am	3-10 pm	4-00 pm	3
NN 012	4-30 am	6-30 am	12-30 pm	3-00 pm	3

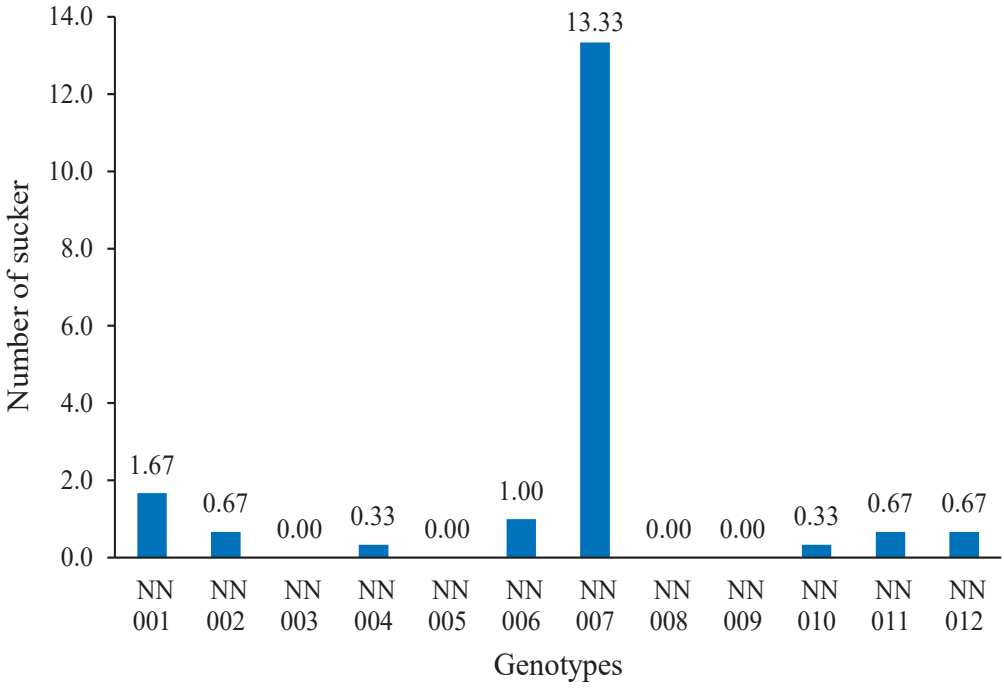

Fig. 4. Number of sucker per plant in different water lily genotypes at 90 DAP.

Table 7. Fruit and seed characteristics in different water lily genotypes

Genotypes	Fruit formation	Color of fruit	Fruit length (cm)	Fruit breadth (cm)	Color of seed
NN 001	Y	Dark green	2.8	2.6	Black
NN 002	Y	Dark brown	2.1	2.2	Black
NN 003	Y	Light green	2.4	2.4	Gray
NN 004	Y	Reddish brown	2.7	4.2	Dark gray
NN 005	N	-	-	-	-
NN 006	Y	Dark green	1.7	1.8	Grayish black
NN 007	N	-	-	-	-
NN 008	Y	Light green	2.6	2.2	Gray
NN 009	Y	Light green	2.4	2.7	Brown
NN 010	N	-	-	-	-
NN 011	N	-	-	-	-
NN 012	N	-	-	-	-

fully between 3-00 pm to 6-15 pm (Table 6). Duration of flowering did not differ much among the genotypes. Duration of flowering was 4 days in the genotypes NN 001, NN 002, NN 004, NN 005 and NN 006; while, in other genotypes the duration of flowering was 3 days. Cavett (2011) discussed the blooming of water lily. He reported that hardy water lilies were opened in the morning and closed in the afternoon, blooming for three to four days. Whereas, tropical water lilies were either day or night bloomers. The night bloomer was opened until late morning. The day bloomer was being just opened when the night bloomer closed.

Regarding sucker production per plant in different genotypes of water lily, it was recorded that four genotypes (NN 003, NN 005, NN 008 and NN 009) did not produce any sucker (Fig. 4). The maximum suckers were produced by the genotype NN 007 (13.33). This implies that the genotype NN 007 is very much suitable for growing in our climatic condition. Moreover, as the plant size is smaller; therefore, it can be grown in bucket or tubs.

Fruit and seed characteristics of different water lily genotypes are presented in Table 7. The genotypes that produced fruits were NN 001, NN 002, NN 003, NN 004, NN 006, NN 008, and NN 009. Fruit color of NN 002 was dark brown; while in NN 004, the fruit color was reddish brown. Fruit color of NN 001 and NN 006 was dark green and in NN 003, NN 008 and NN 009, it was light green (Table 7). Fruit length in the genotypes ranged from 1.7- 2.8 cm and fruit breadth ranged from 1.8- 2.7 cm. The genotypes NN 001 and NN 002 produced seeds with black color; while NN 003 and NN 008 produced gray colored seeds. Dark gray colored seeds were produced by NN 004, grayish black by NN 006 and brown colored seeds by the genotype NN 009 (Table 7).

Conclusion

The studied water lily genotypes were different in flower color as well as other characters. Regarding sucker production, all the genotypes except NN 007 produced sucker less than 2.0%. So, propagation technique of those genotypes needs to be standardized. Length of flower stalk from the base was less than 30 cm in NN 006, NN 007, NN 010, NN 011 and NN 012. These genotypes can be used for producing flowers in small tub or urn. On the other hand, the genotypes NN 002, NN 003, NN 004, NN 008 and NN 009 produced more than 40 cm flower stalk from the base. These genotypes can be evaluated to consume as vegetables. Genotype NN 003 had very strong fragrance with a strong fragrance in NN 008 and NN 009. The genotypes NN 001, NN 002, NN 003, NN 004, NN 007, NN 008, NN 009 and NN 010 produced abundant pollen and they can be used in breeding program for developing more variation through crossing. Hence, all the water lily genotypes should be maintained for further evaluation in the following years.

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