

## CHARACTERIZATION AND EVALUATION OF *LILIUM* IN BANGLADESH

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### Abstract

Thirty-seven genotypes of *Lilium* were collected and evaluated under *Lilium* shade at floriculture Division, Horticulture Research Centre, Bangladesh Agricultural Research Institute, Gazipur during 2017-21 to characterize different species of *Lilium* available in Bangladesh and collected from abroad. Notable variations in different qualitative and quantitative parameters were observed among the 37 genotypes under study. Among them, 31 genotypes were found suitable for cut flowers and six (06) suitable for pot culture. The longest stalk and rachis (94.3 cm and 36.0 cm, respectively) were produced by the genotype Lil-036. The maximum number of florets per stick (10.5) was produced by BARI Lilium-1. The maximum vase life was observed in Lil-007 and BARI Lilium-2 (11.0 days), whereas the minimum in Lil-022 and Lil-026 (5.0 days). The heaviest and the largest bulbs were produced by the genotype Lil-036 (72.4 g) and (6.6 cm) respectively. Considering the length of stalk and rachis, number of florets per stick, duration of vase life, average bulb weight, the genotypes, Lil-018, Lil-021, Lil-034, Lil-035 and Lil-036 were selected for further evaluation.

Keywords: *Lilium*, Cut Flower, Bangladesh, Asiatic Lilium, Oriental Lilium.

### Introduction

*Lilium* (*Lilium* sp.) belongs to the Liliaceae family, has a high demand in the international flower trade. Commercially it is grown as a cut flower for its long-lasting (12-15 days) form with a wide range of colors and assortment. This lucrative flower has recently been introduced in Bangladesh due to its high demand and profitability. Among different types of *Lilium*, the Asiatic and Oriental hybrids have attractive flowers of different hues. Farmers are immensely keen on cultivating this flower. Mostly the northern region of Bangladesh has suitable climate condition for *Lilium* cultivation. One of the core constraints of *Lilium* flower cultivation in Bangladesh is the unavailability of *Lilium* bulbs during the growing season. To meet up the local demand, this flower is being imported to Bangladesh from other countries, especially from China and India. The imported bulb costs about Tk. 60-80 per bulb which is relatively a high value for our flower growers. If the bulb of this flower could be provided by the local market, more flower production would be possible and the price of the bulb

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would also be reduced. For this, the quality bulb should be produced locally. Furthermore, for the improvement of this flower species, diverse genetic resources should be collected. A wide diversity of *Lilium* resources will provide valuable genes for the breeding of novel varieties. Although flower growers in Bangladesh are cultivating this flower, there is a growing demand for new varieties with high attractiveness and productivity.

Considering this viewpoint, it is indispensable to collect *Lilium* germplasm and evaluate them for standardizing the production technology under the climatic conditions of Bangladesh. Therefore, the present experiment was undertaken to collect to characterize them different species of *Lilium* available in Bangladesh and also from abroad and to conserve the collected germplasm for future research.

### **Materials and Methods**

The present investigation was carried out at the Floriculture Research Field of HRC, BARI, Gazipur during the *rabi* season of 2017-21. The prevailing average temperature of the growing season ranges from 20-26°C and humidity was 87-89%. During this period, two genotypes were released as varieties viz. BARI Lilium-1 and BARI Lilium-2. In this study 37 *Lilium* germplasm were used as treatments, along with BARI Lilium-1 and BARI Lilium-2 as control. Bulbs were planted under the shade houses made of UV poly film and agro-shade net from mid-October to mid-November of each year. The experimental land was well prepared by adding coco-dust (50:50 soil and coco-dust) and 10 t cow dung /ha. Chemical fertilizers were not applied up to 3 weeks of bulb planting. After 3 weeks of bulb planting, NPK @ 30:20:20g/m<sup>2</sup> was applied. Urea and MoP @ 100 kg/ha were top-dressed before the spike initiation stage and bulb lifting, respectively. No design was followed and spacing was maintained at 20 cm from row to row and 15 cm from plant to plant. When the lowermost buds showed color, the spikes were harvested. After collecting flowers, the plants keeping 25-30 cm stem were kept in the field for bulb development. Observations on various growth parameters were recorded after one month of planting bulbs. Before flower opening, vegetative parameters like plant height (cm), number of leaves, days to bud initiation were recorded. The height of the plant was recorded by measuring the length from the base of the rachis of the plant. Floral parameters were also recorded which included: spike length (cm), rachis length (cm), bud length (cm), bud diameter (cm), number of flowers per plant, flower diameter (cm), and vase life. When the leaves were brown and more or less damaged, the bulbs were lifted carefully and stored at 2.1-2.5°C temperature with media containing coco-dust for future planting.

### **Results and Discussion**

Wide variations in terms of qualitative parameters were observed (Table 1 & 2). Among the collected *Lilium* germplasm, 37 attractive colored and two types of flowers viz. Asiatic types and Oriental types have been found. There are 31

germplasms suitable for cut flowers and 6 germplasms suitable for pot culture among them. Attractive colors and variations were found in *Lilium* petals and tepals. Various spots were originated by the tepals of 19 *Lilium* genotypes and 18 genotypes did not show any spot in the tepal. Banba (1967) conducted an experiment where most *Lilium* hybrids had spots on their tepals due to the presence of anthocyanin. Regarding fragrance, Oriental type *Lilium* produces highly scented flowers whereas Asiatic *Lilium* has no fragrance. Each species in the genus *Lilium* possess great genetic diversity in its growth habit, flower color, form, shape, size, and as well as in persistence. This diversity in species of agronomic traits offers substantial germplasm and opportunities for the development of hardy and healthy varieties for variable climatic zones (Anderson *et al.*, 2010).

**Table 1. Qualitative traits of some *Lilium* genotypes as cut flower**

Genotypes	Types	Petal description	Anther color	Fragrance
BARI Lilium-1	Asiatic	Creamy white, greenish yellow midrib and sporadic dark spots are present at the base of the petal	Deep maroon	Absent
BARI Lilium-2	Asiatic	Yellow, no spots are present	Deep brown	Absent
Lil-002	Asiatic	Light orange, deep orange midrib is present at the base of the petal	Deep maroon	Absent
Lil-003	Asiatic	Deep orange, dark spots are present at the base of petal	Maroon	Absent
Lil-004	Asiatic	Deep Magenta	Brown	Absent
Lil-007	Asiatic	Deep orange, numerous dark spots are present at the base of the petal	Deep maroon	Absent
Lil-008	Asiatic	Reddish magenta, few dark spots are present at the base of the petal	Deep maroon	Absent
Lil-011	Asiatic	Pink at petal tips, burnt orange in the lower half of the petals and yellow in the center with some dark spots.	Deep maroon	Absent
Lil-012	Asiatic	Light orange, no spots are present	Deep maroon	Absent
Lil-014	Oriental	White curly petals, no spots are present	Deep maroon	Present
Lil-016	Asiatic	Greenish cream, green mid rib and few maroon spots are present at the base of the petal	Maroon	Absent
Lil-017	Oriental	White centered deep pink curvy petals surrounded by white color, no spots are available	Deep maroon	Present
Lil-018	Oriental	White broad petals, no spots are present	Maroon	Present

**Table 1. Cont'd**

Genotypes	Types	Petal description	Anther color	Fragrance
Lil-019	Oriental	Light pink curvy petals surrounded by white color, numerous dark spots are present at the base of the petal	Orange	Present
Lil-020	Oriental	Pink curvy petals surrounded by white color. Deep pink mid rib and numerous hairy spots are present	Maroon	Present
Lil-021	Asiatic	Pinkish maroon, few dark spots are present	Deep maroon	Absent
Lili-022	Asiatic	White petal surrounded by violet narrow markings. Numerous maroon spots are present at the base of petal	Deep maroon	Absent
Lil-023	Asiatic	Light orange with a glassy appearance. No spots are present	Maroon	Absent
Lil-024	Asiatic	Deep blackish maroon with a glassy appearance. Few black spots are present at the base of petals	Orange	Absent
Lil-025	Asiatic	Light yellow. No spots are present	Orange	Absent
Lil-026	Asiatic	Deep orange with a glassy appearance. No spots are present	Maroon	Absent
Lil-027	Asiatic	Pink with a glassy appearance. No spots are present	Maroon	Absent
Lil-028	Asiatic	Light maroon. Few spots are present at the base of the petals	Orange	Absent
Lil-029	Asiatic	Bright yellow, no spots are present	Deep maroon	Absent
Lil-031	Oriental	Pinkish white petal with numerous white hairy appearance at the base, no spots are present	Deep Orange	Present
Lil-032	Asiatic	Light maroon colored long petal with few dark spots at the base	Deep maroon	Absent
Lil-033	Oriental	Pink petals with some hairy appearance at the base and no spots are present	Deep Orange	Present
Lil-034	Oriental	Snow white colored petal along with slight greenish appearance at the base with no spots	Deep maroon	Present
Lil-035	Asiatic	Deep pink petal with whitish appearance at the base of the petal and few dark spots are present	Maroon	Absent

**Table 1. Cont'd**

Genotypes	Types	Petal description	Anther color	Fragrance
Lil-036	Oriental	Drooping type light pink curvy petals surrounded by white color along with whitish appearance at the base of the petal with no dark spots	Deep maroon	Present
Lil-037	Oriental	Snow white colored with some hairy appearance at the base of the petal and tinted with pink color on whole petal and no spots are present	Yellowish orange	Present

**Table 2. Qualitative traits of *Lilium* genotypes as pot plant**

Genotypes	Types	Petal description	Anther color	Fragrance
Lil-005	Asiatic	White, numerous pinkish red spots are present at the base of petal	Orange	Absent
Lil-006	Asiatic	Orange, numerous dark spots are present in the petal	Deep maroon	Absent
Lil-009	Asiatic	Orange, dark spots are present at the base of the petal	Deep maroon	Absent
Lil-013	Oriental	Deep magenta pink petals around a white center with dark spots	Deep orange	Present
Lil-015	Oriental	Thick white petals, white hair are present but no spots are available	Maroon	Present
Lil-030	Asiatic	Light orange petals with reddish spot	Maroon	Absent

Various growth and flowering parameters were influenced by the *Lilium* genotypes (Table 3) as cut flower. The longest plant (82.9 cm) was produced by the genotype Lil-034 and the shortest in Lil-016 (32.8 cm). Balode (2010) also reported the higher phenotypic variability for plant height in *Lilium* genotypes. The maximum number of leaves was recorded in Lil-022 (74.3) and the minimum in Lil-033 (35.2). Variation in the vegetative parameters of Asiatic *Lilium* was also reported similarly by Pandey *et al.* (2008); Deka *et al.* (2010) and Sindhu *et al.* (2012). Differences in vegetative growth characters of different growth cultivars may be due to varied growth rate and their genetic makeup as a result, variations in phenotypic expression occur (Sankari *et al.* 2020). Similar results with vegetative characters were also reported by Mishra (1997). The minimum days were required for bud initiation after planting in Lil-017 and Lil-019 (26.0 days) whereas the maximum days in BARI *Lilium*-1(55.0 days). The findings of the present study are in close agreement with Dhiman (2003) and Sindhu *et al.* (2012) who observed significant variation among *Lilium*. The variation in the number of days taken for

flowering was primarily due to the genetic constitution of various cultivars and prevailing environmental conditions during the period of crop growth (Sankari *et al.*, 2020).

The longest and the broadest bud were produced by the genotype Lil-037 (13.2 cm) and Lil-014 (3.7 cm), respectively. The shortest and the narrowest bud were produced by the genotype Lil-003 (8.0 cm) and Lil-035 (2.3 cm), respectively.

The stalk length which is another important quality parameter significantly varied among Asiatic cultivars. The cost of a flower stalk is determined mostly by the number of florets per stalk. It is an important flowering characteristic for *Lilium* production as a cut flower. Variations were observed in case of flowering parameters of *Lilium* genotypes as cut flower (Table 3). The longest stalk and rachis (94.3 cm and 36.0 cm, respectively) were produced by the genotype Lil-036. The shortest stalk was produced by Lil-004 (30.0 cm) and minimum rachis length was found in Lil-016 (11.5 cm). Such varietal differences for sprouting have been also reported by Sindhu (2006).

The maximum number of florets per stalk (11.0) was produced by BARI *Lilium*-1 and the minimum number of florets in Lil-031 (1.6). The result corroborates with the findings of Deka *et al.* (2010), Srinivas (2002) and Srinivas (2003) who reported similar variation among *Lilium* cultivars concerning this parameter. Wide variation in floral parameters due to varieties has also been reported by Dhiman (2003).

The size of flowers also contributes to the quality of the flowering shoot and bigger buds on flowering stalks are always preferred (Sankari *et al.*, 2020). The largest flower was produced by Lil-036 (24.5 cm) and the size of the flower was minimum in Lil-004 (14.5 cm). Similar performance was found by De Hertogh (1996) where flower diameter ranged from 13.8 cm to 20.2 cm among some *Lilium* varieties and significantly large-sized flowers were recorded in Stargazer (20.6 cm) followed by Prato (20.2 cm) and PKLH-1 (19.3 cm) which could serve as a varietal trait. The vase life was recorded only for cut flowers, not for pot plants. The maximum vase life was observed in Lil-007 and BARI *Lilium*-2 (11.0 days) whereas the minimum was in Lil-022 and Lil-026 (5.0 days).

In case of pot plant (Table 4), maximum plant height was found in Lil-030 (24.0 cm) and the minimum in Lil-015 (10.2 cm). Maximum leaves were produced by Lil-005 (48.0) and minimum leaves in Lil-015 (24.0). Lil-006 took minimum days (27.0) whereas Lil-030 took maximum days (82.0) for bud initiation. The longest and broadest bud was produced by Lil-013 (9.3 cm and 3.3cm, respectively) and shortest and narrowest bud in Lil-030 (5.0 cm and 1.5 cm, respectively).

Table 3. Vegetative and flowering parameters of different *Lilium* genotypes as cut flower

Genotypes	Plant height (cm)	No. of leaves/plant	Days to bud initiation	Bud length (cm)	Bud diameter (cm)	Stalk length (cm)	Rachis length (cm)	No. of florets/stick	Floret diameter (cm)	Vase life (days)
BARI Liliium-1	73.6	67.0	55.0	10.4	3.3	80.0	26.0	11.0	17.0	10.0
BARI Liliium-2	50.1	64.0	33.0	9.9	2.7	60.0	18.5	7.5	20.0	11.0
Lil-002	43.0	40.0	45.0	10.5	3.2	48.0	14.0	2.0	17.0	7.0
Lil-003	33.0	45.0	37.0	8.0	2.5	35.0	14.0	4.0	15.0	8.0
Lil-004	34.0	48.0	45.0	7.5	2.7	30.0	14.0	4.0	14.5	7.0
Lil-007	34.2	70.0	30.0	8.4	2.5	46.0	17.7	4.0	16.7	11.0
Lil-008	43.4	70.0	27.0	7.9	2.7	50.0	17.1	4.4	19.0	8.0
Lil-011	45.1	65.0	30.0	8.5	2.4	46.0	15.5	4.6	18.1	10.0
Lil-012	46.0	60.0	32.0	8.9	2.5	55.0	16.9	2.0	21.5	8.0
Lil-014	36.6	37.0	37.0	11.4	3.7	36.2	12.7	4.0	21.9	8.0
Lil-016	32.8	48.0	34.0	8.8	2.5	31.8	11.5	2.0	20.1	6.0
Lil-017	39.1	51.0	26.0	12.0	3.5	73.3	20.5	3.0	21.2	8.0
Lil-018	48.4	37.0	27.0	10.7	2.9	85.8	23.8	4.0	21.6	7.0
Lil-019	40.2	36.0	26.0	9.7	3.3	70.4	20.8	3.0	20.1	6.0
Lil-020	67.8	36.6	33.0	12.2	3.1	36.5	16.3	2.3	24.0	6.0
Lil-021	53.9	54.0	35.0	9.6	2.7	36.0	29.3	7.2	20.8	6.0
Lil-022	76.0	74.3	32.0	9.6	2.9	55.4	27.3	3.8	20.0	5.0
Lil-023	44.0	55.5	36.0	9.8	2.7	29.4	15.9	2.0	18.0	6.5
Lil-024	60.4	48.0	35.0	9.8	2.7	42.5	20.3	4.8	21.1	5.5

**Table 3. Cont'd.**

Genotypes	Plant height (cm)	No. of leaves/plant	Days to bud initiation	Bud length (cm)	Bud diameter (cm)	Stalk length (cm)	Rachis length (cm)	No. of florets/stick	Floret diameter (cm)	Vase life (days)
Lil-025	48.4	53.0	35.0	9.1	2.4	35.5	25.9	7.0	18.7	6.0
Lil-026	51.2	54.0	34.0	10.1	2.5	41.1	31.9	6.4	20.1	5.0
Lil-027	65.3	80.0	33.0	9.9	2.7	46.8	27.1	3.6	21.7	5.5
Lil-028	58.4	58.2	32.0	9.9	2.6	33.4	14.3	3.2	19.9	6.0
Lil-029	67.1	51.5	34.0	10.7	3.5	48.0	21.1	3.4	20.7	6.5
Lil-031	49.3	35.6	45.0	10.3	3.1	45.5	16.6	1.6	18.0	7.0
Lil-032	61.9	59.1	36.0	9.16	2.9	58.7	18.5	2.6	18.0	8.5
Lil-033	51.0	35.2	46.0	12.5	3.5	48.6	19.5	2.0	18.5	8.0
Lil-034	82.9	58.1	37.0	11.8	3.4	92.2	26.8	3.5	23.5	9.5
Lil-035	65.6	56.4	46.0	8.5	2.3	79.8	17.5	3.0	18.5	7.5
Lil-036	76.9	56.1	38.0	12.7	3.1	94.3	36.0	3.9	24.5	6.0
Lil-037	62.8	53.7	35.0	13.2	3.1	55.0	21.7	4.5	21.0	7.5
Mean	53.0	53.4	35.6	10.0	2.9	52.4	20.3	4.0	19.7	7.3
STD	14.1	12.0	6.67	1.4	0.3	18.7	6.02	2.0	2.3	1.6
CV (%)	26.7	22.6	18.6	14.6	13.3	35.6	29.6	50.1	12.0	22.5



Table 4. Vegetative and flowering parameters of different *Lilium* genotypes as pot plant

Genotypes	Plant height (cm)	No. of leaves/plant	Days to bud initiation	Bud length (cm)	Bud diameter (cm)	Stalk length (cm)	Rachis length (cm)	Florets/stick	Floret diameter (cm)
Lil-005	15.5	48.0	52.0	5.9	2.1	19.0	8.5	4.0	12.60
Lil-006	16.6	41.0	27.0	5.7	2.0	19.0	7.6	2.0	13.40
Lil-009	16.8	45.0	30.0	6.5	2.	18.0	7.5	2.0	13.6
Lil-013	18.6	33.0	52.0	9.3	3.3	20.8	9.6	3.0	17.6
Lil-015	10.2	24.0	40.0	6.4	2.6	28.9	10.0	4.3	14.3
Lil-030	24.0	40.0	82.0	5.0	1.5	36.0	10.0	3.0	8.0
Mean	19.7	44.0	67	5.4	1.8	27.5	9.2	3.5	10.3
STD	6.01	5.6	21.2	0.6	0.4	6.01	0.5	0.3	1.6
CV (%)	30.4	12.8	31.6	12.6	26.1	21.8	5.4	10.1	15.7

The genotypes that are suitable as pot plants (Table 4) produced comparatively shorter stalk (18.0cm to 36.0 cm) and rachis (7.5 cm to 10.0 cm). The maximum number of florets was produced by Lil-015 (4.3) while the minimum in Lil-006 and Lil-009 (2.0). Lil-013 had the largest floret diameter (17.65 cm), while Lil-030 had the smallest (8.0 cm). Sheikh *et al.* (2015) also reported that a wide range of variation was found regarding spike and rachis length (54.0-74.5 cm and 14.9-17.4cm, respectively) and also florets number per flower stick (3.0-8.7).

Like vegetative and flowering parameters, bulb and bulblet production were also influenced by the various *Lilium* genotypes (Table 5). The maximum bulb weight (72.4 g) was found in the genotypes Lil-036 while the minimum bulb weight (15.3g) in Lil-002. Similarly, Lil-036 also produced the largest bulb (6.6c m). The maximum number and weight of bulblet per plant were produced by Lil-009 (8.0 and 12.0 g, respectively) and the minimum in Lil-013 (2.4 g) and Lil-035 (1.2 g) respectively. Similarly, wide variation was also observed by Sheikh *et al.* (2015) who reported that all *Lilium* genotypes produced 1.0 daughter bulb per bulb and the range of bulblet production was 3.30-22.30 per bulb. Significant differences in the various bulb and bulblet characteristics of Asiatic *Lilium* cultivars were also reported by Sindhu (2006) and Deka *et al.* (2010). Noticeable differences among the cultivars of Asiatic lily and the cultivars of Oriental lily for all the characters studied were also reported by Gupta (2002) and Gupta (2003).

**Table 5. Bulb and bulb-let production influenced by *Lilium* genotypes**

Genotypes	Single bulb wt. (g)	Bulb diameter (cm)	Bulb-let no./plant	Bulb-let wt./plant (g)
BARI Lilium-1	16.2	3.4	4.0	5.6
BARI Lilium-2	30.0	4.5	3.0	2.3
Lil-002	15.3	3.5	3.0	1.9
Lil-003	18.9	4.0	5.0	2.6
Lil-004	20.0	4.5	4.0	3.4
Lil-005	20.0	3.6	7.0	10.0
Lil-006	40.5	4.7	4.0	5.0
Lil-007	60.0	6.0	5.4	2.4
Lil-008	34.0	4.8	4.3	2.8
Lil-009	30.0	4.0	8.0	12.0
Lil-011	38.0	4.7	4.3	2.8
Lil-012	60.0	5.5	4.0	3.2
Lil-013	49.0	4.9	2.4	1.6
Lil-014	26.0	4.6	3.0	3.0
Lil-015	50.0	5.3	3.6	7.5
Lil-016	33.0	4.8	4.5	6.0

**Table 5. Cont'd.**

Genotypes	Single bulb wt. (g)	Bulb diameter (cm)	Bulb-let no./plant	Bulb-let wt./plant (g)
Lil-017	40.0	5.3	6.0	5.5
Lil-018	48.0	5.6	2.6	1.7
Lil-019	48.0	5.3	3.8	2.1
Lil-020	25.0	3.6	2.7	2.5
Lil-021	22.0	3.9	2.5	2.2
Lil-022	40.6	5.3	3.6	3.1
Lil-023	22.8	3.7	4.0	3.7
Lil-024	53.8	5.1	4.5	3.8
Lil-025	30.8	4.3	3.0	3.5
Lil-026	23.6	3.5	3.5	4.1
Lil-027	27.2	3.9	4.1	4.5
Lil-028	26.2	3.7	2.9	3.0
Lil-029	40.4	5.3	3.0	3.2
Lil-030	25.0	3.4	3.2	3.0
Lil-031	38.4	4.6	3.6	3.2
Lil-032	28.6	5.2	3.4	3.1
Lil-033	46.5	5.4	2.6	3.1
Lil-034	36.5	4.4	4.3	4.3
Lil-035	44.4	5.9	3.5	1.2
Lil-036	72.4	6.6	5.5	2.1
Lil-037	40.8	5.2	2.5	2.3
Mean	28.5	4.3	3.2	3.9
STD	17.3	1.2	1.0	2.3
CV (%)	60.8	29.1	32.6	58.0

### Conclusion

*Lilium* genotypes exhibited wide-range variations in all qualitative and quantitative parameters considered. After evaluating the performance of collected genotypes, two varieties (BARI *Lilium*-1 and BARI *Lilium*-2) have been released in 2020 for their noticeable productivity and attractiveness. Considering the length of stalk and rachis, number of florets per stick, duration of vase life, average bulb weight of the genotypes, Lil-018, Lil-021, Lil-034, Lil-035 and Lil-036 were selected for further evaluation. Subsequently, with the collection and evaluation procedure, conservation of these germplasm should be a vital concern for *Lilium* researchers and the proper bulb preservation techniques are indispensable to preserve these bulbs for the next season. Equal emphasis should be given to quick multiplication through tissue culture to meet the intensifying demand of this flower species in the local market of Bangladesh.

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