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Growth and flowering responses of Lisianthus to different plant spacing

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ABSTRACT

A field experiment was accomplished at the Horticulture farm of Sher-e-Bangla Agricultural University to study the effect of different plant spacing on the growth and flowering of Lisianthus (variety-SAU Blue Nandini). Plant Spacings viz. S_1= 30 cm x 15 cm (BARI recommended for Gerbera), S_2= 30 cm x 20 cm, S_3= 30 cm x 25 cm were used in this experiment arranged in a Randomized Complete Block Design with three replications. Data on different growth and flower yield attribute parameters were taken in which all the treatments showed significant variations. The results showed that applied spacing significantly affected growth and flowering attributes positively. Tallest plants (75.9 cm), the maximum number of leaves (68.7), leaf length (6.0 cm), highest SPAD value (51.0), highest stem length (58.4 cm) and maximum stem diameter (5.3 mm), highest peduncle length (12.6 cm), maximum stem number per plant (6.5), flower number per plant (42.3) was found from (S_3) whereas minimum in (S_1). The study showed that higher spacing application would be the potential for commercial Lisianthus production among all these.

Key Words*: Nandini, Eustoma grandiflorum, Growth and Quality flower.*

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I. Introduction

Lisianthus is a beautiful eye soothing cut flower. It belongs to the family Gentianaceae, which is originated in the Rocky Mountains (eastern slope), USA (Halevy and Kofranek, 1984). *Eustoma grandiflorum* is the scientific name of this flower which Bengali name is Nandini. It's a trendy new cut flower in Bangladesh. It is a perennial herbaceous ornamental species with big and attractive flowers, long stalks, and long duration in vases. It also has standard leaves, hard stems and petals with thousands of colors. Day by day, demand for this flower is increasing among the people. Bangladesh often has to import them from other countries like Japan, China and India. However, in Bangladesh, there is no recommended technology for Lisianthus production. Specially, optimum plant spacings are still unknown for commercial Lisianthus flower production.

Plant spacing is crucial for cultivating flowers to maximize flower growth, yield, quality and quantity. Plant spacing can influence crop productivity and quality (Langton et al., 1999). Spacing between plants is crucial for the maximize flower production. In the cut flower industry, the most important aspects are maximum production of good quality cut flowers to fetch more market prices. Plant spacing plays an important role in obtaining better vegetative growth, increasing the yield, and better qualities of flowers. Some research has been carried out in Lisianthus regarding plant spacing; hence, sufficient information on different agro-techniques followed in this crop as a cut flower is unavailable. In Bangladesh, no research has been conducted to determine the optimum plant spacing, so flower growers in our country still face problems producing large number and standard quality flowers. Number of flowers and flowering attributes produced per plot was affected by plant spacing and the performance of cut flower crops is greatly influenced by spacing (Bijimol and Singh (2000)). Spacing has been found to influence growth, flowering and yield of daughter bulbs in gladiolus (Swetha et al., 2018). Plant population affects crop yield by imposing competition among plants for nutrients, moisture, sunlight and other growth sources. Plants won't have to fight with one another for resources if they are placed far apart. The yield for the entire field of plants may still be poor if they are spaced too widely apart even if they may generate better yields per plant than plants that are more crowded. The ideal spacing aids in not only achieving high-quality cut flowers but also in improved land usage, preserving soil moisture, weed control and the availability of nutrients necessary for subsequent crop production and quality. (Sanjib et al., 2002). Keeping this in view, this study aims to determine the optimum plant spacings for growth and quality flowering of Lisianthus production in Bangladesh.

II. Materials and Methods

The experiment was conducted at the Horticulture Farm, Sher-e-Bangla Agricultural University, Dhaka, to study the performance of growth and flowering of Nandini (Lisianthus) to different plant spacing. The Location of the site is $23^0 74'$ N latitude and $90^0 35'$ E longitudes with an elevation of 8.2 meters from sea level (Anon., 1989) in Agro-Ecological Zone of Madhupur Tract (AEZ No. 28). Seeds of Lisianthus (variety-SAU Blue Nandini) were used in this experiment and seeds were collected from Takii Seed Co., Japan. The seeds were sown in 200 holes plug trays filled with growth medium and placed in Plant factory (growth chamber). Required care for proper development of seedlings was taken and 70 days old seedlings (with 2-3 pairs of true leaves) were taken for transplanting into the field.

The field experiment was accomplished with three replications following Randomized Complete Block Design (RCBD). This study was conducted with three different spacings: S_1 = 30 cm x 15 cm, S_2 = 30 cm x 20 cm, S_3 = 30 cm x 25 cm (BARI recommendation spacing for gerbera). Data have been collected based on three attributes: growth related parameters, yield attributing parameters and quality attributes parameters. All the data recorded for different parameters were statistically analyzed using Statistix-10 scientific analysis software to determine the significance of variation among the treatments and treatment means were compared by LSD test at 5% probability.

III. Results and Discussion

Growth parameters

Plant height: Statistically significant variation in plant height of Lisianthus was shown due to different plant spacing at 30, 45, 65, 75 and 90 DAT (Figure 01). At different days after transplanting (DAT) the tallest plant (23.0 cm, 38.2 cm, 52.5 cm, 64.7 cm and 75.9 cm at 30, 45, 65, 75 and 90 DAT respectively) was recorded from S_3 (30 cm × 25 cm). On the other hand, the shortest plant (19.3 cm, 33.9 cm, 46.5 cm, 60.7 cm and 70.6 cm at 30, 45, 65, 75 and 90 DAT, respectively) was found from S_1 (30 cm × 15 cm). The results could be due to elongation of cells and the number of cells from cell division. A similar observation has been reported in other research by Gaire et al. (2020) on chrysanthemum (Karavadia and Dhaduk 2002) and tuberose (Mane et al., 2007). It may be due to intra-plant competition for light, moisture, space, nutrients and aeration, where more plant spacing has less competition and influences plant height. Bijimol and Singh (2000) reported that the plant height of gladiolus flower positively impacted the optimum plant spacing. The results revealed that optimum plant spacing ensured maximum plant height with plant growth.

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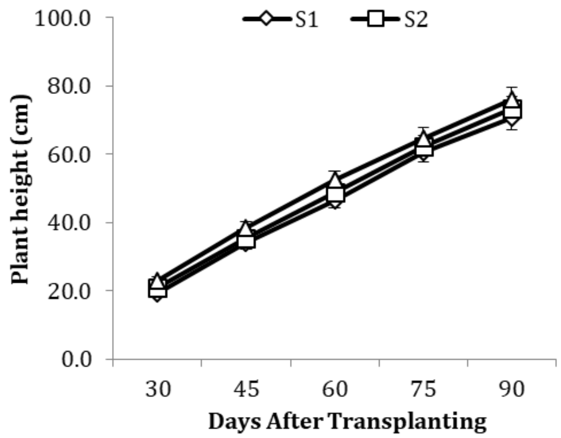

Figure 01. Effect of different spacing on plant height (cm) at different days after transplanting

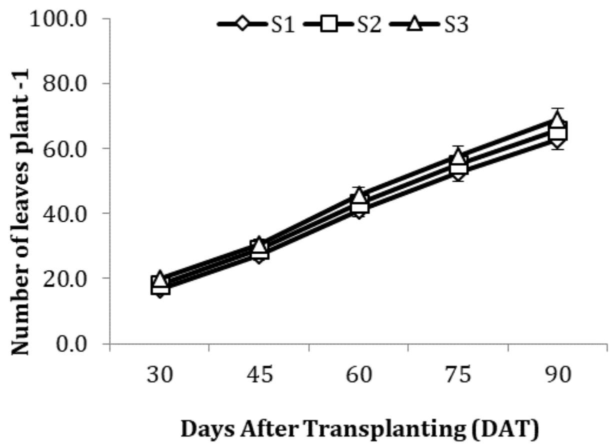

Figure 02. Effect of different spacing on number of leaves per plant of Lisianthus at different days after transplanting

Number of leaves per plant: Effect of plant spacing showed significant difference among the treatment in terms of number of leaves per plant of Lisianthus on different days after transplanting (Figure 02). The maximum number of leaves per plant (19.8, 30.6, 45.8, 57.7 and 68.7 at 30, 45, 65, 75 and 90 DAT, respectively) was obtained from S_3 (30 cm × 25 cm). At the same condition, the minimum number of leaves per plant (16.8, 27.1, 41.1, 52.6 and 62.6 at 30, 45, 65, 75 and 90 DAT, respectively) was recorded from S_1 (30 cm × 15 cm). It was revealed that as plant spacing rose, so did the number of leaves on each plant. Enough room to expand both vertically and horizontally at the ideal spacing, which produces more leaves per plant overall than closer spacing. Similar findings were previously reported by Steingrobe and Schenk (1994).

Leaf length: Leaf length of Lisianthus was significantly varied among different spacing treatment (Figure 03). The highest leaf length (6.0 cm) was observed from S_3 (30 cm × 25 cm) and the lowest leaf length (5.4 cm) was recorded from S_1 (30 cm × 15 cm). It was revealed that with the increases in spacing, leaf length showed an increasing trend. In case of closer spacing plant compete for light and for the time being, leaf length decreases. Kumar et al. (2001) observed that growth of Lisianthus plant varied with different spacing.

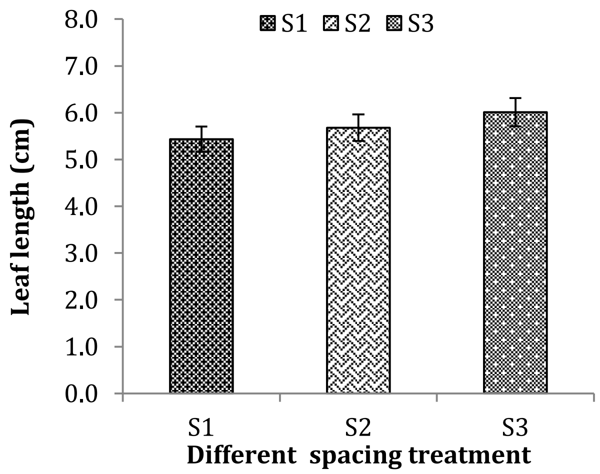

Figure 03. Effect of different spacing on on leaf length of Lisianthus (Here, S_1: 30 cm × 15 cm; S_2: 30 cm × 20 cm and S_3: 30 cm × 25 cm)

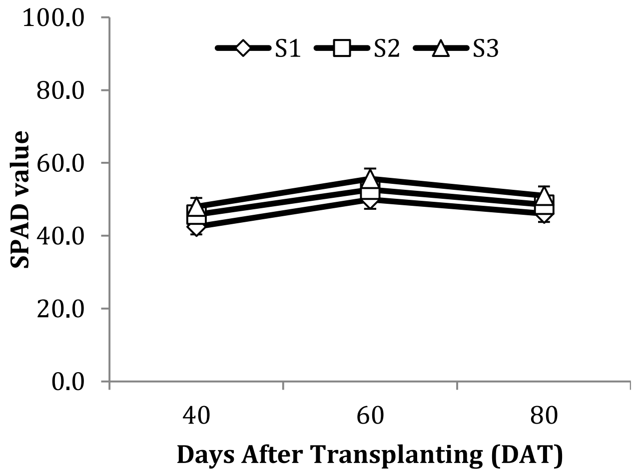

Figure 04. Effect of different spacing on SPAD value of leaves on different days after transplanting (Here, S_1: 30 cm × 15 cm; S_2: 30 cm × 20 cm and S_3: 30 cm × 25 cm)

SPAD Value: Chlorophyll enhances the growth of a plant which is correlated with plant growth. In different spacing treatments, SPAD value of leaves showed significant variation (Figure 04). Maximum SPAD value (47.9, 55.6 and 51.0) was found at 40, 60 and 80 DAT from treatment S_3 and minimum (42.4, 49.9 and 46.0) were observed at 40, 60 and 80 DAT in S_1 (Figure 04). Effective photochemical quantum yield of photosystem, coefficient of photochemical fluorescence quenching varied with the row and plant spacing, so spacing is conducive to improving the photosynthetic performance of crop population (Pratibha et al., 2018). This is because plant density affects the nutritional state of plants, light interception and distribution of crop canopy.

Number of stems per plant: Number of stems per plant of Lisianthus showed statistically significant variation due to different plant spacing (Figure 05). The wider spacing of 30 cm x 25 cm had recorded significantly maximum stem number (6.5) and minimum number of stem (5.5) was observed with the closer spacing of 30 cm x 15 cm. This might be due to sufficient nutrients available for widely spaced plants to produce vigorous plant growth with maximum number of stems. A similar result was reported by Singh and Kumar (2009).

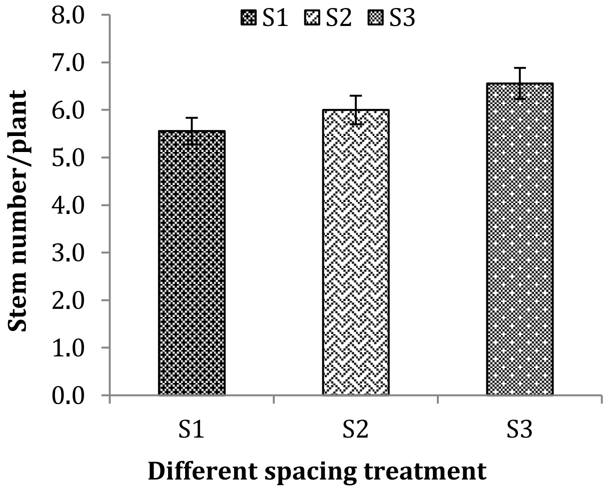

Figure 05. Effect of different spacing on number of stems per plant of Lisianthus (Here, S_1: 30 cm × 15 cm; S_2: 30 cm × 20 cm and S_3: 30 cm × 25 cm)

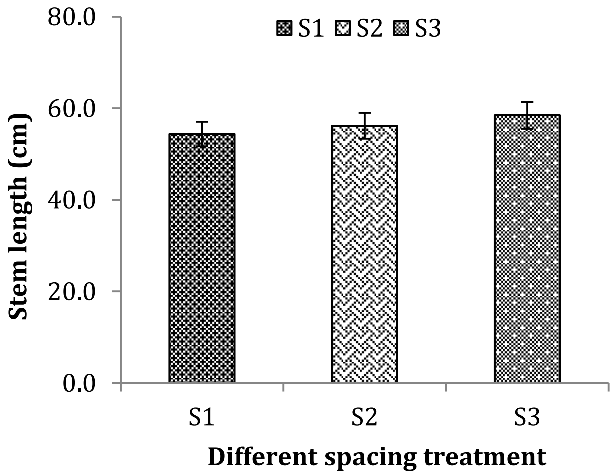

Figure 06. Effect of different spacing on stem length (Here, S_1: 30 cm × 15 cm; S_2: 30 cm × 20 cm and S_3: 30 cm × 25 cm)

Stem length: The stem length increased probably due to higher nutrient content, which resulted in better vegetative and reproductive growth of the plant. In case of different spacing treatments, stem length of Lisianthus showed significant variation (Figure 06). The highest stem length (58.4 cm) was observed from S_3 (30 cm × 25 cm) and the lowest stem length (54.3 cm) was recorded from S_1 (30 cm × 15 cm). The increase in plant stem with wider levels of spacing might be due to less competition for nutrients, optimum plant population per unit area and all the plants receiving proper amount of sunlight, aeration and nutrition for maximum vegetative growth (Sudhakar and Kumar, 2012).

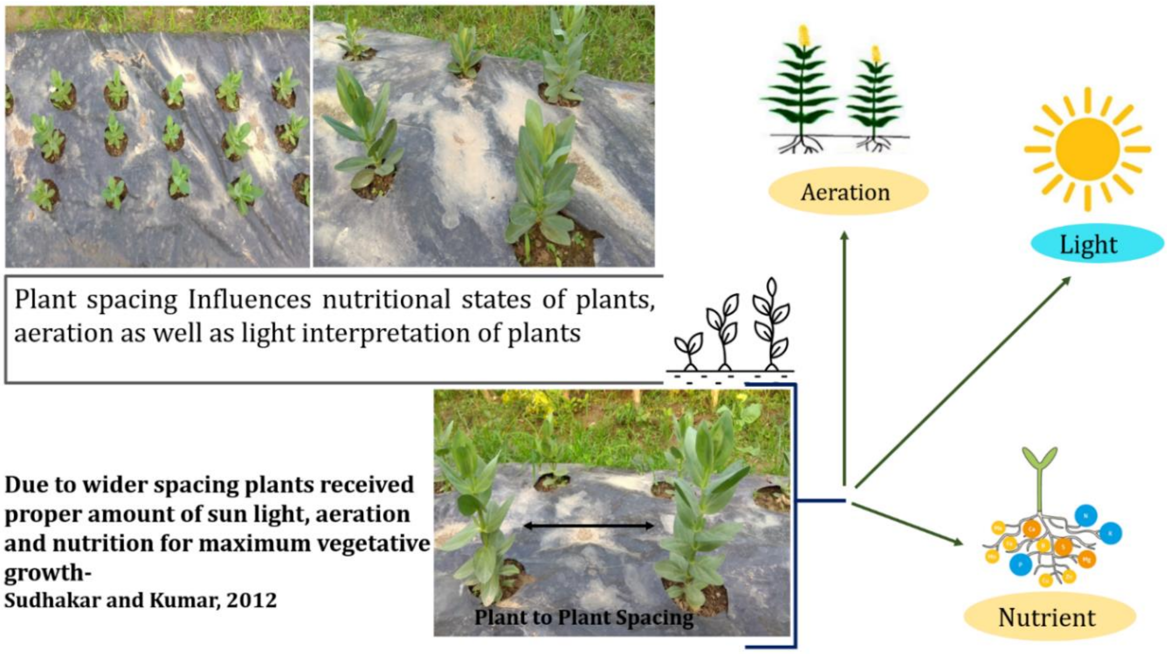

Plate 01. Vegetative growth stages of the plant and performances of cut flower crops are greatly influenced by optimum spacing

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Stem diameter: The wider spacing of 30 cm x 25 cm had recorded significantly maximum stem diameter (5.3 mm) and minimum stem diameter (4.6 mm) was observed with the closer spacing of 30 cm x 15 cm (Figure 07). Similar responses have also been observed in Sunflowers with wider spacing (Khalaj and Edrisi, 2012). This is because the more comprehensive spaced plants compete less for nutrients, water and light, which induces better quality flower production.

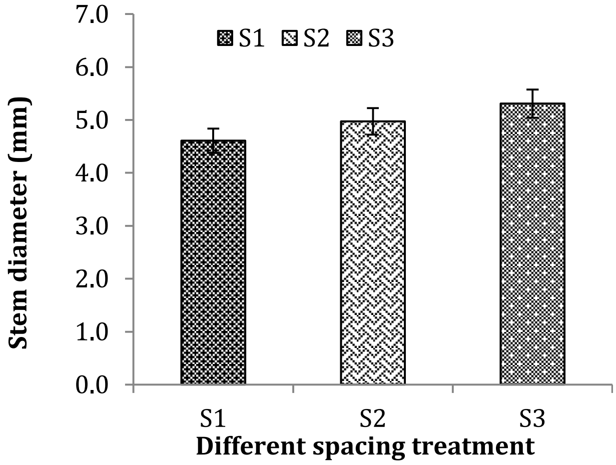

Figure 07. Effect of different spacing on stem diameter (Here, S_1: 30 cm × 15 cm; S_2: 30 cm × 20 cm and S_3: 30 cm × 25 cm)

Yield parameters

Number of flower bud per stem: Number of flower buds per stem was significantly varied among different spacing treatments (Table 01). The highest number of flower buds (10.4) was observed from S_3 (30 cm × 25 cm) and the minimum (6.7) was recorded from S1 (30 cm × 15 cm). It was discovered that the length of the leaves increased as the separation increased. The development of flower buds may be caused by less rivalry amongst plants for water, nutrient-rich minerals, and light. Similar outcomes have been noted in other places (Roychowdhury, 1989).

Number of flowers per stem: In case of different spacing treatment, flowers per plant showed positive effect (Table 01). The maximum number of flowers per stem (6.4) was produced at the wider spacing of 30 cm x 25 cm, compared to the minimum flower number per stem at the narrower spacing of 30 cm x 15 cm, which produced 3.8 (Table 01). The decrease in flower number might be due to higher plant population pressure leading to an increase in competition for nutrients among the plants, whereas an increase in flower number might be due to lesser availability of space and solar radiation in closely spaced calendula plants. Similar findings were reported by Mane et al. (2007).

Number of flowers per plant: In different spacing treatments, flower number per plant showed significant variation. The wider spacing of 30 cm x 25 cm recorded significantly maximum flower number (42.3) and minimum number of flowers (22.1) was observed with the closer spacing of 30 cm x 15 cm (Table 01). This might be due to availability of more area per plant for absorption of nutrients and moisture, no shading effect which ultimately increased the rate of net photosynthesis and translocation of assimilates to the storage organs, which promotes more flowers in plant compared to less space per plant. A similar result was found in Singh and Kumar (2009).

Table 01. Effect of different spacing on number of flower buds per stem, number of flowers per stem, number of flowers per plant and number of flower yield per plot of Lisianthus*

Treatment	Flower bud per stem	Flower per stem	Flower per plant	Flower yield per plot
S_1	6.7c	3.8c	22.1c	783.8c
S_2	8.6b	5.3b	32.3b	950.0b
S_3	10.4a	6.4a	42.3a	1013.9a
LSD	0.7	0.4	1.5	8.6
CV	9.0	8.4	4.8	0.9

*Here, S_1: 30 cm × 15 cm; S_2: 30 cm × 20 cm and S_3: 30 cm × 25 cm

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Number of flowers per plot: In different spacing treatments, flowers per plot showed significant variation. The maximum number of flowers per plot was 1013.9, produced at the wider spacing of 30 cm x 25 cm, compared to the minimum flower number per plot at the lesser spacing of 30 cm x 15 cm, which produced 783.8 (Table 01). It might be because more space is available, facilitating greater aeration and light penetration. This, in turn, might have enhanced photosynthetic activity and translocation of assimilates to growing portions, which results in higher nutrition availability (Ram et al., 2012).

Flower quality parameters

Peduncle length: Considering different spacing treatments peduncle length of Lisianthus flower showed significant variation (Table 02). The longest peduncle (12.6 cm) was observed in S_3 treatment and the lowest peduncle length (11.4 cm) in S_1 treatment (Table 02). Wider spacing led to longer peduncles, which may have been caused by higher nutrient intake by root hairs and increased space availability, which led to increased photosynthetic activity (Tehranifar and Akbari, 2012).

Table 02. Effect of different spacing on peduncle length, receptacle diameter, flower head diameter and number of petals per flower of Lisianthus*

Treatment	Peduncle length (cm)	Receptacle dia. (mm)	Flower head dia. (cm)	No. of petal/flower
S_1	11.4a	7.68c	5.40c	17.00c
S_2	12.1ab	7.91b	5.67b	17.78b
S_3	12.6a	8.16a	6.07a	18.67a
LSD	0.7	0.13	0.16	0.54
CV	6.2	1.63	2.75	3.01

*Here, S_1: 30 cm × 15 cm; S_2: 30 cm × 20 cm and S_3: 30 cm × 25 cm

Receptacle diameter: Different plant spacing positively influenced the receptacle diameter of Lisianthus flower. The highest receptacle diameter of flower (8.1 mm) was found in S_3 and the lowest (7.6 mm) was obtained from S_1 (Table 02). The availability of more light for photosynthesis synthesis and more area for better root growth and nutrient absorption in widest spacing may have enhanced the flower quality. A similar result was found in Bhat and Khan (2007).

Flower head diameter: Different plant spacing showed significant variation with respect to flower head diameter (Table 02). The maximum flower head diameter (6.0 cm) was observed in wider spacing (S_3), while the minimum diameter (5.4 cm) was found in closer spacing S_1 (Table 02). Wider spacing's caused flowers to open earlier and to have larger open flower diameters. Wider leaf spacing and better leaf growth may have sped up photosynthesis during the vegetative phase and its transfer to other metabolic sinks during the reproductive phase may have improved floral characteristics. Malam et al. (2010) found a similar outcome.

Petal number per flower: Considering different spacing treatments petal number per flower of Lisianthus flower showed significant variation (Table 02). The highest number of petal (18.6) was observed in S_3 treatment and the lowest number (17.0) in S_1 treatment (Table 02). The most florets per spike were seen at medium and broader spacing. There may be reduced rivalry among plants for water, minerals, nutrients and light. Similar findings were made by Kuldip et al. (2016).

IV. Conclusion

With respect to the above results, it can be articulated that different plant spacings showed a significant variation in Lisianthus growth and flowering. According to result, plant spacing S_3(30 cm × 25 cm) showed tallest plant height, maximum stem number, SPAD value, stem length, stem diameter, flower head diameter, peduncle length, receptacle diameter and ultimately the highest yield, even recorded maximum petal number per flower. To sum up, it can be concluded that S_3 (30 cm × 25 cm) was the most optimum spacing for the better growth, quality and yield attributes of Lisianthus production in Bangladesh.

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