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Research Article

Physiochemical Evaluation of Selected Local Soilless Substrates for their Effect on Growth and Quality of Lisianthus (*Eustoma grandiflora*)

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ABSTRACT

Growing substrates are very important for the growth and development of plants, it is quite possible to get maximum yield from flowering crops just by selecting proper growing substrate, a study was conducted to evaluate the physiochemical characteristics and effect of selected local soilless substrates on growth and quality of lisianthus. The experiment was laid out according to Randomized Complete Block Design (RCBD), there were five treatments and every treatment was replicated thrice, each replication was consisting of 20 plants, and were planted in plastic creates of 45×60-inch surface area. Substrates were crushed and well mixed and filled in plastic crates after lining with polythene green net sheet for proper drainage as per following treatments, viz. silt (100%) as control, silt+pressmud (1:1; v/v), silt+coco-coir+pressmud (1:1:1; v/v/v), silt+rice hulls+pressmud (1:1:1; v/v/v), Coco-coir+Rice hulls+press mud (1:1:1; v/v/v). Data collection was done on weekly bases for all the growth and quality parameters. Results indicated that tallest plants (52.0 cm) with higher numbers of leaves (50.0), open flowers per stem (5.4) having thickest stem, bigger size flower (52.8 mm) with higher vase life (12 days) were produced in coco-coir+rice hulls+pressmud (1:1:1; v/v/v) substrate. It is recommended that coco-coir+rice hulls+pressmud (1:1:1; v/v/v) can used for premium quality stem production of lisianthus (*Eustoma grandiflora*) and would be best local soilless substrate among the tested substrate for commercial production.

Keywords: Nursery media; Specialty cut flowers; Soilless substrates; Seedling production.

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INTRODUCTION

Majority of the nurserymen are not aware of modern substrates for use in nursery production. There were many bottlenecks reported, which included unawareness of technical skills, ignorance of modern substrates being used, cost of imported substrates and import-export barriers. Moreover, majority of nurserymen were interested to use modern soilless substrates and demanded to develop a cheaper and local substrate as well as provide training for their capacity building. Preparation of substrate seemed to be a problematic thing for majority of nurserymen but still they wanted to use their own indigenous raw materials to use as growth substrates and were least interested in importing substrates or ornamental plants because of huge capital requirement.

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Therefore, there is need to develop locally available cheaper substrate, which should be economical and sustainable for nursery production of ornamental plants. Organic materials from agriculture, forestry, green areas and livestock farming as well as residues from community, industrial waste all these are a good resource of various nutrients (Mehta *et al.*, 2015) and all have been proposed to be used for beneficial nutrients for growing plants in containers or different pots, perhaps it will reduce the negative and destructive impact upon indigenous and worldwide ecological filth. Meanwhile different combinations of several growing substrates like sewage sludge, sawdust, spent mushroom compost; coco-coir and rice hulls also being utilized like local substrates in Pakistan.

In cut *Eustoma* flowers, there are numerous cultivars with morphological distinctions in color of flower its size and shape. The *Eustoma* inflorescence has quite a lot of opened flowers and buds (Yulemne *et al.*, 2020). Thus, the permanency of each flower and the rate of bud opening are imperative issues in outspreading the vase life of the inflorescence. Furthermore, there are cultivar dissimilarities in the vase life of flowers (Shimizu-Yumoto and Ichimura, 2010).

Substrates with amusing nutrient innards disclosed to endorse plant vegetative growth and tardy maturity and solicitation of such growing substrates were perceived to curtail the time taken by plant to give flower occurrence (Younis *et al.*, 2015). Use of leaf mould potting media acquired least possible days to flower bud establishment among all other treatments (Mehmood *et al.*, 2013). Abul-Soud *et al.* (2015) have testified an upsurge in microbial biomass in soilless culture media subsequently modifications with vermicompost, proliferations in microbial biomass can speed up microbial competition. Majeed *et al.* (2020) witnessed that notwithstanding of the different organic and synthetic sources of nutrient aid in preserving the balance of nutrients in soils, while inorganic fertilizers easily provide nutrients, boosting crop growth initially and ultimately leading to improved development and production. That’s why, development of best combination of different substrate can improve the growth and quality production of flower in soilless substrates. Therefore, current study was performed to evaluate the potential of local soilless substrates for the lisianthus, having the objective to develop an economical and low-cost substrate for the promotion of local substrate in the country.

MATERIALS AND METHODS

This study was conducted to evaluate the physiochemical characteristics and effect of selected local soilless substrates on growth and quality of lisianthus at Commercial Floriculture Research Area at Institute of Horticultural Sciences, University of Agriculture Faisalabad. The experiment was laid out according to Randomized Complete Block Design (RCBD), there were five treatments and every treatment was replicated thrice, each replication was consisting of 20 plants, and were planted in plastic creates of 45×60-inch surface area.

Substrates were crushed and well mixed and filled in plastic crates after lining with polythene green net sheet for proper drainage as per following treatments, viz. silt (100%) as control, silt+pressmud (1:1;v/v), silt+coco-coir+pressmud (1:1:1; v/v/v), silt+rice hulls+pressmud (1:1:1; v/v/v), Coco-coir+Rice hulls+press mud (1:1:1; v/v/v). Substrates samples weighing 250 g each were collected for physicochemical analysis like pH, electrical conductivity, water holding capacity, aeration, total available nitrogen, available phosphorous (ppm), available potassium (ppm) estimation.

Plant height was measured with measuring scale. Number of leaves per plant, Number of buds per stem and number of open flowers per plant were counted. Leaf area was recorded through graph paper. While, Leaf total chlorophyll contents were observed with the help of chlorophyll meter. Time to inflorescence initiation and Production time was noted from sowing. Vase life was observed in days from harvesting to fading of flowers. Vernier caliper was used for flower diameter and stem diameter. For fresh and dry weight of flowers, protocol of Majeed *et al.* (2020) was followed. Data was analyzed using the software Statistix 8.1.

RESULTS

Results of growth attributes indicated that longest stems were produced by plants grown in coco-coir+rice hulls+pressmud (52.0 cm), maximum numbers of leaves (50.0) were also found in the same ratios of substrates (Figure 1A, B). Whereas coco-coir+rice, hulls+pressmud and silt+rice hulls+pressmud showed the similar results of getting maximum leaf area (2.8 cm^2) and leaf total chlorophyll contents (68.1 SPAD) as shown in figure 2A, B. Higher plants with maximum leaf number in coco-coir+rice hulls+pressmud might be due to availability of nitrogen and phosphorous.

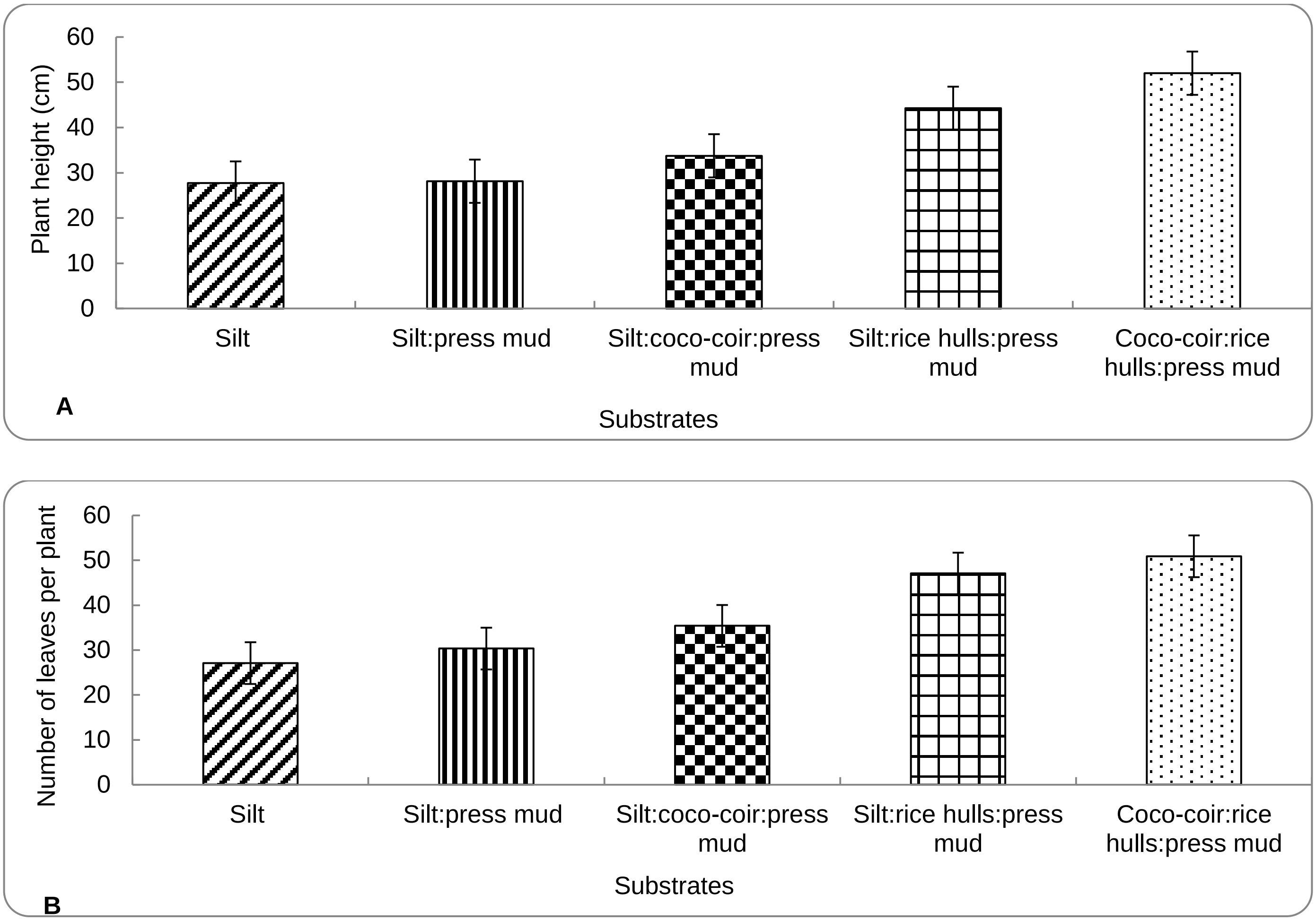

Figure 1. Compar ison of various substrates for (A) plant height (cm) and (B) number of leaves per plant of lisianthus (*Eustoma grandiflorus*).

Because nitrogen and phosphorus have significant impact on photosynthesis, leads to increase in plant height. Results were also in line with Mirakalaei *et al.* (2013), they observed a greater number of leaves in *Lilium longiflorum* grown in compost substrate rather than other substrates. Ahmad *et al.* (2012) in another experiment observed more leaf area of gerbera using different ratios of soil + silt.

Production time showed that maximum production time was taken by plants grown in silt (100%) that were (158 days), whereas plant grown in coco-coir+rice hulls+pressmud took minimum time of production (134 days), same composition took the lest time to bud initiation (114 days) whereas maximum days to bud initiation (134 days) were taken by silt (Table 1). Early flowering in soilless substrate may be resultant of availability of optimal and maximum nutrients to support the bud initiation. El-Hanafy *et al.* (2018) also observed the earliest bud initiation in gladiolus under rice husk substrate than other substrates.

As for flowering attributes of plants are concerned, plants grown in coco-coir+rice hulls+pressmud possess the higher number of buds per plant and also the maximum number of open flowers per stem (5.4) as shown in (Table 1). Moreover, maximum flower diameter (52.8 mm) and stem thickness too is also being measured in plants grown in coco-coir+rice hulls+pressmud (Figure 3A, B). Plant development is improved and yields are increased when inorganic materials, like peat, are added to organic ones. This is likely because the inorganic element can store more water and the peat moss takes up more oxygen. Increased crop production is a result of improved peat aeration, which encourages vigorous root growth that supports improved leaf growth (El-Hanafy *et al.*, 2018).

Coco-coir+rice hulls+pressmud showed the best results for fresh weight of stems after being harvested (47.8 g) and also the dry weight of stems (15.9 g) as shown in Fig. 4A, B. If we talk about vase life, then again coco-coir+rice hulls+press mud took the lead as the flowers harvested from coco-coir+rice hulls+pressmud possess the longest span of vase life (12 days) after being cut from the plant (Table 2).

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Table 1: Effect of various substrates on time to inflorescence initiation (d), production time (d), number of buds per plant and number of open buds/flowers per plant of lisianthus (*Eustoma grandiflorus*).

Treatments	Time to inflorescence initiation (d)	Production time (d)	Number of buds per stem	Number of open flowers per plant
Silt	134 b[z]	158 a	4.5 e	1.0 c
Silt:pressmud (1:1; v/v)	130 c	157 ab	6.6 d	1.3 c
Silt:coco-coir:pressmud (1:1:1; v/v/v)	137 a	149 ab	9.8 c	1.6 c
Silt:rice hulls:pressmud (1:1:1; v/v/v)	133 b	147 b	15.2 b	3.8 b
Coco-coir:rice hulls:pressmud (1:1:1; v/v/v)	114 d	134 c	19.6 a	5.4 a
Significance[y]	<0.0001	<0.0036	<0.0001	<0.0002

[z] Means sharing different letters in the column are statistically different at $P<0.05$; [y] *P* values were obtained using general linear model (GLM) procedures of statistics (version 8.1 analytical software) for effect of various substrates.

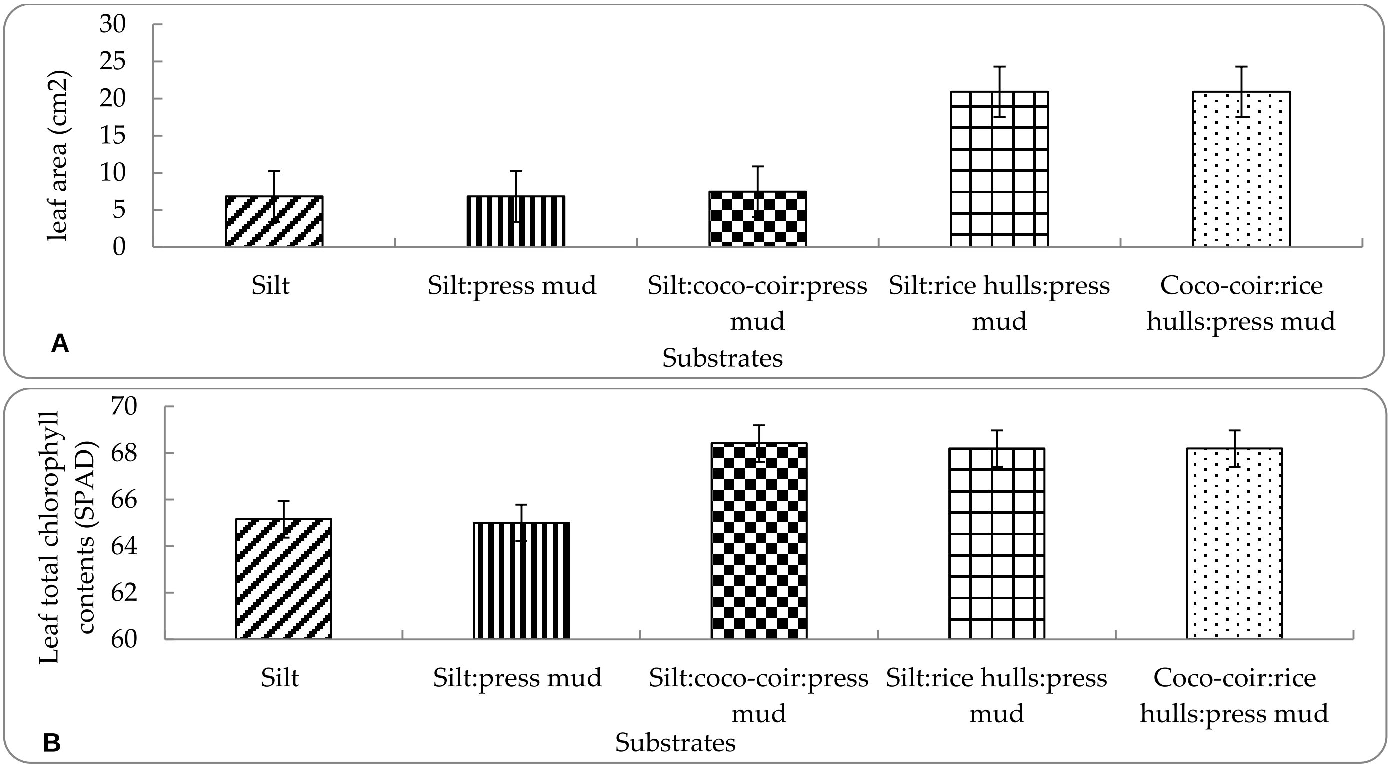


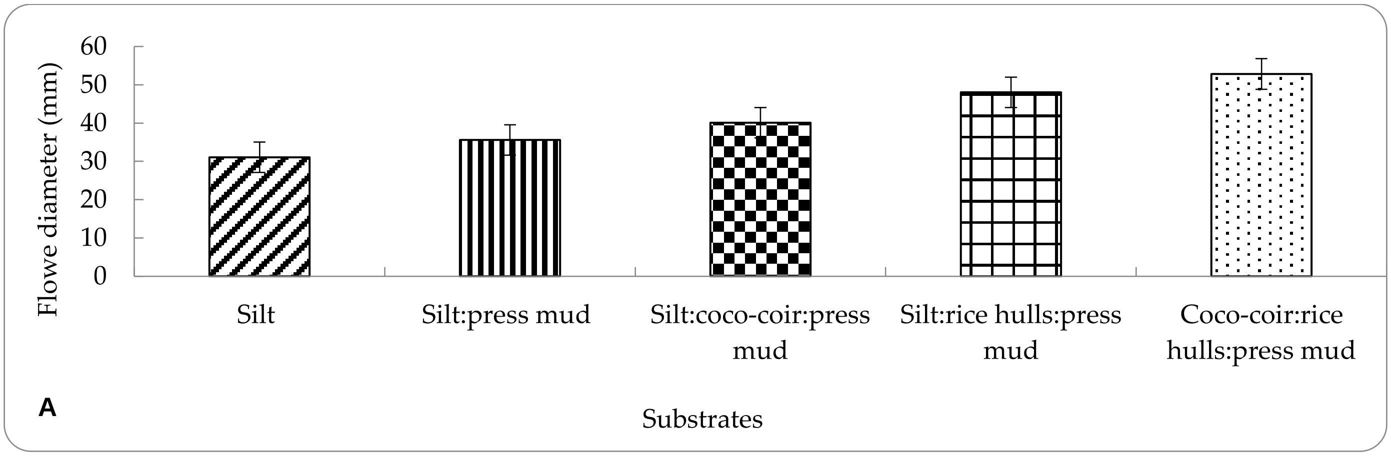
Figure 2: Comparis on of various substrates for (A) leaf area (cm^2) and (B) leaf total chlorophyll contents (SPAD) of lisianthus (*Eustoma grandiflorus*).

Table 2: Effect of various substrates on vase life (days) of stems of lisianthus grown in various soilless growing substrates of lisianthus (*Eustoma grandiflorus*).

Treatments	Vase life (days)
Silt	5.7 d[z]
Silt:pressmud (1:1; v/v)	6.1 d
Silt:coco-coir:pressmud (1:1:1; v/v/v)	7.8 c
Silt:rice hulls:pressmud (1:1:1; v/v/v)	10.6 b
Coco-coir:rice hulls:pressmud (1:1:1; v/v/v)	12 a
Significance[y]	<0.0001

[z] Means sharing different letters in the column are statistically different at $P<0.05$.

[y] *P* values were obtained using general linear models (GLM) procedures of statistics (version 8.1 analytical software) for effect of various substrates.



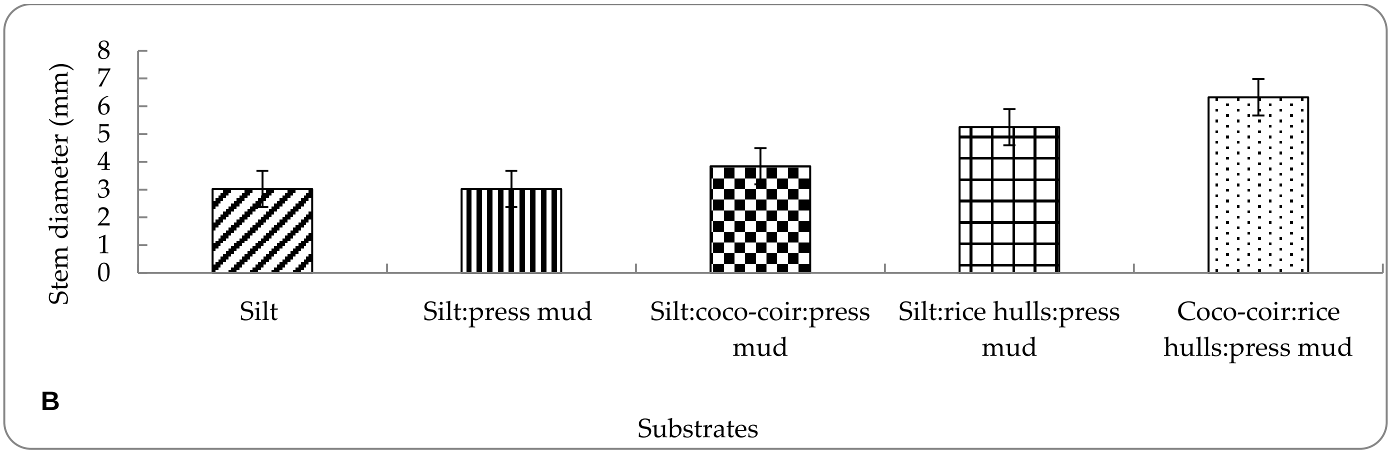
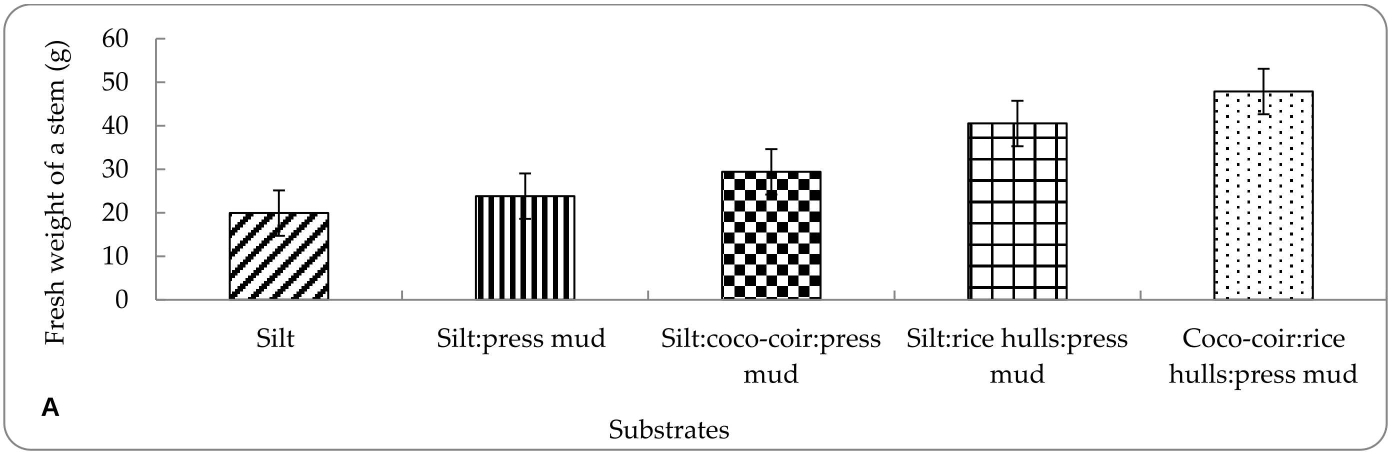


Figure 3: Comparison of various substrates (A) flower diameter (B) stem diameter of lisianthus (*Eustoma grandiflorus*).

These results are in agreeme nt with the results of Metwally *et al.* (2013) who testified that peat moss significantly improved the fresh and dry weight of the aerial parts, flower quality and yield in carnation. Plants grown in coco-coir+rice hulls+press mud produced the supreme quality flowers, which were better than the flowers grown in other substrates (Figure 5).

If we talk about physico-chemical analysis of growing substrates, the lightest bulk density (0.23 g/cm^3) was found in coco-coir+rice hulls+pressmud that allows the maximum penetration of roots and nutrients availability, whereas maximum bulk density was found in silt that's not preferred for maximum root penetration, maximum water holding capacity (1023.8 %) and aeration (52.7 %) was also found in coco-coir+rice hulls+pressmud (Table 5).



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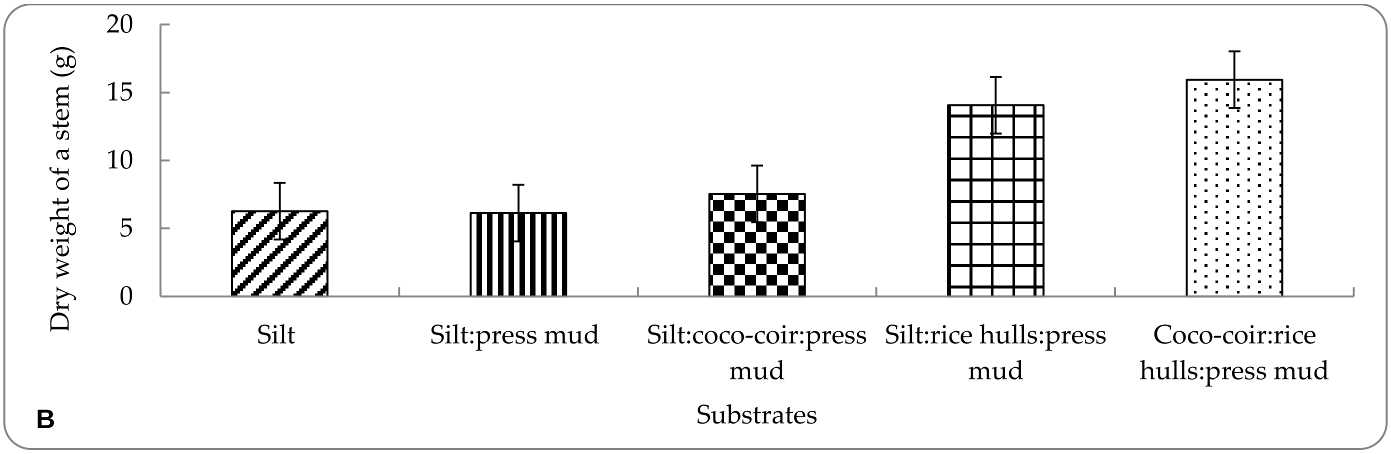

Figure 4: Comparison of (A) fresh weight and (B) dry weight of lisianthus (*Eustoma grandiflorus*).

Table 3 Effect of various substrates on pre and post analysis of pH and EC (dS m^{-1}) of substrates of lisianthus.

Treatments	pH		EC (dS m^{-1})	
	Pre-study analysis	Post-study analysis	Pre-study analysis	Post-study analysis
Silt	7.5 d[z]	7.8 b	2.1 e	4.6 e
Silt:pressmud (1:1; v/v)	7.8 a	8.0 a	4.8 c	8.0 c
Silt:coco-coir:pressmud (1:1:1; v/v/v)	7.7 b	7.7 c	4.6 d	7.7 d
Silt:rice hulls:pressmud (1:1:1; v/v/v)	7.7 b	7.7 c	8.6 b	11.3 b
Coco-coir:rice hulls:pressmud (1:1:1; v/v/v)	7.6 c	7.6 d	8.9 a	11.6 a
Significance[y]	<0.0001	<0.0001	<0.0001	<0.0001

[z] Means sharing different letters in the column are statistically different at $P<0.05$; [y] *P* values were obtained using general linear models (GLM) procedures of statistics (version 8.1 analytical software) for effect of various substrates.

Initially silt+pressmud possessed highest pH (7.8) was later increased to (8.0) on the end of study, whereas coco-coir+rice hulls+pressmud possess the moderate pH (7.6) same for both pre and post study for the better growth of plants, more like other attributes coco-coir+rice hulls+press mudpossess the maximum EC in pre study (8.9 dS m^{-1}) which was further increased to (11.6 dS m^{-1}) in the post study analysis (Table 3).
Moreover, maximum level of total nitrogen was found maximum in pre study analysis of substrates in coco-coir+rice hulls+pressmud (4.4 %) which increased to (6.6 %) in post study analysis. Available phosphorous was on maximum ranking in coco-coir+rice hulls+pressmud in pre study (33.4 mg L^{-1}) and was increased to (34.1 mg L^{-1}) in post study (Table 4).

Table 4: Effect of various substrates on pre and post study total nitrogen (%) and phosphorus (mg L^{-1}) various soilless growing substrates on growth attributes of lisianthus (*Eustoma grandiflorus*).

Treatments	Total Nitrogen (%)		Available Phosphorus (mg L^{-1})	
	Pre-study analysis	Post-study analysis	Pre-study analysis	Post-study analysis
Silt	0.05 e[z]	0.06 e	27.9 e	26.0e b
Silt:pressmud (1:1; v/v)	1.02 d	0.7 d	29.9 d	27.0 d
Silt:coco-coir:pressmud (1:1:1; v/v/v)	1.7 c	0.8 c	30.5 c	29.6 c
Silt:rice hulls:pressmud (1:1:1; v/v/v)	4.1 b	6.0 b	32.1 b	32.9 b
Coco-coir:rice hulls:pressmud (1:1:1; v/v/v)	4.4 a	6.6 a	33.4 a	34.1 a
Significance[y]	<0.0001	<0.0001	<0.0001	<0.0001

Table 5: Effect of various substrates for pre and post study available potassium (mg L^{-1}), water holding capacity (% weight), bulk density (g cm^3) and aeration (%) on growth attributes of lisianthus (*Eustoma grandiflorus*).

Treatments	Potassium (mg L^{-1})		Water holding capacity (% weight)	Bulk density Aeration (g cm^3)	Aeration (%)
	Pre-study analysis	Post-study analysis			
Silt	140.0 e[z]	180.0 e	272.9 e	1.33 b	24.9 e
Silt:pressmud (1:1; v/v)	660.0 d	580.0 d	420.6 d	2.76 a	27.4 d
Silt:coco-coir:pressmud (1:1:1; v/v/v)	1240.0 c	1000.0 c	637.7 c	0.72 c	34.4 c
Silt:rice hulls:pressmud (1:1:1; v/v/v)	2700.0 b	1300.0 b	916.3 b	0.51 d	52.7 b
Coco-coir:rice hulls:pressmud (1:1:1; v/v/v)	2800.0 a	2180.0 a	1023.8 a	0.23 e	63.9 a
Significance[y]	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001

[z] Mean sharing different letters in the column are statistically different at P<0.05; [y] *P* values were obtained using general linear models (GLM) procedures of statistics (version 8.1 analytical software) for effect of various substrates.

Figure 5: Comparison of different substrates with best performing combination (coco-coir+Rice hulls+Peatmoss).

If we talking about available potassium, the maximum available potassium initially was found in coco-coir+rice hulls+press mud (2800.0 mg L^{-1}) which was further decreased to (2180.0 mg L^{-1}) in post study analysis of substrates (Table 5). Which indicates the maximum availability and used by plants for the higher vegetative and flower quality of lisianthus (Figure 6).

Figure 6: Comparison of different substrates on leaf growth and flowering, T1:silt (100%; T2:silt+pressmud (1:1;v/v); T3:silt+coco-coir+pressmud (1:1:1; v/v/v); T4:silt+rice hulls+pressmud (1:1:1; v/v/v); T5:Coco-coir+Rice hulls+press mud (1:1:1; v/v/v).

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CONCLUSION

Coco-coir+rice hulls+pressmud (1:1:1: v/v/v) would be best for commercial production of lisianthus. similarly growing substrates are very important for the growth and development of plants, it is quite possible to get maximum yield from flowering crops just by selecting proper growing substrate. From current study, it can be concluded that plants grown in coco-coir+rice hulls+pressmud (1:1:1; v/v/v) alone or in combination silt+rice hulls+pressmud (1:1:1; v/v/v) had best performance regarding most of the parameters studied. Therefore, commercial growers can use coco-coir+rice hulls+pressmud (1:1:1; v/v/v) or mixed with silt/soil for premium quality stem production of lisianthus (*Eustoma grandiflora)*.

AUTHOR CONTRIBUTIONS

All authors contributed equally to this research.

COMPETING OF INTEREST

The authors have not declared any conflict of interest.

REFERENCES

Abul-Soud, M., M. Emam and N. El-Rahman. 2015. The potential use of vermicompost in soilless culture for producing strawberry. International Journal of Plant & Soil Science, 8: 1-15.

Ahmad, I., M. A. Khan, M. Qasim, M. S. Zafar and R. Ahmad. 2012. Substrates effects on growth, yield and quality of Rosa hybrida L. Pakistan Journal of Botany, 44: 177-85.

El-Hanafy, S. H., S. S. Helmy, A. Dahab, N. E. Metwally and W. R. Hamed. 2018. Evaluating different soilless culture substrates for growth, flowering and quality of Gladiolus (Gladiolus grandiflorus). Middle East Journal of Agriculture Research, 7: 944-57.

Majeed, Y., K. Ziaf, M. A. Ghani, I. Ahmad, M. A. Ahmad, K. Abbasi, H. Mujahid and K. L. Cheema. 2020. Effect of different combinations of organic and synthetic sources of nutrients on growth, yield and quality parameters of turmeric under Faisalabad conditions. Journal of Environmental and Agricultural Science, 22: 1-7.

Mehmood, T., W. Ahmad, K. S. Ahmad, J. Shafi, M. A. Shehzad and M. A. Sarwar. 2013. Comparative effect of different potting media on vegetative and reproductive growth of floral shower (Antirrhinum majus L.). Universal Journal of Plant Science, 1: 104-11.

Mehta, C. M., W. O. Khunjar, V. Nguyen, S. Tait and D. J. Batstone. 2015. Technologies to recover nutrients from waste streams: a critical review. Critical Reviews in Environmental Science and Technology, 45: 385-427.

Metwally, N., U. El Behairy and A. Abou Hadid. 2013. Evaluation for producing carnations in different growing media under protected cultivation. Middle East Journal of Agriculture Research, 2: 167-72.

Mirakalaei, S., Z. Ardebill and M. Mostafavi. 2013. The effects of different organic fertilizers on the growth of lilies (Lillium longiflorum). International Research Journal of Applied and Basic Sciences, 4: 181-86.

Shimizu-Yumoto, H. and K. Ichimura. 2010. Postharvest physiology and technology of cut Eustoma flowers. Journal of the Japanese Society for Horticultural Science, 79: 227-38.

Younis, A., A. Riaz, F. Javaid, M. Ahsan, U. Tariq, S. Aslam and N. Majeed. 2015. Influence of various growing substrates on growth and flowering of potted miniature rose cultivar ‘‘Baby Boomer’’. Curr Sci Perspect, 1: 16-21.

Yulemne, Z., R. Barba Gonzalez, E. Aguilera-Cauich, G. Herrera Cool, A. Uc Varguez, E. Tapia and G. Lopez Puc. 2020. Morphological variability of eustoma hybrids obtained from interspecific crosses between *Eustoma grandiflorum* X *Eustoma exaltatum*. International Journal of Advanced Research, 8: 873-83.

https://doi.org/10.55627/agrivet.003.02.0726