Original Research Article

Effect of potting mixtureand polybag size on growth and flowering of Asiatic lily(*Lillium asiaticum* var. Nashville) under protected condition

Abstract

An experiment on recognizing the significance of cultivating lilies under polyhouse conditions, this study contributes the valuable insights to the cultivation practices of Asiatic lilies, focusing on the pivotal roles of potting mixture composition and polybag size. Healthy bulbs of each cultivar were freshly planted in various media compositions in different polybag size within a protected environment. From the present investigation, it is concluded that the treatment 12 x 12 polybag size combined with Garden soil + Vermicompost + Cocopeat (1:1:2) was found in superior among other treatments in terms of plant height (69.30cm), leaf length (8.60 cm),leaf width (3.03 cm), number of flower buds/plant (4.60), days to appearance of first flower bud (40.10), flower bud length (8.43 cm), stalk length (68.15 cm), weight of bulb per plant (64.75g), shelf life of flower spike (15.22 days), number of flowers per 250 m^2 (10032.75). The study concluded that, the lilies readily respond to various medium for cultivation and 12 x 12 Polybag combined with potting mixture Garden soil + Vermicompost + Cocopeat (1:1:2)observed to be the best for plant growth and flowering of Asiatic lily under protected condition.

Keywords: Cocopeat, FYM, Lilium, Media, Perlite, vermiculite

1. INTRODUCTION

Lilium holds a significant position as a commercial bulbous cut flower cultivated worldwide. Belonging to the family *Liliaceae*, the genus *Lilium* encompasses over 80 species spread across North America, Asia, and Europe, showcasing notable diversity in plant structure, flower characteristics, bulb types, and fragrances [17, 13]. Lilium, ranks fourth among the bulbous plants after Tulipa, Gladiolus, and Narcissus [12]. Its popularity stems from its exquisite blooms, diverse varieties, and versatility in landscaping, cut flower production, and ornamental gardening[15]. With its wide array of colors, shapes, and sizes, Lilium continues to be cherished by growers, florists, and enthusiasts alike, contributing to the vibrant and diverse floral industry[7].

Lilium, renowned for its distinctive bulbous flowers, stands as a highly sought-after cut flower in the global market. So, the commercial cultivation of Asiatic hybrid lilies is expanding steadily in India. Its popularity stems from its diverse colour palette, robust shelf life, and the ease with which it thrives under both open field and shaded conditions. Noteworthy is its ability to rehydrate effectively post long-distance transportation when provided with suitable cut flower food, thus ensuring its freshness for consumers [28].Soil-borne diseases and pests pose significant challenges in the production of cut flower Lilium, often leading to a notable decline in flower quality. As a result, soilless cultivation has emerged as the preferred method for ornamental plants among modern growing techniques [21].

Cocopeat, a byproduct of coconut processing, is a fibrous material known for its excellent moisture retention and soil aeration properties [43]. Vermiculite, a mineral that expands when heated, is valued for its ability to improve soil structure and moisture retention, making it popular in gardening and horticulture[20]. Perlite, another lightweight mineral, is prized for its exceptional drainage properties and aeration benefits, commonly used in potting mixes to promote healthy root growth[1]. Vermicompost, on the other hand, is compost produced through the digestion of organic waste by earthworms. Rich in nutrients and beneficial microorganisms, vermicompost enhances soil fertility, improves soil structure, and promotes vigorous plant growth[13]. Each of these soil amendments plays a unique role in improving soil health and supporting plant growth in various gardening and agricultural applications.

The characteristics of the growing media utilized in soilless cultivation directly or indirectly impact both yield and quality and lilies readily respond to various medium for cultivation[36]. Thus, recognizing the significance of cultivating lilies under polyhouse conditions, this study contributes the valuable insights to the cultivation practices of Asiatic lilies, focusing on the pivotal roles of potting mixture composition and polybag size. By elucidating the optimal conditions for growth and flowering, this research aims to empower growers in Prayagraj and similar agro-climatic regions to harness the full potential of *Lilium asiaticum* as a prominent cut flower in the international trade market.

2. MATERIALS AND METHODS

Thepresentinvestigationwascarriedoutintheformoffieldexperimentin Horticultural Research Field,Departmentof Horticulture,NainiAgricultural Institute, SamHigginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh,Indiaduring2023-2024 under protected condition. The experiment was laid out in Completely Randomized Design with twelve treatments and three replications. The experiment includes the combination of various potting mixtures *viz.*, garden soil, cocopeat, vermicompost, FYM, vermiculite and perlite in varying proportions and different polybag sizes (6, 31 &35). The metrological observations during the experimental period of November2023 toMarch2024 is represented in Table 1.

Different media composition used for filling of pots were; T_1: Garden soil+ FYM+Cocopeat (1:1:2) in 8x8 polybag size, T_2: Garden soil+ Vermicompost +Cocopeat (1:1:2) in 8x8 polybag size, T_3: Garden soil+ Cocopeat + Vermiculite (1:2:1) in 8x8 polybag size, T_4: Garden soil+ Cocopeat + Vermiculite + Perlite (1:2:1:1) in 8x8 polybag size, T_5: Garden soil+ FYM+Cocopeat (1:1:2) in 10x10 polybag size, T_6: Garden soil+ Vermicompost +Cocopeat (1:1:2) in 10x10 polybag size, T_7: Garden soil+ Cocopeat + Vermiculite (1:2:1) in 10x10 polybag size, T_8: Garden soil+ Cocopeat + Vermiculite + Perlite (1:2:1:1) in 10x10 polybag size, T_9: Garden soil+ FYM+Cocopeat (1:1:2) in 12x12 polybag size, T_{10}: Garden soil+ Vermicompost +Cocopeat (1:1:2) in 12x12 polybag size, T_{11}: Garden soil+ Cocopeat + Vermiculite (1:2:1) in 12x12 polybag size and T_{12}: Garden soil+ Cocopeat + Vermiculite + Perlite (1:2:1:1) in 12x12 polybag size. Observations were recorded for the six plants within each treatment at 20-days interval. Statistical analysis was conducted using Fisher's analysis of variance (ANOVA) technique, in accordance with the guidelines outlined by [16].

3. RESULTS AND DISCUSSION

A. IMPACT OF POTTING MIXTURE & POLYBAG SIZE ON VEGETATIVEPARAMETERS

Vegetative parameters are essential for assessing the growth and development of plants, understanding their response to different environmental conditions, and evaluating the effectiveness of various treatments and the results on the effect of different growing media and polybag sizes of these vegetative parameters on Asiatic lily are represented in Table 2.

Plant height was observed maximum (69.30 cm) in T_{10} - 12 x 12 - Garden soil + Vermicompost + Cocopeat (1:1:2) followed by T_{11} - 12 x 12 -Garden soil + Cocopeat + Vermiculite (1:2:1) (66.27 cm) whereas, minimum (60.73 cm) was reported in T_2 - 8 x 8 - Garden soil + Vermicompost + Cocopeat (1:1:2).The significant increase in plant height observed in the treatment using a potting mixture of Garden soil, Vermicompost, and Cocopeat (1:1:2) in 12 x 12 polybags can be attributed to the unique mineral composition of the substrates. Cocopeat, rich in essential minerals for crop plant growth, likely played a pivotal role in this enhancement. [38]demonstrated that a blend comprising 30% vermicompost and 70% cocopeat resulted in the tallest plants (81.7 cm) in lilium, while substrates without cocopeat led to shorter heights (67.5 cm).

The Number of leaves per plant (54.17) was observed maximum in T_{11}- 12 x 12 - Garden soil + Cocopeat + Vermiculite (1:2:1) followed by T_{10}- 12 x 12 - Garden soil + Vermicompost + Cocopeat (1:1:2) (54.08) whereas, minimum (47.63) was reported in T_3- 8 x 8 - Garden soil + Cocopeat + Vermiculite (1:2:1).Vermicompost, known for its water retention and nutrient uptake, combined with cocopeat, boosts organic nutrients for lilium growth. [29] found more leaves with vermicompost in 'Navona' lilies, while [11] noted highest leaf counts in a mix of rice hull, sawdust, and vermicompost.

The Leaf length (8.60 cm) was observed maximum in T_{10}- 12 x 12- Garden soil+ Vermicompost + Cocopeat (1:1:2) followed by T_{12}- 12 x 12- Garden soil+ Cocopeat + Vermiculite + Perlite (1:2:1:1) (8.17 cm) whereas, minimum (7.03 cm) was reported in T_3- 8 x 8 - Garden soil + Cocopeat + Vermiculite (1:2:1).Photosynthesis is crucial for plant growth, as it produces their food. More leaves usually mean increased photosynthesis, driving overall growth. Minerals absorbed by plants enhance leaf size, boosting photosynthesis and yields. This aligns with [11] in lilium. [31] found cocopeat-amended mediums led to more leaves, area, and better yields in lilium.

The maximum Leaf Width (3.03 cm) was observed with T_{10}- 12 x 12- Garden soil+ Vermicompost +Cocopeat (1:1:2) which was at par with T_{11}- 12 x 12 -Garden soil+ Cocopeat + Vermiculite (1:2:1) (2.97 cm) whereas, minimum (2.47 cm) was reported in T_1- 8 x 8 - Garden soil+ FYM + Cocopeat (1:1:2).Potassium in vermicompost boosts plant metabolism, aiding in amino acid and protein production crucial for growth. It also supports photosynthetic pigment emergence, enlarging leaf surfaces. [29] found similar results in lilium, indicating that vermicompost and coirpith enhance leaf characteristics, signaling robust growth and higher yields.

B. IMPACT OF POTTING MIXTURE & POLYBAG SIZE ON FLORALPARAMETERS

Floral parameters provides the ornamental value, and overall health of plants, particularly in the economic view of lilium plants and the results on the effect of different growing media and polybag sizes on Asiatic lily are represented in Table 3.

The maximum Number of Flower Buds/Plant (4.60) was observed with T_{10}- 12 x 12- Garden soil+ Vermicompost +Cocopeat (1:1:2) which was at par with T_{11}- 12 x 12 -Garden soil+ Cocopeat + Vermiculite (1:2:1)(3.93) whereas, minimum (2.23) was reported in T_3- 8 x 8 - Garden soil+ Cocopeat + Vermiculite (1:2:1).Optimal conditions from vermicompost and cocopeat enhance plant health and flower production. Vermicompost, a rich nutrient source, boosts growth, while cocopeat

provides ideal moisture and aeration for early and improved flowering. This fosters a higher flower count per plant, as seen in studies like [29] on Asiatic hybrid lily 'Navona'.

The minimum Days to appearance of flower bud (40.10) was observed with T_{10}- 12 x 12 - Garden soil + Vermicompost + Cocopeat (1:1:2) which was at par with T_{11}- 12 x 12 - Garden soil + Cocopeat + Vermiculite (1:2:1) (41.20) whereas, maximum (50.83) was reported in T_3 - 8 x 8 - Garden soil + Cocopeat + Vermiculite (1:2:1).Variations in flowering initiation time may be due to cocopeat and vermicompost benefits. Cocopeat offers aeration and moisture, promoting early flowering, while vermicompost supplies vital nutrients. This aligns with [20] findings. Similar results were reported by [6], noting shorter flower bud formation time (94.41 days) in carnations with soil, vermicompost, and cocopeat (in 2:1:1 ratio). [18] also observed quicker flower bud formation in anthuriums with cocopeat and vermicompost.

The maximum Flower bud length (8.43 cm) was observed with T_{10} - 12 x 12 - Garden soil + Vermicompost + Cocopeat (1:1:2) which was at par with T_{11} - 12 x 12 - Garden soil + Cocopeat + Vermiculite (1:2:1) (7.99 cm) whereas, minimum (6.64 cm) was reported in T_2- 8 x 8 - Garden soil + Vermicompost + Cocopeat.Flower quality significantly impacts the appeal of cut flowers, determined by factors like floret arrangement, size, and number on the spike. Research by [35] on LA Lilium cultivars found that mediums with cocopeat and vermicompost led to early bud visibility, longer stalks, and flower bud lengths compared to natural soil. Similar results were noted by [34] and [8], suggesting gibberellins in vermicompost may regulate the reproductive phase, enhancing stalk and bud lengths.Vermicompost, rich in micronutrients and macronutrients, promotes plant growth, improving flower characteristics. [30] experiments on LA hybrid lilies support this, indicating cocopeat and vermicompost amendments enhance plant growth, resulting in longer flower bud and stalk lengths, and prolonged vase life.

The maximum Stalk Length (68.15 cm) was observed with T_{10} - 12 x 12 - Garden soil + Vermicompost + Cocopeat (1:1:2) which was at par with T_{11}- 12 x 12 - Garden soil + Cocopeat + Vermiculite (1:2:1) (67.30 cm) whereas, minimum (60.10 cm) was reported in T_3 - 8 x 8 - Garden soil + Cocopeat + Vermiculite (1:2:1).Stalk length is crucial for export quality, as per [32], cocopeat's carbon content and porosity foster beneficial microorganism growth, enhancing nitrogen fixation, phosphorus solubilization, and phytohormone production for better plant growth. [20] found vermicompost and cocofibre combo maximized anthurium stalk length due to improved aeration and moisture, a conclusion supported by [6, 10 & 37].

The maximum Self-life of flower spike (15.22 days) was observed with T_{10} - 12 x 12 - Garden soil + Vermicompost + Cocopeat (1:1:2) which was at par with T_{11} - 12 x 12 - Garden soil + Cocopeat + Vermiculite (1:2:1) (14.58 days) whereas, minimum (10.02 days) was reported in T_3 - 8 x 8 - Garden soil + Cocopeat + Vermiculite (1:2:1).The prolonged shelf life of cut flowers is linked to stored carbohydrate content, crucial for longevity. Cocopeat and vermicompost in the growing medium help maintain high water content and nutrient uptake, enhancing flower durability [10]. [33] observed improved flower quality and longevity in Asiatic hybrids on new substrates compared to traditional ones. [6] found the longest flowering duration (70.56 days) in soil, vermicompost, and cocopeat mediums, consistent with [18] report of 87.50 days for anthuriums in cocopeat.

C. IMPACT OF POTTING MIXTURE & POLYBAG SIZE ON BULB AND YIELD PARAMETERS

Bulb and yield parameters encompass on various aspects such as the weight, diameter and yield per plant, indicating the quantity of harvested produce obtained from individual plants, and the total yield, which represents the overall quantity of harvested produce from the entire cultivation area.

The results on the effect of different growing media and polybag size on Asiatic lily are represented in Table 3.

The maximum bulb diameter (6.12 cm) was observed with T_{10}- 12 x 12 - Garden soil + Vermicompost + Cocopeat (1:1:2) (64.75) which was at par with T_{11} - 12 x 12 - Garden soil + Cocopeat + Vermiculite (1:2:1) (5.78 cm) whereas, minimum (3.98 cm) was reported in T_3 - 8 x 8 - Garden soil + Cocopeat + Vermiculite (1:2:1).Differences in lilium bulb diameter may be due to higher organic matter percentages in vermicompost and cocopeat media, enhancing nutrient availability and promoting cell division and size elongation. [14] noted larger flower diameters in peat and vermicompost mixes, improving media physicochemical characteristics. Similar findings were reported by [1, 3, 4, 10, 23&34].

The maximum weight of bulb per plant (g) was observed with T_{10}- 12 x 12 - Garden soil + Vermicompost + Cocopeat (1:1:2) (64.75) which was at par with T_{11} - 12 x 12 - Garden soil + Cocopeat + Vermiculite (1:2:1) (62.18) whereas, minimum was reported in T_3 - 8 x 8 - Garden soil + Cocopeat + Vermiculite (1:2:1) (43.91).The rise in bulb weight may be attributed to Gibberellin in vermicompost, promoting cell division, elongation, and differentiation, along with enhancing protein and nucleic acid uptake, resulting in increased bulb weight. Similar outcomes were observed by [19, 26 & 39]. [31] noted increased bulb size, measured by perimeter, in cocopeat mediums for lilium. [24] found maximum bulb size in soil with cocopeat and vermicompost (2:1:1, v/v) for lilium Asiatic hybrids.

The maximum Weight of bulb per plant (0.064 kg) was observed with T_{10}- 12 x 12 - Garden soil + Vermicompost + Cocopeat (1:1:2) followed by T_{11} - 12 x 12 - Garden soil + Cocopeat + Vermiculite (1:2:1) (0.062 kg) whereas, minimum (0.043 kg) was reported in T_3 - 8 x 8 - Garden soil + Cocopeat + Vermiculite (1:2:1).Vermicompost-amended mediums in large polybags enhance vegetative and flower parameters, likely leading to heavier bulbs. Gibberellin from vermicompost enhances cell division and elongation, potentially increasing protein and nucleic acid uptake. Similar results were reported for Oriental lilies with cocopeat-containing media [42].

The weight of bulbs per plant per 250m² (143.81 kg) was observed with T_{10}- 12 x 12 - Garden soil + Vermicompost + Cocopeat (1:1:2) followed by T_{11} - 12 x 12 - Garden soil + Cocopeat + Vermiculite (1:2:1) (140.38 kg) whereas, minimum (102.37 kg) was reported in T_3 - 8 x 8 - Garden soil + Cocopeat + Vermiculite (1:2:1).Maximum bulblet weight was achieved in soil amended with garden soil, cocopeat, and vermicompost in 12 x 12 polybags due to enhanced carbohydrate translocation underground, facilitating bulblet formation. This nutrient-rich combination promotes stem elongation via increased cell division. Soil microflora continuously mineralize complex substances, synthesizing biologically active metabolites, potentially leading to more leaves per plant and heavier bulb weight [10].

The maximum number of flowers per 250 m^2 (10032.75) was observed with T_{10}- 12 x 12 - Garden soil + Vermicompost + Cocopeat (1:1:2) followed by T_{11} - 12 x 12 - Garden soil + Cocopeat + Vermiculite (1:2:1) (9867.12 kg) whereas, minimum (5312.34) was reported in T_3 - 8 x 8 - Garden soil + Cocopeat + Vermiculite (1:2:1).Cocopeat and vermicompost positively impact flower numbers due to their enhanced structure, nutrient content, and moisture retention, especially in larger polybags. [5] found the highest net returns in gerbera flowers with a cocopeat and vermicompost blend (1:1 ratio), consistent with [37] for gerberas. Similar outcomes were seen by [25] and [27] in *Lilium longiflorum*, [41] in Asiatic cultivars, and [41] in Oriental lilies.

4. CONCLUSION

The present study indicates that the treatment involving garden soil, cocopeat, and vermicompost in 12 x 12 polybags exhibited superior growth and yield attributes compared to other treatments. This superiority is likely due to their positive effects on soil structure, nutrient availability, and moisture retention, which significantly influence both vegetative and reproductive characteristics of lilium plants. The utilization of cocopeat and vermicompost as amendments has been demonstrated to have a beneficial impact on various aspects of plant growth, such as plant height, leaf number and dimensions, flower characteristics, bulb weight, and shelf life. By optimizing the composition of the medium, growers have the potential to enhance crop productivity, quality, and marketability, meeting the requirements of both local and export markets. Furthermore, insights gained from this study contribute to our understanding of the role of organic amendments in sustainable horticultural practices and emphasize their potential for improving crop production and post-harvest traits.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Table1.Metrological observations during the experimental period of Nov.2023 -Mar.2024

Monthandyear	Week	Temperature (°C)		Relativehumidity (%)	
		Max.	Min.	Max.	Min.
November, 2023	1st week	36.35	22.89	89.84	49.70
	2nd week	27.90	25.39	86.27	47.70
	3rd week	27.30	13.04	85.49	39.13
	4th week	25.22	29.99	92.99	61.99
December, 2023	1st week	33.20	13.84	86.56	47.70
	2nd week	31.75	10.56	89.41	53.70
	3rd week	27.09	10.99	92.56	60.41
	4th week	21.00	9.59	97.70	64.56
January,2024	1st week	24.77	15.24	94.70	58.99
	2nd week	21.32	10.70	94.56	74.70
	3rd week	18.92	9.84	98.27	68.13
	4th week	22.00	14.84	95.27	75.27
February,2024	1st week	27.18	12.88	82.13	47.13
	2nd week	29.78	14.99	77.56	47.28
	3rd week	31.21	13.85	80.42	46.56
	4th week	35.86	15.70	77.99	44.70
March,2024	1st week	37.66	15.62	77.56	42.42
	2nd week	37.92	16.88	78.85	42.70

	3rd week	35.61	16.42	82.13	54.28
	4th week	34.38	20.22	70.56	49.59

Table 2. Effect of potting mixture and polybag size on growth and floral parameters of Asiatic lily

Tr.	Plant height (cm)	Number of leaves/plant	Leaf length (cm)	Leaf width (cm)	Number of Flower Buds/Plant	Days to appearance of flower bud	Flower bud length (cm)	Stalk Length (cm)	Self-life of flower (days)
T_1	64.53	51.53	7.40	2.47	2.55	50.25	7.33	62.30	10.33
T_2	60.73	51.20	8.07	2.60	2.73	46.50	6.64	61.45	11.83
T_3	61.40	47.63	7.03	2.73	2.23	50.83	6.73	60.10	10.02
T_4	61.27	50.74	7.97	2.80	3.87	49.53	7.20	61.25	12.12
T_5	64.60	52.88	7.40	2.77	3.03	44.12	7.37	63.11	10.49
T_6	62.73	51.27	6.83	2.57	3.27	48.73	7.67	61.80	11.62
T_7	63.40	52.43	7.83	2.87	3.08	45.97	7.53	63.30	12.18
T_8	64.63	51.93	8.10	2.70	3.15	50.20	7.43	63.28	10.55
T_9	65.73	53.97	7.90	2.63	3.21	44.40	7.83	64.50	13.77
T_{10}	69.30	54.18	8.60	3.03	4.60	40.10	8.43	68.15	15.22
T_{11}	66.27	54.07	7.97	2.97	3.93	41.20	7.99	67.30	14.58
T_{12}	61.33	54.00	8.17	2.67	3.37	42.50	7.64	66.12	13.26
F-Test	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**
S.Ed (±)	**1.97**	**2.62**	**0.46**	**0.19**	**0.19**	**0.99**	**0.35**	**1.50**	**0.81**
$CD_{(0.05)}$	**4.09**	**5.45**	**0.97**	**0.52**	**0.41**	**2.05**	**0.73**	**3.13**	**3.24**

Table 3. Effect of potting mixture and polybag sizeon bulb and yield parameters of Asiatic lily

Treatments	Diameter of the Bulb (cm)	Weight of bulb per plant (g)	Weight of bulb per plant (kg)	Weight of bulb per 250 m^2 (kg)	Number of Flowers per 250 m^2
T_1	4.20	49.88	0.050	104.54	7338.78
T_2	4.52	47.02	0.047	106.69	8528.02
T_3	3.98	43.91	0.043	102.37	5312.34
T_4	4.11	52.27	0.052	118.61	7489.22
T_5	4.29	56.38	0.056	124.14	8094.38
T_6	4.75	58.33	0.058	127.25	9442.86
T_7	4.52	56.92	0.057	119.32	9298.04
T_8	4.47	54.07	0.054	116.29	9342.18
T_9	5.21	58.61	0.059	130.55	9574.91
T_{10}	6.12	64.75	0.064	143.81	10032.75
T_{11}	5.78	62.18	0.062	140.38	9867.12
T_{12}	5.45	59.55	0.060	138.24	9612.88
F-Test	**S**	**S**	**S**	**S**	**S**
S.Ed (±)	**0.11**	**1.98**	**1.56**	**6.05**	**543.95**
CD (5%)	**0.24**	**4.22**	**4.01**	**14.23**	**1091.12**