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THE ROLE OF SOILLESS SUBSTRATES AND CHITOSAN TREATMENT IN ENHANCING THE VEGETATIVE GROWTH OF LILIUM CV. BREAK OUT GROWN UNDER SHADE NET CONDITION

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ABSTRACT

The present investigation was carried out at the Horticultural experimental field, Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (Allahabad), during season of October 2022-2023 and 2023-2024, Showed significant variation in vegetative growth of lilium and other related parameters experiment. The present investigation was conducted on Asiatic lilium cv Break Out in a two factor factorial experiment in Factorial Complete Randomized Design which comprise of 4 types of soilless substates viz., (Peat, Perlite, leaf mould and coconut fiber) and three concentration of chitosan viz., (0.00, 100, 250 and 400ppm) and their combination. The findings revealed that among the treatment M_2: Peat+Perlite +Leaf Mould (1:1:1) performed better in most of the vegetative growth viz., days taken to bulb sprouting, plant height (cm), number of leafs per plant, stem diameter (cm), leaf length (cm), leaf width (cm) and plant spread (cm) of lilium cv. Break Out. Among different concentration of foliar application of chitosan, plants applied with C_2:250ppm Chitosan performed better over control in most of the vegetative growth parameters viz., days taken to bulb sprouting, plant height (cm), number of leafs per plant, stem diameter (cm), leaf length (cm), leaf width (cm) and plant spread (cm) of lilium Cv. Break Out. Among different combinations of both soilless susbstrates and foliar application of chitosan, plant applied with T_{11}:(M_2: Peat+Perlite +Leaf Mould (1:1:1)+C_2:250ppm Chitosan) performed better over control in relation to the majority of the vegetative growth parameters viz., days taken to bulb sprouting, plant height (cm), number of leafs per plant, stem diameter (cm), leaf length (cm), leaf width (cm) and plant spread (cm) of lilium cv. Break Out grown under shade net condition.

***Keywords* :** Soilless substrates, Chitosan growth and lilium.

Introduction

Lilium is considered one of the most elegant and sought-after bulbous flowers in the realm of ornamental horticulture. The genus Lilium belongs to the Liliaceae family and includes around 100 species. Historically, these flowers have been celebrated for their visual appeal and are often associated with pureness and nobility. The Northern Hemisphere is the native habitat of the lily, thriving in regions of Asia, Europe, and North America. They can be found growing at elevations ranging from sea level to 2000 meters, adapting to various soil types, including alkaline and acidic soils (Rajera *et al.,* 2017). Utilizing soilless culture is a proficient method for enhancing the efficiency of water use, addressing local water shortages, and fostering the production of premium quality crops, even in areas where soil conditions are not favorable (Gruda, 2019). This cultivation strategy poses a reduced threat to the environment and promotes ideal circumstances for plant development, achieving better results than those obtained through traditional farming techniques. A suitable soilless growing medium is essential for successful soilless culture, and a variety of mineral and organic substrates are currently employed in these systems. Common alternatives to peat include coir, pine bark, wood fiber, and green composts (Barrett *et al.,* 2016). Nonetheless, Rajera *et al.* noted instances of root damage due to fungal infections in Boston ferns, which they attributed to waterlogging in the growing medium. In their research, Magnani *et al*. (2003) examined the use of lapillus as a growth medium for Gladiolus and Lilium species, discovering significant disparities in performance among the different cultivars. Furthermore, Wilson *et al*. (2009) indicated that Aglaonema cultivated in substrates consisting of different proportions of peat, bark, stalite, rice hulls, and coir showed no significant alterations in plant height, growth index, visual quality, or the dry weight of shoots and roots after a period of 24 weeks. It has been observed that Aglaonema demonstrates a significant tolerance to a range of chemical composition, physical properties, and nutritional characteristics of the growing medium. In the field of ornamental horticulture, there is a significant demand for high-quality products; for instance, cut roses with stems shorter than 30 cm are deemed unmarketable. Customer preferences for lily cut flowers mirror those for rose cut flowers, necessitating that lily growers deliver superior products to the marketplace. The cultivation and production of superior lily cut flowers in a soilless substrates culture require the identification of the optimal growing medium for this purpose.

Materials and Methods

The present investigation 'Effect of soilless substrates and chitosan treatment on vegetative growth of Lilium cv. Break Out grown under shade net condition' was conducted at Horticulture Research Field, Department of Horticulture, Sam Higginbottom University of Agriculture, Technology and Sciences, during the year 2022-2023 and 2023-2024. The experimental material for the research investigation was Asiatic Lillium cv. Break out. For the research bulbs were obtained from Derck Schipper Bloembollen/ Exporet B.B. Stede Broacweg 10*1611 HV Bovenkarspel Product of Holland. Uniformly sized lilium bulbs, categorized as 12/14 size, were chosen for the experimental procedure. The bulbs were positioned in the soil at a depth ranging from 5 to 7 inches. The pots were kept sheltered and protected inside a shade net house. Different soiless susbtrates were prepared using peat, perlite, leaf mould and coconut fiber in different proportions. Prior to bulb planting, the components of the growing media underwent a thorough solar sterilization process lasting one week. Thorough cleaning of the media constituents was done by removing the stones, pebbles and unwanted materials present in it. Different growing media were prepared by mixing peat, perlite, leaf mould and coconut fiber in required ratios volume by volume. The media was then poured into earthen pots that had drainage holes to allow for aeration and the removal of excess water. The experiment comprised of different soilless substrates growing media viz., (Peat, perlite, leaf mould and coconut fiber) and foliar application of different concentration of chitosan viz., (0.00, 100, 250 and 400ppm) having 16 treatment combinations. The experimental was laid out in Factorial Complete Randomized Design (FCRBD) with three replications and the data were analyzed accordingly. The treatments in each replication were allotted randomly. Sixteen factor combinations having one cultivar were tried in the experimental design. The data generated from present investigations were subjected to the statistical analysis in accordance with the procedure outlined by Panse and Sukhatme (1985). The significance of differences among growing conditions, foliar application treatments and their combinations means were tested by F-test.

Results and Discussion

The observation on vegetative growth parameters of lilium as influenced by different soilless substrates and foliar application of different concentration of chitosan have been represented in table 1. The combined data from the first and second years (2022-23 and 2023-2024) indicated that the minimum number of days required for bulb sprouting was significantly lower (8.66 days) in plants cultivated in the M_2 treatment, which consisted of a mixture of Peat, Perlite, and Leaf Mould in a 1:1:1 ratio. This result was statistically comparable to that of the M_3 treatment, which included Peat, Perlite, and Coconut Fiber in the same ratio. However, maximum days taken to bulb sprouting (11.15) were reported in the plant growing in control M_0: Soil. Among the foliar application of various concentration of chitosan, Significantly lowest days to taken bulb sprouting (8.78) was recorded in C_2 which includes application of 250 ppm Chitosan via foliar methods showed statistical parity with the reference treatment C_1:100ppm Chitosan. However, a highest day to taken bulb sprouting (10.25) was recorded in C_0 (foliar application of water). During both the years as well as in the pooled values, significant differences were observed in interaction effect of different soilless susbtrates and foliar application of various concentration of chitosan on days taken to bulb sprouting. The interaction results showed that, lowest days taken to bulb sprouting (7.75, 7.25 and 7.50) was recored in treatment T_{11}:(M_2: Peat+Perlite +Leaf Mould (1:1:1)+C_2:250ppm Chitosan). Whereas the highest days to bulb sprouting (11.66, 15.50 and 13.58) was recorded in control

T_1:(M_0: Soil+C_0:Water The development of lilium can be linked to the improved porosity and aeration of the soil, which results from the incorporation of sand and cocopeat. This combination fosters an optimal environment for the growth of small sprouts and facilitates the early sprouting of lilium. Lyngdoh *et al.* (2015) observed early sprouting during the multiplication of lilium scales in a cocopeat-based medium. Similarly, Masoodi and Nayeem (2018) noted that the shortest duration for bulb sprouting occurred when scales were introduced into a propagation medium composed of perlite and vermiculite. When evaluating the soilless substrates individually, it was found that plants cultivated in a Peat+Perlite+Leaf Mould medium exhibited early bulb sprouting, whereas those grown in soil experienced delayed bulb sprouting. The outcomes of this study are consistent with the research conducted by Karagüze Özgül (2020). Furthermore, Tehranifar *et al.* (2011) indicated that the maximum length of flower stems was attained when utilizing a substrate consisting of 100% cocopeat, as well as a mixture comprising 40% peat and 60% perlite. Significantly maximum plant height (90.84, 105.45 & 98.15) at 75 DAP was recorded in the plants growing in M_2: Peat+Perlite +Leaf Mould (1:1:1), which was statistically at par with treatment M_3: Peat+Perlite+Coconut fiiber (1:1:1). However, minimum plant height (cm) (68.31, 93.05 & 80.68) ws reported in the plant growing in control M_0: Soil. During the first and second year (2022-23 & 2023-2024) research experiment with the pooled data respectively. The application of different concentrations of chitosan via foliar methods resulted in the highest recorded plant heights (cm) at 75 days after planting (DAP), with values of 84.26, 103.31, and 93.79 observed in treatment C_2, which utilized a 250 ppm chitosan solution. This treatment demonstrated statistical equivalence to both treatment C_3, which employed a 400 ppm chitosan concentration, and treatment C1, which used a 100 ppm chitosan solution. However, lowest plant height (cm) (81.51, 99.32 and 90.42) was recorded in C_0 (foliar application of water). One potential reason for this phenomenon may be that the growth substrate provides plants with essential nutrients and moisture, which are vital for maximizing plant height. The lack or inadequate levels of essential nutrients in the selected growing medium can impede the growth and development of plants. The results demonstrated that cocopeat and leaf mould exerted a more pronounced quantitative effect on plant height in comparison to the other treatments, as observed by Younis *et al.* (2015). Comparable findings were reported by Yaseem *et al.* (2012) in their study on Carnation, by Gupta *et al.* (2004) in relation to Gerbera, and by Jawaharlal *et al.* (2001) concerning Anthurium. Kakoei and Salehi (2013) also reported comparable results in various pot mixtures for spathiphyllum. In contrast, Merhaut and Newman (2005) concluded that the application of coir and peat had no substantial impact on plant growth metrics, including shoot dry weight, across both varieties of lilium. These findings align with the research conducted by Özgür Kahraman and Arda Akçal (2016). Research indicates that the foliar application of chitosan significantly supports plant growth under conditions of mild stress. This phenomenon has also been documented in sweet pepper (Ghoname *et al.,* 2010), as well as in cucumber and radish (Farouk *et al.,* 2011). Chitosan facilitates the availability and absorption of water and mineral nutrients by influencing cellular osmotic pressure and encouraging the production of reactive oxygen species (ROS), which are subsequently reduced through increased antioxidant and enzyme activity (Guan *et al.,* 2009). Moreover, chitosan plays a significant role in reducing the detrimental effects of water stress by stimulating the activity of crucial enzymes associated with nitrogen metabolism and aiding in the transport of nitrogen in functional leaves. This process results in an elevated photosynthetic rate, which in turn supports plant growth and development (Mondal *et al.,* 2012). These results are consistent with the findings of Ananthaselvi *et al.* (2019) in marigold. A considerable maximum of leafs leaves can be observed on each individual plant (96.46, 97.33 and 96.90) at 75 DAP was recorded in the plants growing in M_2: Peat+Perlite +Leaf Mould (1:1:1), the data indicated a statistical parity with the treatment applied M_1: Peat + Perlite (1:1) and M_3: Peat+Perlite+Coconut fiiber (1:1:1). However, minimum number of leafs per plant (82.87, 79.88 and 81.38) was reported in the plant growing in control M_0: Soil. During the first and second year (2022-23 & 2023-2024) research experiment with the pooled data respectively. Among the foliar application of various concentration of chitosan, significantly highest number of leafs per plant at 75 DAP (94.42, 89.63 and 92.03) was recorded in C_2 which includes foliar application of 250ppm Chitosan which was statistically at par with treatment C_3:400ppm Chitosan and C_1:100ppm Chitosan. However, lowest number of leafs per plant (91.21, 86.71 and 88.96) was recorded in C_0 (foliar application of water). The quantity of leaves per stem primarily increases in relation to the nutritional status of the plant. Supporting this observation are the results presented by Yonis *et al.* (2015) and Ahmed *et al.* (2012) in their studies on Rose, in addition to the findings of Riaz *et al.* (2008) regarding Zinnia. Kakoei and Salehi (2013) observed comparable outcomes for spathiphyllum when subjected to various potting mixtures. In contrast, Merhaut and Newman (2005) found that the incorporation of coir and peat had no significant effect on growth metrics, including shoot dry weight, in both lilium varieties. These findings align with the reports of Özgür Kahraman and Arda Akçal (2016). Significantly maximum stem diameter (1.70, 1.72 and 1.71) was recorded in the plants growing in M_2: Peat+Perlite +Leaf Mould (1:1:1), The results were statistically comparable to the treatment M_3: Peat+Perlite+Coconut fiiber (1:1:1). However, minimum stem diameter (1.29, 1.52 and 1.41) was reported in the plant growing in control M_0: Soil. During the first and second year (2022-23 & 2023-2024) research experiment with the pooled data respectively. Among the foliar application of various concentration of chitosan, Significantly highest stem diameter (cm) (1.59, 1.66 and 1.63) was recorded in C_2 which includes The application of Chitosan at a concentration of 250 ppm via foliar methods showed statistical parity with the reference treatment C_3:400ppm Chitosan and C_1:100ppm Chitosan. However, lowest stem diameter (1.46, 1.55 and 1.51) was recorded in C_0 (foliar application of water). The observed differences may be attributed to the growth substrate providing essential nutrients and moisture, which are vital for maximizing stem diameter. Tehranifar *et al.* (2011) indicated that substrates composed of 100% cocopeat and a combination of 40% peat with 60% perlite resulted in the longest stem lengths. In a similar vein, Tribulato and Noto (2001) discovered that the stem length of Lilium varieties increased with the use of peat and a basalt mixture. Grassotti *et al.* (2003) found that longer flower stems were associated with substrates containing perlite and coconut, coconut fiber, and a combination of perlite and peat, in contrast to those grown in clay pellets with coconut fiber and perlite. Additionally, Lopez *et al.* (2008) noted that in gladiolus (*Gladiolus tristis* subsp. *concolor*), plants cultivated in peat exhibited greater stem length, spike length, and number of florets compared to those grown in perlite. It is argued that the observed differences between this study and the results reported by earlier researchers can be attributed to variations in the types of growing media, their volumes, the growth conditions employed, ecological factors, and the plant varieties involved. Significantly maximum leaf length (cm) (9.06, 8.01 and 8.54) was recorded in the plants growing in M_2: Peat+Perlite +Leaf Mould (1:1:1), The results were statistically comparable to the treatment M_1: Peat + Perlite (1:1) and M_3: Peat+Perlite+Coconut fiiber (1:1:1). However, minimum leaf length (cm) (8.83, 7.81 and 8.33) was reported in the plant growing in control M_0: Soil. During the first and second year (2022-23 & 2023-2024) research experiment with the pooled data respectively. Among the foliar application of various concentration of chitosan, Significantly highest leaf length (cm) (9.04, 8.01 annd 8.53) was recorded in C_2 which includes foliar application of 250ppm Chitosan which was statistically at par with treatment C_3:400ppm Chitosan and C_1:100ppm Chitosan. However, lowest leaf length (cm) (8.86, 7.82 and 8.34) was recorded in C_0 (foliar application of water). The observed phenomenon may be attributed to the growth substrate's provision of all necessary nutrients and water to the plants, which is crucial for achieving optimal leaf length. Comparable findings regarding lamina length were reported in a study examining various freesia cultivars (Tahir *et al.,* 2011). These results also corroborated the conclusions of Saygılı (2012), who noted differing leaf lengths for lilium across various substrates. Significantly maximum leaf width (cm) (1.56, 1.51 and 1.54) was recorded in the plants growing in M_2: Peat+Perlite +Leaf Mould (1:1:1), the results were statistically comparable to the treatment M_1: Peat + Perlite (1:1) and M_3: Peat+Perlite+Coconut fiiber (1:1:1). However, minimum leaf width (cm) (1.49, 1.46 and 1.48) was reported in the plant growing in control M_0: Soil. During the first and second year (2022-23 & 2023-2024) research experiment with the pooled data respectively. Among the foliar application of various concentration of chitosan, significantly highest leaf width (cm) (1.54, 1.52 and 1.53) was recorded in C_2, C_1 and C_3 which includes foliar application of 250ppm, 100ppm and 400ppm Chitosan. However, lowest leaf width (cm) (1.49, 1.45 and 1.47) was recorded in C_0 (foliar application of water). It is plausible that all growth characteristics interact synergistically to contribute to the increase in leaf width. Similar results were observed regarding lamina length in research conducted by Tahir *et al.* (2011) on various freesia cultivars. These findings corroborate the observations made by Saygılı (2012), who reported that different substrates resulted in varying leaf lengths for lilium. Such results align with the studies authored by Arda Akçal and Özgür Kahraman (2016). The application of chitosan through foliar methods enhanced plant development under mild stress conditions. Comparable outcomes were noted in sweet pepper (Ghoname *et al.,* 2010), as well as in cucumber and radish (Farouk *et al.,* 2011).

Table 1: Effect of soilless substrates and chitosan treatment on vegetative growth parameters of Lilium cv. Break Out grown under shade net condition

Effect of Growing Media (v/v)	Days taken to bulb sprouting			Plant height (cm) at 75 DAP			Stem Diameter (cm)			Leaf length (cm)			Leaf width (cm)			Plant spread (cm)		
	2022-2023	2023-2024	Pooled	2022-2023	2023-2024	Pooled	2022-2023	2023-2024	Pooled	2022-2023	2023-2024	Pooled	2022-2023	2023-2024	Pooled	2022-2023	2023-2024	Pooled
M_0: Soil	10.44	11.85	11.15	68.31	93.05	80.68	1.29	1.52	1.41	8.83	7.81	8.33	1.49	1.46	1.48	15.90	16.76	16.33
M_1: Peat + Perlite (1:1)	9.46	8.84	9.15	83.28	100.74	92.01	1.47	1.57	1.52	8.92	7.85	8.39	1.50	1.50	1.50	16.04	19.50	17.77
M_2: Peat+Perlite +Leaf Mould (1:1:1)	9.06	8.25	8.66	90.84	105.45	98.15	1.70	1.72	1.71	9.06	8.01	8.54	1.56	1.51	1.54	16.75	20.60	18.68
M_3: Peat+Perlite+Coconut fiiber (1:1:1)	9.06	8.65	8.86	87.25	105.41	96.34	1.62	1.66	1.65	8.96	7.95	8.46	1.55	1.48	1.52	16.62	19.42	18.02
F-Test	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**
S.Ed. (±)	**0.100**	**0.096**	**0.071**	**0.936**	**1.169**	**0.8108**	**0.017**	**0.017**	**0.0124**	**0.106**	**0.089**	**0.0675**	**0.018**	**0.018**	**0.0118**	**0.172**	**0.236**	**0.1485**
CD (5%)	**0.204**	**0.196**	**0.1445**	**1.906**	**2.380**	**1.6515**	**0.036**	**0.035**	**0.0252**	**0.216**	**0.182**	**0.1375**	**0.037**	**0.036**	**0.024**	**0.350**	**0.482**	**0.3025**
Effect of Chitosan																		
C_0-Water	10.06	10.44	10.25	81.51	99.32	90.42	1.46	1.55	1.51	8.86	7.82	8.34	1.49	1.45	1.47	16.23	17.59	16.91
C_1:100ppm Chitosan	9.54	8.81	9.18	83.00	100.82	91.92	1.52	1.61	1.57	8.96	7.94	8.45	1.54	1.47	1.51	16.4	18.99	17.70
C_2:250ppm Chitosan	8.79	8.77	8.78	84.26	103.31	93.79	**1.59**	1.66	1.63	9.04	8.01	8.53	1.54	1.52	1.53	16.42	21.42	18.92
C_3:400ppm Chitosan	9.63	9.56	9.60	80.89	101.21	91.05	1.5	**1.64**	1.57	8.91	7.86	8.39	1.51	1.52	1.52	16.26	18.27	17.27
F-Test	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**
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CD (5%)	**0.204**	**0.196**	**0.1445**	**1.906**	**2.380**	**1.6515**	**0.036**	**0.035**	**0.0252**	**0.216**	**0.182**	**0.1375**	**0.037**	**0.036**	**0.024**	**0.350**	**0.482**	**0.3025**
Treatment combinations																		
T_1:(M_0: Soil+C_0:Water)	11.66	15.50	13.58	66.75	90.51	78.63	1.20	1.38	1.29	8.55	7.78	8.17	1.46	1.4	1.43	15.85	16.02	15.94
T_2:(M_0: Soil+C_1:100ppm Chitosan)	10.42	10.00	10.21	70.28	92.92	81.61	1.23	1.54	1.39	8.77	7.82	8.30	1.49	1.42	1.46	15.86	16.31	16.09
T_3:(M_0: Soil+C_2:250ppm Chitosan)	9.58	10.00	9.79	68.29	96.12	82.21	1.30	1.52	1.41	8.9	7.83	8.37	1.53	1.52	1.53	15.87	17.27	16.57
T_4:(M_0: Soil+C_3:400ppm Chitosan	10.08	11.92	11	67.91	92.65	80.29	1.42	1.65	1.54	9.11	7.81	8.46	1.5	1.43	1.47	16.01	17.46	16.74
T_5:(M_1: Peat + Perlite (1:1)+C_0:Water)	9.67	9.17	9.42	81.66	98.01	89.84	1.49	1.55	1.52	8.72	7.84	8.28	1.47	1.57	1.52	16.16	16.92	16.54
T_6:(M_1: Peat + Perlite (1:1)+C_1:100ppm Chitosan)	9.25	9.00	9.125	84.65	101.78	93.22	1.48	1.53	1.51	9.09	7.87	8.48	1.52	1.47	1.50	15.95	16.28	16.12
T_7:(M_1: Peat + Perlite (1:1)+C_2:250ppm Chitosan)	9.00	8.84	8.92	84.08	101.19	92.64	1.50	1.53	1.52	8.93	7.91	8.42	1.5	1.54	1.52	16.17	17.91	17.04
T_8:(M_1: Peat + Perlite (1:1)+C_3:400ppm Chitosan)	9.92	8.33	9.125	82.71	101.98	92.35	1.42	1.66	1.54	8.93	7.79	8.36	1.46	1.42	1.44	15.88	17.56	16.72
T_9:(M_2: Peat+Perlite +Leaf Mould (1:1:1)+C_0:Water)	9.91	9.00	9.455	87.95	101.67	94.81	1.54	1.66	1.61	9.14	7.91	8.53	1.5	1.56	1.53	16.48	18.53	17.51
T_{10}:(M_2: Peat+Perlite +Leaf Mould (1:1:1)+C_1:100ppm Chitosan)	9.33	8.08	8.705	89.12	103.06	96.10	1.64	1.61	1.63	8.69	7.99	8.34	1.54	1.48	1.51	16.59	18.84	17.72
T_{11}:(M_2: Peat+Perlite +Leaf Mould (1:1:1)+C_2:250ppm Chitosan)	7.75	7.25	7.5	97.97	109.73	103.85	1.86	1.83	1.85	9.28	8.27	8.78	1.67	1.56	1.62	17.30	21.49	19.40
T_{12}:(M_2: Peat+Perlite +Leaf Mould (1:1:1)+C_3:400ppm Chitosan)	9.25	8.67	8.96	88.32	107.35	97.84	1.75	1.77	1.76	9.13	7.88	8.51	1.52	1.53	1.53	16.63	19.13	17.88
T_{13}:(M_3: Peat+Perlite+Coconut fiiber (1:1:1)+C_0:Water)	9.00	8.17	8.585	86.15	104.67	95.41	1.59	1.63	1.61	9.04	7.87	8.46	1.51	1.45	1.48	16.45	18.90	17.68
T_{14}:(M_3: Peat+Perlite+Coconut fiiber (1:1:1)+C_1:100ppm Chitosan)	9.17	8.17	8.67	91.49	107.94	99.72	1.73	1.78	1.76	9.31	8.08	8.70	1.63	1.5	1.57	17.21	20.53	18.87
T_{15}:(M_3: Peat+Perlite+Coconut fiiber (1:1:1)+C_2:250ppm Chitosan	8.83	9.00	8.915	86.72	106.19	96.46	1.72	1.69	1.71	8.52	8.04	8.28	1.48	1.46	1.47	16.32	19.30	17.81
T_{16}:(M_3: Peat+Perlite+Coconut fiiber (1:1:1)+C_3:400ppm Chitosan	9.25	9.25	9.25	84.64	102.85	93.75	1.43	1.55	1.49	8.98	7.82	8.40	1.57	1.52	1.55	16.52	18.93	17.73
F-Test	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**	**S**
S.Ed. (±)	**0.200**	**0.193**	**0.1419**	**1.872**	**2.337**	**1.6215**	**0.035**	**0.034**	**0.0247**	**0.212**	**0.179**	**0.135**	**0.036**	**0.036**	**0.0236**	**0.343**	**0.473**	**0.297**
CD (5%)	**0.408**	**0.393**	**0.2891**	**3.813**	**4.761**	**3.3029**	**0.071**	**0.070**	**0.0504**	**0.432**	**0.364**	**0.2749**	**0.074**	**0.072**	**0.048**	**0.700**	**0.963**	**0.6049**

Chitosan improves the availability and absorption of water and mineral nutrients by modifying cell osmotic pressure and promoting the production of reactive oxygen species (ROS), which are mitigated by increased antioxidant and enzyme activity (Guan *et al.*, 2009). Furthermore, chitosan alleviates the detrimental effects of water stress by enhancing the activity of key enzymes involved in nitrogen metabolism and facilitating nitrogen transport in functional leaves, thereby boosting the photosynthetic rate and promoting overall plant growth and development (Mondal *et al.*, 2012). These findings are consistent with the reports by Ananthaselvi *et al.* (2019) concerning marigold. Significantly maximum plant spread (cm) (16.75, 20.60 and 18.68) was recorded in the plants growing in M_2: Peat+Perlite +Leaf Mould (1:1:1), which was statistically at par with treatment M_1: Peat + Perlite (1:1) and M_3: Peat+Perlite+Coconut fiiber (1:1:1). However, minimum plant spread (cm) (15.90, 16.76 and 16.33) was reported in the plant growing in control M_0: Soil. During the first and second year (2022-23 & 2023-2024) research experiment with the pooled data respectively. Among the foliar application of various concentration of chitosan, Significantly highest plant spread (cm) (16.42, 21.42 and 18.92) was recorded in C_2 which includes foliar application of 250ppm Chitosan which was statistically at par with treatment C_3:400ppm Chitosan and C_1:100ppm Chitosan. However, lowest plant spread (cm) (16.23, 17.59 and 16.91) was recorded in C_0 (foliar application of water). The observed increase in plant spread (cm) may be attributed to the cumulative effects of various growth parameters. Kakoei and Salehi (2013) reported similar findings in different potting mixtures for spathiphyllum. Conversely, Merhaut and Newman (2005) indicated that the incorporation of coir and peat did not significantly affect plant growth, including shoot dry weight, in either of the lilium varieties. Throughout both years, as well as in the aggregated data, significant differences were noted in the interaction effects of various soilless substrates and the foliar application of different concentrations of chitosan on the vegetative growth parameters of lilium in pots. The interaction results showed that, highest vegetative growth parameters was recorded in treatment T_{11} :(M_2: Peat+Perlite +Leaf Mould (1:1:1) +C_2: 250ppm Chitosan). Whereas the lowest vegetative growth parameters was recorded in control T_1: (M_0: Soil+C_0:Water).

Conclusion

It is concluded that treatment T_{11}:(M_2: Peat+ Perlite+Leaf Mould (1:1:1)+C_2:250ppm Chitosan observations documented include the least number of days taken for bulb sprouting, the tallest plant height (cm), the total number of leaves per plant, the stem diameter (cm), as well as the dimensions of the leaves in terms of length and width in centimeters, and the plant spread (cm) for Lilium. cv. Break Out grown under shade net condition. The effect of interaction of soilless substrates and chitosan on vegetative growth of Lilium cv. Break Out grown was recorded significantly maximum.

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