Standardization of growing substrates to produce quality cut *Lilium* under agro-climatic conditions of Faisalabad, Pakistan.

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Abstract: The research work presented in this dissertation was carried out at Rose Project Research Area, Institute of Horticultural Sciences, University of Agriculture, Faisalabad, during 2015- 2016 to evaluate comparative efficacy of various substrates on vegetative and reproductive growth of Asiatic Lilium hybrid L. 'Vermeer' for cut flower production. Soilless substrates are increasingly used to produce cut flowers of superior quality. Nutritional status and standardization of growing substrate is of prime importance for the quality production of cut flowers. Cut *Lilium* production is gaining momentum in Pakistan, but growers are unaware of advanced production systems and techniques for best quality flower production. Moreover, very limited work has been reported so far on efficacy of various organic substrates for cut *Lilium* production in the country. Therefore, keeping in view above mentioned characteristics, an experiment was conducted using coco coir, mushroom compost and conventional medium alone or in various combinations as growing substrates. Substrates were mixed by volume and filled in wooden crates after lining with polythene sheet and making small holes for drainage as per following treatments, viz. Soil + Silt (Control) (1:1, v/ v), Mushroom Compost, Coco Coir, Silt + Mushroom Compost (1:1; v/ v), Silt + Coco Coir (1:1; v/ v), Mushroom Compost + Coco Coir (1:1; v/ v) and Silt + Mushroom Compost + Coco Coir (1:1:1; v/ v/ v). The experiment was laid out in a completely randomized design (CRD) with seven treatments. Each treatment was replicated thrice having twelve plants per replication. The objectives of this study were to standardize growing substrates to produce best quality cut *Lilium* and to evaluate suitability of coco coir and or mushroom compost in comparison to traditionally used soil/silt for flower production under agro- climatic conditions of Faisalabad. Result concluded that plants grown with coco coir alone and in combination with soil + silt had best performance regarding most of the parameters studied. Therefore, growers may use coco coir alone or mixed with soil/ silt for better growth and superior quality stem production of cut Asiatic *Lilium*.

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Key words: Cut flowers, 'Vermeer' *Lilium*, agro- climatic

1. Introduction

Floriculture industry is gaining popularity at a rapid pace in Pakistan. Cut flower product ion has risen due to elevating demand for their common use in bouquets, arrangements at community events, celebrating occasions and for decoration purpose (Usman and Ashfaq, 2013). Agro-climatic conditions of Pakistan are tremendously favorable to produce flowers (SMEDA, 2009). Annual production of cut flowers in Pakistan and is about 10- 12 thousand tons per annum (Khosa et al., 2011). *Lilium* L. belongs to family *Liliaceae*, which has a prominent place as cut f lowers, garden plants and potted plants production in horticulture (Lim and van Tuyl, 2006). It is one of the most demanding cut flower serving international markets with 150 million cut stems for total sales per year (Burchi et al., 2010). Asiatic and Oriental lilies have been produced as cut flowers for long and got fame in recent years. After *Tulipa*, *Lilium* attains second position in production of bulbous crops in Holland (vander Meulen- Muisers, 1999).

Cut flowers demand is increasing sharply in our country, particularly in early winter when scarce blooming is observed during this period. Superior quality flower production requires strong consideration for nutrients uptake. For getting desired plants with superior quality flowers, the significance of growing substrate cannot be negotiated (Ahmad et al., 2012 b). Garden soils possess weed seeds, stimulating the invasion of soil borne diseases (Jacobs et al., 2009). For producing superior quality flowers, utilization of substrate mix is the key element. Utilization of many agricultural by- products as a nutrient source and substrate substitute has been attaining additional significance and response in floriculture. Nursery growers and flower farmers are keenly interested in developing enhanced substrate mix to produce superior quality ornamental plants

(Grigatti, 2008). The use of soilless substrates as growing media has enhanced the vitality of horticultural crops positively than the traditional soil culture (Massantini et al., 1988). Soilless substrates enhance crop yield by influencing production protocols, lowering labor strength, leaving no requirement for soil fumigation and providing additional crops annually (Tuzel et al., 2008).

Recommended physical properties percentage of growth substrates includes 45- 65% water retention ability, 50- 80% total porosity, and 0.19 to 0.70 g/ cm3 bulk density (Yeager et al., 2007). While pH 5.2- 6.3, electrical conductivity 0.75- 3.49 dS m- 1, organic matter >80%, nitrate 100- 199 (mg mL- 1), potassium 150- 249 (mg mL- 1), sodium <115 (mg mL- 1), chlorine <180 (mg mL- 1) and sulphur dioxide <960 (mg mL- 1) are the chemical attributes of an ideal substrate (Abad et al., 2001). Coco coir, a by- product of coconut industry, has been fortified to substitute peat. Utilization of coconut coir as growth substrate is intensifying due to having numerous properties same as peat and has excellent bio- stability (Lennartsson, 1997). Coco fiber has excellent chemical properties including electrical conductivity, pH (Abad et al., 2002). Incorporation of coarse textured materials in coco coir would enhance the physical characteristics of the substrate (Richards and Beardshell, 1986).

The surplus wastes after harvesting of different mushroom flushes are called spent mushroom compost. Nutrients used for the growth of valuable photosynthetic plants are present in spent mushroom compost (Fasidi et al., 2008). Mushroom compost is a good source of phosphorus (Larson, 1980). Spent mushroom compost increases electrical conductivity, pH and the level of macronutrients but reducing the water retention ability in the growing medium (Medina et al., 2009). Now- a- days, composts of different substrates are becoming popular in potting substrates due to the advantage of minimizing many deleterious effects like high salt concentration, nitrogen immobilization and phytotoxicity (Verdonck, 1988).

Composts possess physico- chemical characteristics identical to peat and can be used as its replacement (Sanchez- Monederoet al., 2004). The objectives of this study were to standardize growing substrates to produce best quality cut *Lilium* and to evaluate suitability of coco coir and or mushroom compost in comparison to traditionally used soil/silt for flower production under agro- climatic conditions of Faisalabad.

2. Materials and methods

The present study was conducted at Rose Project Research Area, Institute of Horticultural Sciences, University of Agriculture, Faisalabad, to evaluate the best supporting growing substrate for cut lilium production. The bulbs were purchased from a well-reputed importing agency, transported to the laboratory from cold storage within 4h, acclimatized in laboratory for a week at ambient temperature and relative humidity, treated with 2% Ridomil Gold solution for 10 minutes to disinfect against fungi and air dried under shade before planting. Substrates were mixed by volume and filled in wooden crates after lining with polythene sheet and making small holes for drainage. Substrates were used as per following treatments:

T1 = Soil + Silt (Control) (1:1, v/ v)
T2 = Mushroom Compost
T3 = Coco Coir
T4 = Silt + Mushroom Compost (1:1; v/ v)
T5 = Silt + Coco Coir (1:1; v/ v)
T6 = Mushroom Compost + Coco Coir (1:1; v/ v)
T7 = Silt + Mushroom Compost + Coco Coir (1:1:1; v/ v/ v)

The experiment was laid out in a completely randomized design (CRD) with seven treatments. Each treatment was replicated thrice having twelve plants per replication. Bulbs were planted 7.5 cm deep with 7.5 cm bulb to bulb distance in 10 cm spaced rows in 30 × 40 cm size wooden crates containing substrates. All cultural practices such as fertilization, irrigation, IPM, hoeing, staking etc. were similar for all treatments during entire period of study. Data were collected on following parameters using standard procedures: stem length (cm), leaf area (cm^2), leaf transpiration rate (mmol m^{-2} s^{-1}), photosynthetic rate (µmol m^{-2} s^{-1}), leaf temperature (ºC), sub- stomatal CO2 (vpm), production time (days), bud diameter (cm), flower diameter (cm), stem diameter (cm), and diameter of bulbs (cm). Data were analyzed statistically using Statistix 8.1 sof tware. Analysis of variance technique was used to determine the overall significance of data, while Least Significant Difference (LSD) test ($P \leq 0.05$) was used to compare the differences among the means (Steel et al., 1997).

3. Results and discussion

3.1. Stem length (cm)

The results obtained from (table 1.1) of comparison means and (fig 1.1) that represent the comparative effect of different substrates on stem length shows that there is a highly significant difference among various substrates and plants grown in soil + silt (control) produced longest stems (45.7 cm) which was statistically similar with coco coir (44.9 cm) and silt + coco coir (42.7 cm). While, plants grown in silt + mushroom compost had shortest stem length (30.5 cm), which was statistically similar with plants grown in silt + mushroom compost + coco coir (32.1 cm) and mushroom compost + coco coir (32.4

cm). Plants grown in mushroom compost had stunted growth and did not produce f lowers. Flowers with longer stems are preferred in cut f lower markets. Results revealed that growing substrates containing soil + silt, coco coir alone and silt+ coco coir increased stem length of *Lilium*, which might be due to higher organic matter, physico- chemical attributes of substrates or greater uptake of nutrients by plants. While, plants grown in mushroom compost had no increase in stem length, which might be due to poor uptake of nutrients. Similarly, Treder (2008) reported that *Lilium* grown in coco coir had longer stems as compared to other substrates.

Table1.1: Comparison of treatment means for stem length (cm) of cut 'Vermeer' *Lilium*.

Original order		Ranked order	
Soil+ Silt	45.7a[Z]	Soil+ Silt	45.7a
Mushroom compost	0.0c	Coco coir	44.9a
Coco coir	44.9a	Silt+ coco coir	42.7a
Silt+ mushroom compost	30.5b	Mushroom compost+ coco coir	32.4b
Silt+ coco coir	42.7a	Silt+ mushroom compost+ coco coir	32.1b
Mushroom compost+	32.4b	Silt+ mushroom	30.4b
Coco coir		Compost	
Silt+ mushroom compost+ coco coir	32.1b	Mushroom compost	0.0c
Significance [Y]		P<0.0001	

Z = Mean separation within columns by fishers LSD at P> 0.05.
Y= P values were obtained using general linear models (GLM) procedures of statistix (version 8.1 analytical software) for effect of growing substrates.

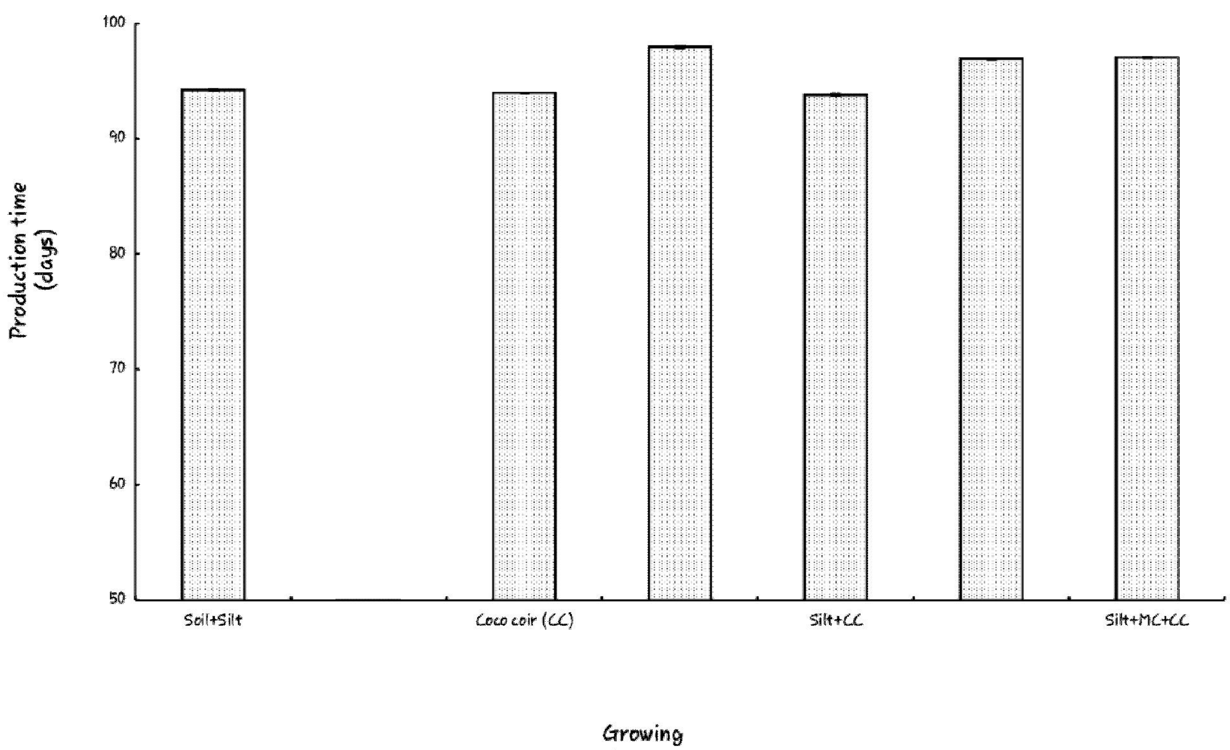

Fig. 1.1 Efficacy of various growing substrates on stem length (cm) of cut 'Vermeer' *Lilium*.

3.2. Leaf Area (cm²)

The results obtained from (table 1.2) of comparison means and (fig 1.2) that represent the comparative effect of different substrates on leaf area shows that there is a highly significant difference among various substrates and plants grown in silt + coco coir had the maximum leaf area (4.7 cm2), which was statistically at par with coco coir (4.5 cm2) and soil + silt (4.3 cm2). Minimum leaf area (1.79 cm2) was observed in plants grown in mushroom compost.

Plants grown in silt + mushroom compost + coco coir had 3.3 cm2 leaf area which was statistically similar with mushroom compost + coco coir (3.07 cm2) and silt + mushroom compost (2.76 cm2). The availability of nutrients in growing substrate greatly affects the size of leaves. Best substrate having adequate supply of nutrients may have increased the area of leaves. Maximum increase in size of leaves shows adaptability of plants to substrate. Maximum leaf area was obtained in silt + coco coir, which could be due to sufficient supply of nutrients and less transpiration rate, while, the smallest leaves were produced by mushroom compost when used as a growing substrate which might be due to the insufficient availability of nutrients, less cell division or expansion, and more transpiration rate. These results are in line with the findings of Khayyat et al., (2007) who reported maximum leaf area of *Epipremnum aureum* in growing substrate containing (1:3; v/v) peat: coco coir mixture.

Table1.2: Comparison of treatment means for leaf area (cm^2) of cut 'Vermeer' *Lilium*.

Original order		Ranked order	
Soil+ Silt	$4.2a^Z$	Silt+ coco coir	4.7a
Mushroom compost	1.8c	Coco coir	4.5a
Coco coir	4.5a	Soil+ Silt	4.2a
Silt+ mushroom compost	2.7b	Silt+ mushroom compost+ coco coir	3.3b
Silt+ coco coir	4.7a	Mushroom compost+ coco coir	3.1b
Mushroom compost+ coco coir	3.1b	Silt+ mushroom compost	2.7b
Silt+ mushroom compost+ coco coir	3.3b	Mushroom compost	1.8c

Significance ^{Y} $P<0.0001$

Z =Mean separation with in columns by fisher's LSD at P>0.05.

Y =P values were obtained using general linear models (GLM) procedures of statistix (version 8.1 analytical software) for effect of growing substrates.

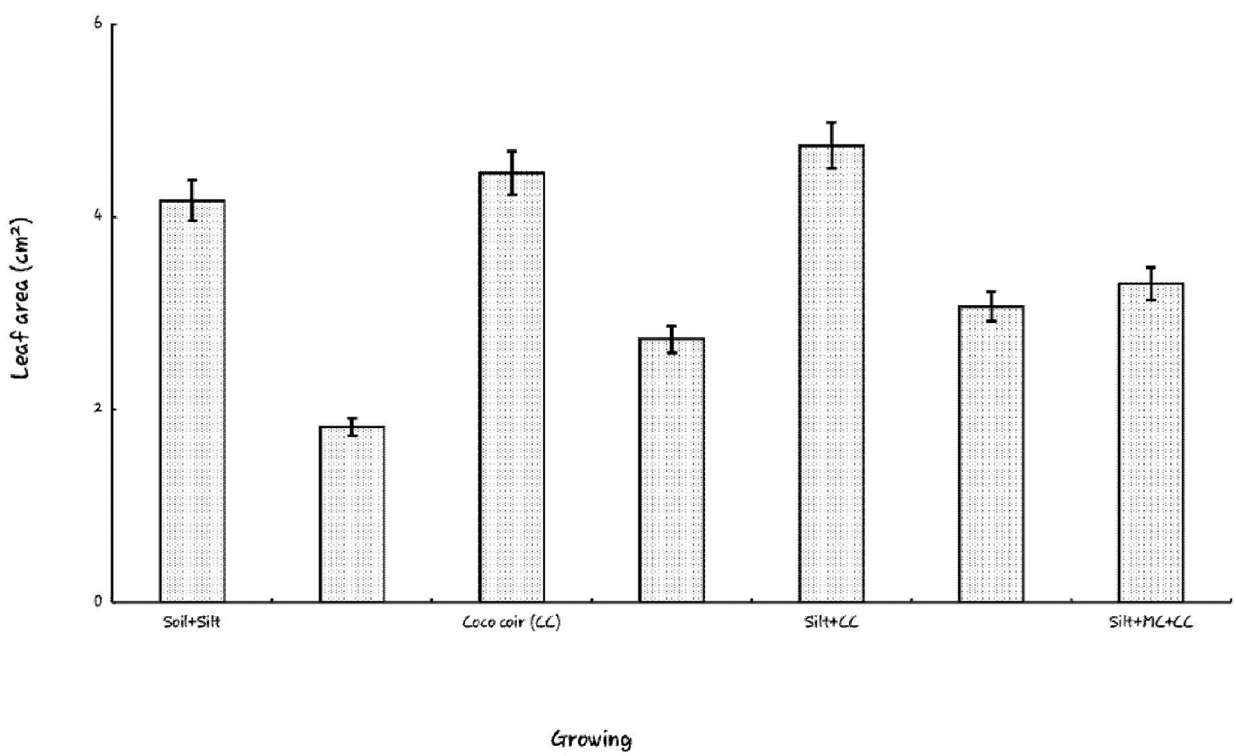

Fig. 1.2 Efficacy of various growing substrates on leaf area (cm^2) of cut 'Vermeer' *Lilium*.

3.3. Leaf Transpiration rate (mmol m^{-2} s^{-1})

The results obtained from (table 1.3) of comparison means and (fig 1.3) that represent the comparative effect of different substrates on leaf transpiration rate shows that there is a significant difference among various substrates and plants grown in coco coir had maximum leaf transpiration rate (7.10 mmol m^{-2} s^{-1}) and minimum in mushroom compost + coco coir (5.4 mmol m^{-2} s^{-1}). Silt + mushroom compost grown plants had 7.3 mmol m^{-2} s^{-1} leaf transpiration rate. While, other substrates yielded non-significant results regarding leaf transpiration rate in plants grown in silt + mushroom compost + coco coir (6.6 mmol m^{-2} s^{-1}), silt + coco coir (6.5 mmol m^{-2} s^{-1}) and soil + silt (6.3 mmol m^{-2} s^{-1}). However, leaf transpiration rate was not recorded in plants grown in mushroom compost due to the poor growth of leaves. Maximum leaf transpiration rate was recorded in coco coir. These results are in accordance with the findings of Raviv et al., (2001) who obtained higher specific transpiration rate of 'kardinal' rose grown in coco coir as compared to others composted substrate.

Table1.3: Comparison of treatment means for leaf transpiration rate (mmol$m^{-2}s^{-1}$) of cut 'Vermeer' *Lilium.*

Original order		Ranked order	
Soil+ Silt	6.3bc[Z]	Coco coir	7.10a
Mushroom compost	0.0d	Silt+ mushroom compost	7.3ab
Coco coir	7.1a	Silt+ mushroom compost+ coco coir	6.6b
Silt+ mushroom compost	7.3ab	Silt+ coco coir	6.5b
Silt+ coco coir	6.5b	Soil+ Silt	6.3bc
Mushroom compost+ coco coir	5.4c	Mushroom compost+ coco coir	5.4c
Silt+ mushroom compost+ coco coir	6.6b	Mushroom compost	0.0d
Significance [Y]		P<0.1	

Z =Mean separation with in columns by fisher's LSD at P>0.05.
Y =P values were obtained using general linear models (GLM) procedures of statistix (version 8.1 analytical software) for effect of growing

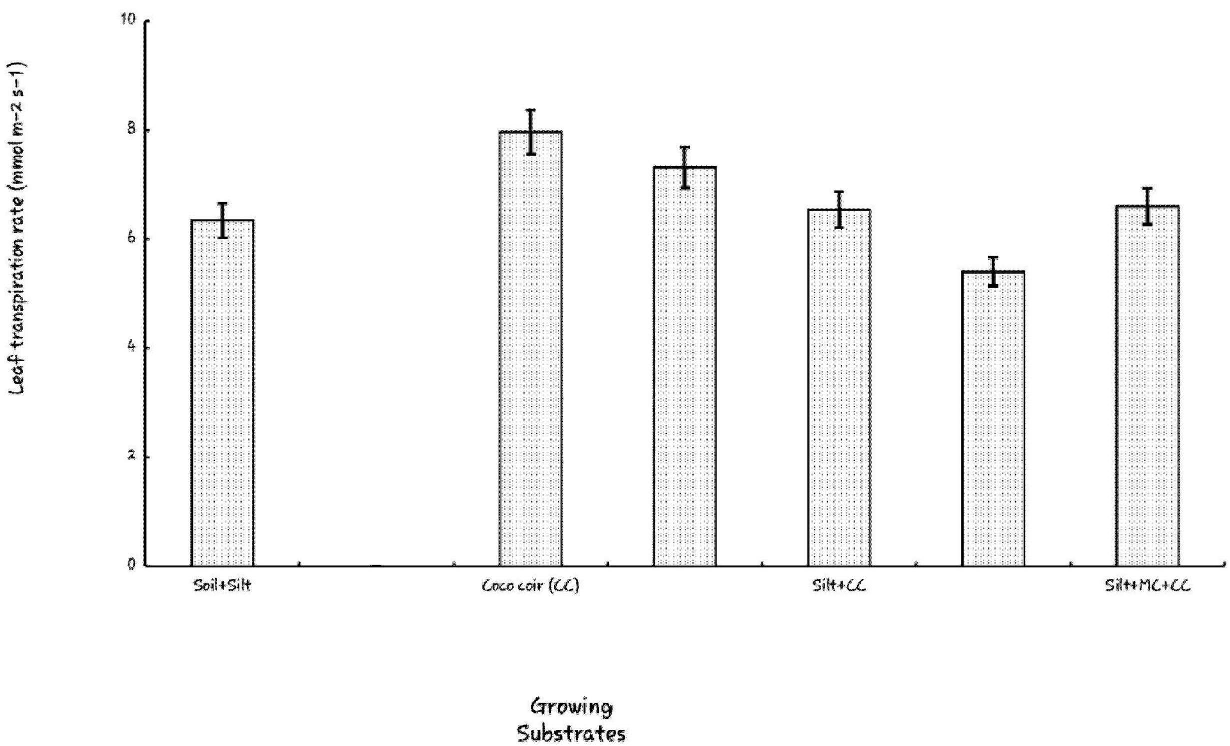

Fig.1.3 Efficacy of various growing substrates on leaf transpiration rate (mmol$m^{-2}s^{-1}$) of cut 'Vermeer' *Lilium.*

3.4. Photosynthetic rate (µmol m^{-2} s^{-1})

The results obtained from (table 1.4) of comparison means and (fig 1.4) that represent the comparative effect of different substrates on photosynthetic rate shows that there is a non-significant difference among various substrates with maximum photosynthetic rate in plants grown in coco coir (7.3 µmol m^{-2} s^{-1}) and minimum in mushroom compost + coco coir (1.0 µmol m^{-2} s^{-1}). Silt + mushroom compost grown plants had 5.8 µmol m^{-2} s^{-1}, soil + silt (3.9 µmol m^{-2} s^{-1}), silt + coco coir (3.9 µmol m^{-2} s^{-1}), silt + mushroom compost + coco coir (3.6 µmol m^{-2} s^{-1}) photosynthetic rates. However, photosynthetic rate was not recorded in mushroom compost due to the poor growth of leaves. Maximum photosynthetic rate was obtained in plants grown in coco coir which was statistically non- significant with all the other substrates. These results are in alliance with the findings of Nazari et al., (2011) who reported maximum photosynthetic rate in cocopeat when used as a growing substrate for *Hyacinthus orientalis*.

Table1.4: Comparison of treatment means for photosynthetic rate (µmol$m^{-2}s^{-1}$) of cut 'Vermeer' *Lilium*.

Original order		Ranked order	
Soil+ Silt	3.9ab^{Z}	Coco coir	7.3a
Mushroom compost	0.0d	Silt+ mushroom compost	5.8a
Coco coir	7.3a	Soil+ Silt	3.9ab
Silt+ mushroom compost	5.8a	Silt+ coco coir	3.9ab
Silt+ coco coir	3.9ab	Silt+ mushroom compost+ coco coir	3.6ab
Mushroom compost+ coco coir	1.0b	Mushroom compost+ coco coir	1.0b
Silt+ mushroom compost+ coco coir	3.6ab	Mushroom compost	0.0d
Significance ^{Y}		P>0.05	

Z =Mean separation with in columns by fisher's LSD at P>0.05 Y =P values were obtained using general linear models (GLM) procedures of statistix (version 8.1 analytical software) for effect of growing substrates.

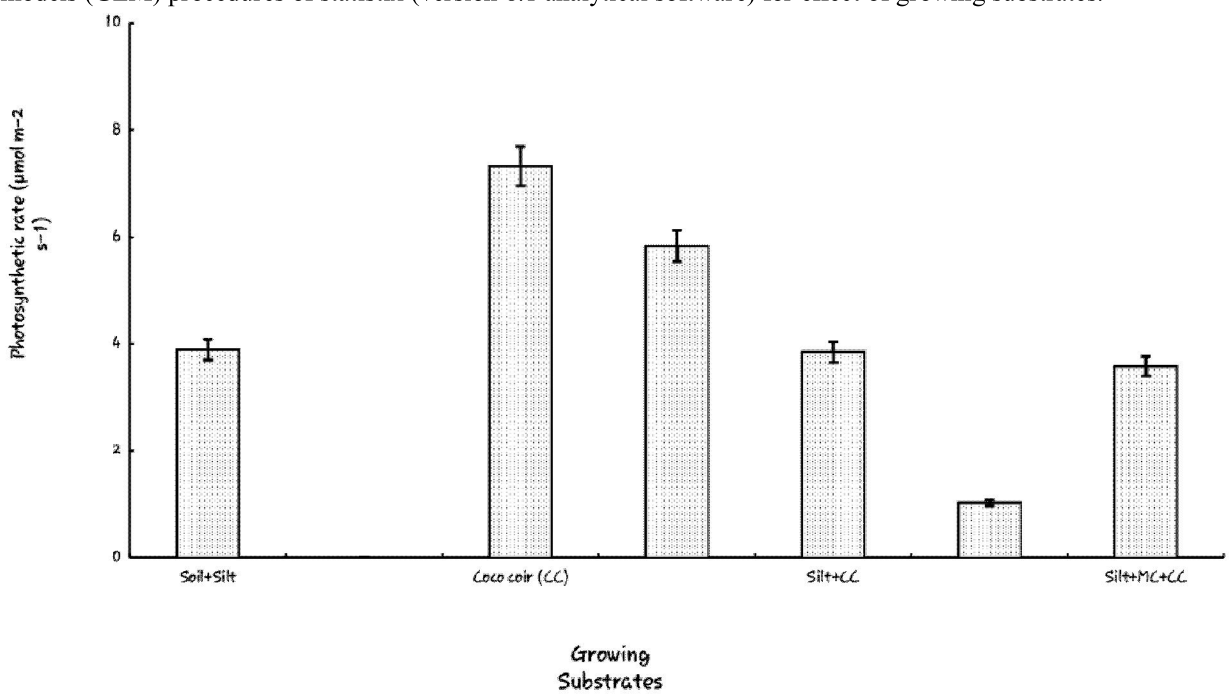

Fig.1.4 Efficacy of various growing substrates on photosynthetic rate (µmolm-2s-1) of cut 'Vermeer' *Lilium*.

3.5. Sub- stomatal CO2 (vpm)

The results obtained from (table 1.5) of comparison means and (fig 1.5) that represent the comparative effect of different substrates on Sub- stomatal CO2 shows that there are non- significant differences among various substrates and plants grown in coco coir had the maximum sub- stomatal CO2 (409.5 vpm) and minimum in soil + silt (373.5 vpm). Following silt + coco coir (389.5 vpm), mushroom compost + coco coir (388.0 vpm), silt + mushroom compost (384.5 vpm) silt + mushroom compost + coco coir (379.5 vpm). However, sub- stomatal CO2 was not recorded in mushroom compost due to the poor growth of leaves. Maximum sub- stomatal CO2 was found plants grown in coco coir. These results are similar with the findings of Nazari et al., (2011) who obtained maximum sub- stomatal CO2 in coco peat when used as a growing substrate for *Hyacinthus orientalis*.

Table1.5: Comparison of treatment means for sub-stomatal CO2 (vpm) of cut 'Vermeer' *Lilium.*

Original order		Ranked order	
Soil+ Silt	373.5b[Z]	Coco coir	409.5a
Mushroom compost	0.0d	Silt+ coco coir	389.5ab
Coco coir	409.5a	Mushroom compost+ coco coir	388.0b
Silt+ mushroom compost	384.5b	Silt+ mushroom compost	384.5b
Silt+ coco coir	389.5ab	Silt+ mushroom compost+ coco coir	379.5b
Mushroom compost+ coco coir	388.0b	Soil+ Silt	373.5b
Silt+ mushroom compost+ coco coir	379.5b	Mushroom compost	0.0d
Significance [Y]		P>0.05	

Z = Mean separation with in columns by fisher's LSD at P>0.05.
Y =P values were obtained using general linear models (GLM) procedures of statisti (version 8.1 analytical software) for effect of growing substrates.

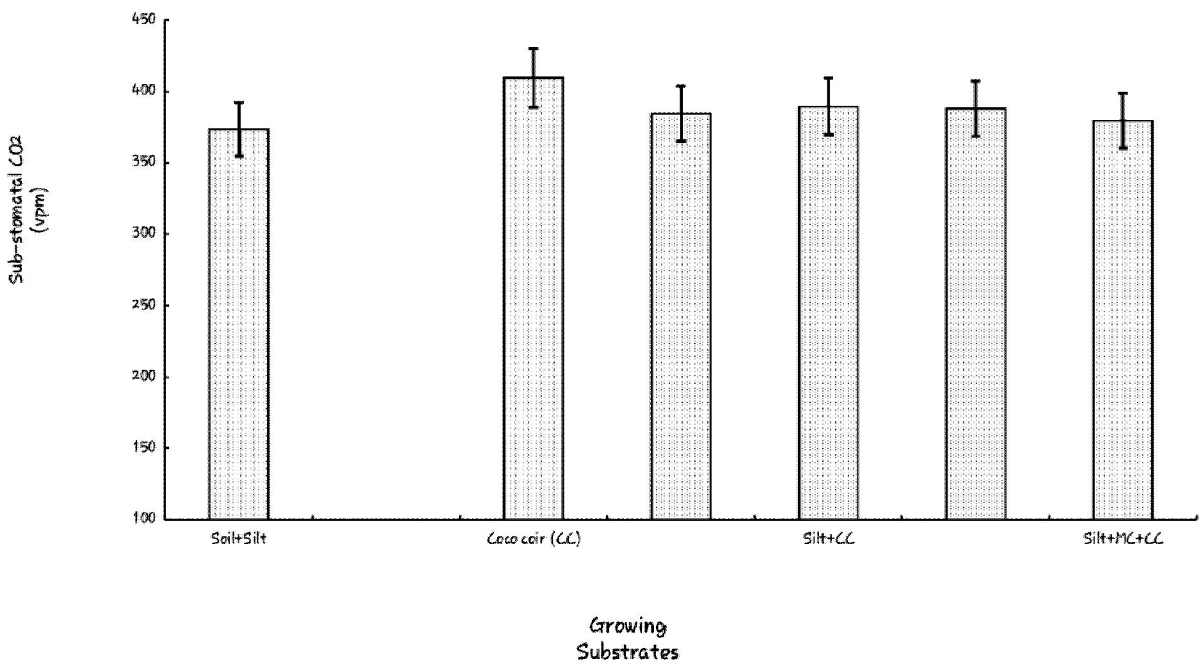

Fig. 1.5 Efficacy of various growing substrates on sub- stomatal CO2 (vpm) of cut 'Vermeer' *Lilium.*

3.6. Production time (days)

The results obtained from (table 1.6) of comparison means and (fig 1.6) that represent the comparative effect of different substrates on production time (days) shows that there are highly significant differences among various substrates and plants grown in silt + coco coir had least production time (93.8 days) which was statistically at par with coco coir (94.0 days) and soil + silt (94.3 days). Maximum production time was recorded in mushroom compost (110.0 days). While, plants grown in mushroom compost + coco coir had 96.9 days, silt + mushroom compost + coco coir had 97.1 days and silt + mushroom compost had 98.0 days production time. In floriculture, early flowering in plants has great importance. Early flowering species will be harvested early and fetch premium price in market. To minimize production time, different methods are being practiced in floriculture. Good growing substrate can reduce production time in flowering plants by early flowering because it may contain balanced nutrients required for plant growth. Best results regarding production time was found in silt + coco coir, which could be due to optimal physico- chemical characteristics of the substrate required for a quality plant growth. Lowest results regarding production time was recorded in mushroom compost, which might be due to unsuitability of the substrate for the plant. These results are in alliance with the findings of Treder (2008) who reported early blooming of lilies in substrate comprising coco peat.

Table1.6: Comparison of treatment means for production time (days) of cut 'Vermeer' *Lilium*.

Original order		Ranked order	
Soil+ Silt	94.3bc[Z]	Silt+ mushroom compost	98.0a
Mushroom compost	0.0d	Silt+ mushroom compost+ coco coir	97.1ab
Coco coir	94.0c	Mushroom compost+ coco coir	96.9ab
Silt+ mushroom compost	98.0a	Soil+ Silt	94.3bc
Silt+ coco coir	93.8c	Coco coir	94.0c
Mushroom compost+ coco coir	96.9ab	Silt+ coco coir	93.8c
Silt+ mushroom compost+ coco coir	97.1ab	Mushroom compost	0.0d

Significance [Y] P<0.0001

Z = Mean separation with in columns by fisher's LSD at P>0.05.

Y = P values were obtained using general linear models (GLM) procedures of statistix (version 8.1 analytical software) for effect of growing substrates.

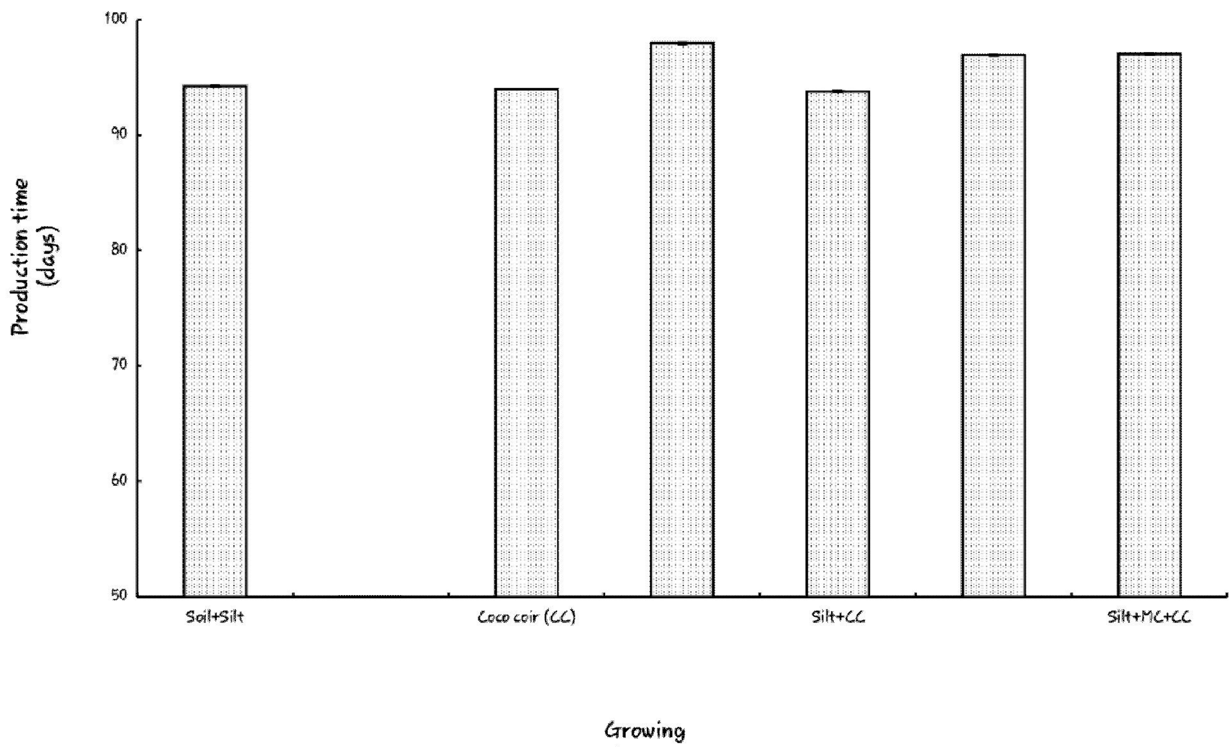

Fig. 1.6 Efficacy of various growing substrates on production time (days) of cut 'Vermeer' *Lilium*

3.7. Bud diameter (cm)

The results obtained from (table 1.7) of comparison means and (fig 1.7) that represent the comparative effect of different substrates on bud diameter (cm) shows that there are highly significant differences among various substrates and maximum bud diameter was recorded in plants grown in soil + silt (1.6 cm), which was statistically at par with coco coir (1.5 cm) and silt + coco coir (1.5 cm). However, no bud formation took place in mushroom compost. Plants grown in silt + mushroom compost had 1.3 cm bud diameter, which was statistically similar with silt + mushroom compost + coco coir (1.3 cm) and mushroom compost + coco coir (1.3 cm). Maximum bud diameter was obtained in soil + silt and coco coir, which might be due to maximum uptake of nutrients. While, no bud formation recorded in mushroom compost that could be due to minimum or no uptake of nutrients.

Table1.7: Comparison of treatment means for bud diameter (cm) of cut 'Vermeer' *Lilium*.

Original order		Ranked order	
Soil+ Silt	1.6a[Z]	Soil+ Silt	1.6a
Mushroom compost	0.0c	Coco coir	1.5a
Coco coir	1.5a	Silt+ coco coir	1.5a
Silt+ mushroom compost	1.3b	Silt+ mushroom compost	1.3b
Silt+ coco coir	1.5a	Silt+ mushroom compost+ coco coir	1.3b
Mushroom compost+ coco coir	1.3b	Mushroom compost+ coco coir	1.3b
Silt+ mushroom compost+ coco coir	1.3b	Mushroom compost	0.0c
Significance [Y]		P<0.0001	

Z = Mean separation with in columns by fisher's LSD at P>0.05.
Y = P values were obtained using general linear models (GLM) procedures of statistix (version 8.1 analytical software) for effect of growing substrates.

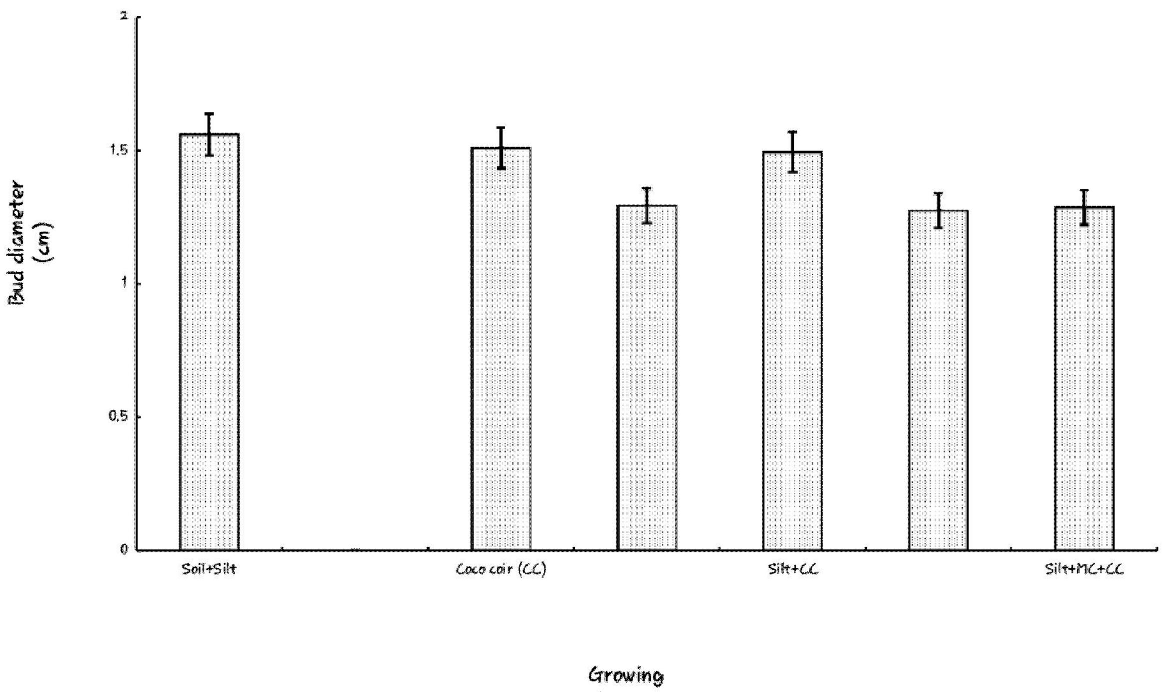

Fig. 1.7 Efficacy of various growing substrates on bud diameter (cm) of cut 'Vermeer' *Lilium*

3.8. Flower diameter (cm)

The results obtained from (table 1.8) of comparison means and (fig 1.8) that represent the comparative effect of different substrates on flower diameter (cm) shows that there are highly significant differences among various substrates and plants grown in soil + silt (control) had maximum f lower diameter (13.6 cm), which was statistically similar with mushroom compost + coco coir (13.5 cm), silt + coco coir (13.1 cm) and coco coir (13.0 cm). However, mushroom compost didn't produce flowers. While, plants grown in silt + mushroom compost + coco coir had 12.5 cm flower diameter and 11.4 cm in silt + mushroom compost. Maximum flowering as well as increase in flower bud diameter and subsequently increase in flower diameter indicates the use of best growing medium. Organic matter in growing substrate and optimum amount of NPK manipulate plant growth and flower size. Maximum flower diameter was obtained in substrate comprising soil + silt and mushroom compost + coco coir, which could be due to rich uptake of nutrients by plant. While, no flower produced in plants grown in mushroom compost, which might be due to poor uptake of nutrients by plants. These results are similar with the findings of Ikram et al., (2012) who reported maximum floral diameter of *Polianthes tuberosa* grown in coco coir + FYM (1:1, v/v).

Table1.8: Comparison of treatment means for flower diameter (cm) of cut 'Vermeer' *Lilium*.

Original order		Ranked order	
Soil+ Silt	13.6a[Z]	Soil+ Silt	13.6a
Mushroom compost	0.0c	Mushroom compost+ coco coir	13.5a
Coco coir	13.0a	Silt+ coco coir	13.1a
Silt+ mushroom compost	11.4b	Coco coir	13.0a
Silt+ coco coir	13.1a	Silt+ mushroom compost+ coco coir	12.5ab
Mushroom compost+ coco coir	13.5a	Silt+ mushroom compost	11.4b
Silt+ mushroom compost+ coco coir	12.5ab	Mushroom compost	0.0c
Significance [Y]		P<0.0001	

Z =Mean separation with in columns by fisher's LSD at P>0.05. Y=P values were obtained using general linear models (GLM) procedures of statistix (version 8.1 analytical software) for effect of growing substrates.

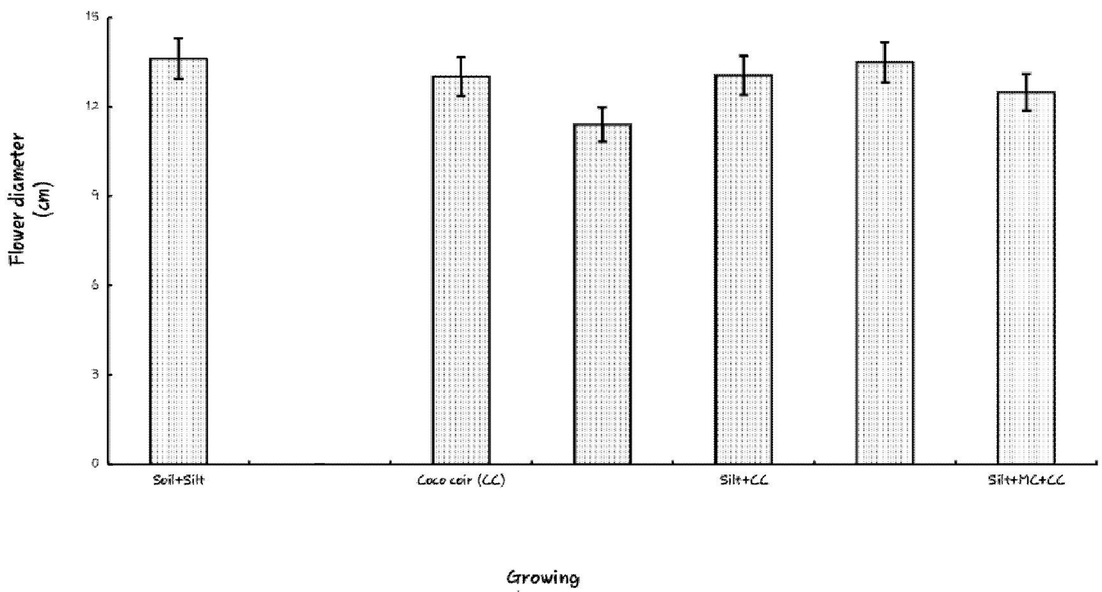

Fig. 1.8 Efficacy of various growing substrates on flower diameter (cm) on cut 'Vermeer' *Lilium*

3.9. Stem diameter (cm)

The results obtained from (table 1.9) of comparison means and (fig 1.9) that represent the comparative effect of different substrates on stem diameter (cm) shows that there are significant differences among various substrates and plants grown in mushroom compost + coco coir had maximum stem diameter (0.7 cm), while, the least stem diameter (0.6 cm) was recorded in plants grown in silt + mushroom compost followed by mushroom compost (0.6), soil + silt (0.6 cm), silt + mushroom compost + coco coir (0.6 cm), coco coir (0.6 cm), silt + coco coir (0.6 cm). Flowers with good stem diameter have high mechanical strength against bending and breaking. Mushroom compost + coco coir produced maximum stem diameter, which might be due to good uptake of nutrients. Whereas, silt + mushroom compost yielded the lowest stem diameter.

Table1.9: Comparison of treatment means for stem diameter (cm) of cut 'Vermeer' *Lilium*.

Original order		Ranked order	
Soil+ Silt	0.6bc[Z]	Mushroom compost+ coco coir	0.7a
Mushroom compost	0.6ab	Mushroom compost	0.6ab
Coco coir	0.6bc	Soil+ Silt	0.6bc
Silt+ mushroom compost	0.6c	Silt+ mushroom compost+ coco coir	0.6bc
Silt+ coco coir	0.6bc	Coco coir	0.6bc
Mushroom compost+ coco coir	0.7a	Silt+ coco coir	0.6bc
Silt+ mushroom	0.6bc	Silt+ mushroom	0.6c

Significance [Y] P<0.01

Z = Mean separation with in columns by fisher's LSD at P>0.05.

Y =P values were obtained using general linear models (GLM) procedures of statistix (version8.1analytical software) for effect of growing substrates.

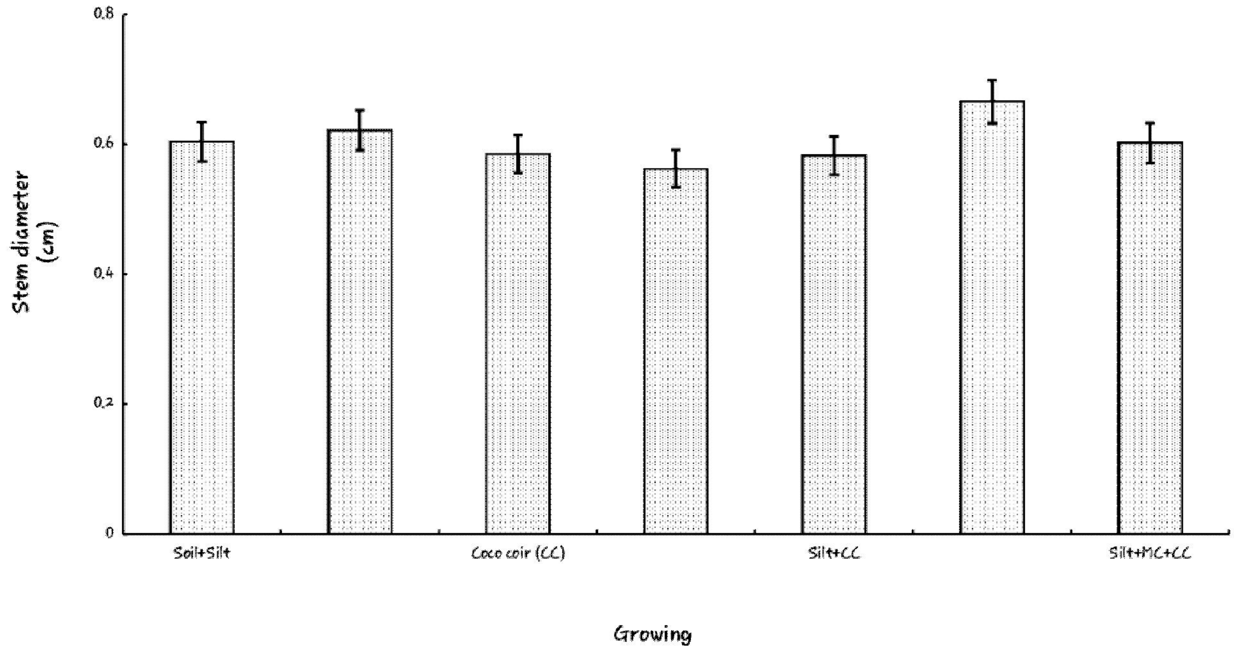

Fig. 1.9 Efficacy of various growing substrates on stem diameter (cm) of cut 'Vermeer' *Lilium*

4. Conclusion

The investigation led to the conclusion that growing substrates are of utmost importance for the better growth and development of flowering plants. Through proper selection of growing substrates, it is possible to attain the maximum yield from a flowering crop. From the present study, it can be concluded that plants grown with coco coir alone and in combination with soil + silt had best performance regarding most of the parameters studied. Therefore, growers may use coco coir alone or mixed with soil/ silt for better growth and superior quality stem production of cut Asiatic *Lilium*.

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