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Effect of Different Substrates on Growth and Flowering of *Dianthus caryophyllus* cv. 'Chauband Mixed'

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Abstract: This study was conducted to evaluate the growth and flowering response of different potting media for the commercial variety of carnation viz. 'Chaubad Mixed'. Different substrates including sand, silt, leaf manure, farmyard manure and garden soil were used in different proportions to check the best suitable medium for carnation plant. Plants parameters of growth and flowering such as plant height, number of branches/plant, length of branches/plant, number of leaves/plant, leaf area (cm^2), least days to first flower emergence, number of flowers/plant, flower diameter (cm) and quality of the flowers showed good results in silt and garden soil but overall leaf compost + sand showed best results while, farmyard manure with higher pH produced the least results regarding all plant parameters. Analysis of potting medium reflected that substrates with appropriate nutrients, electrical conductivity and organic matter, can be amended with different organic materials with different combinations at different rates.

Key words: Carnation · Potting medium · Substrates · Properties of media · Chauband Mixed

INTRODUCTION

There is a continuing interest by using various agricultural by-products as an organic nutrient source for plants due to increasing environment-related issues, as well as the need to dispose of and use rising amounts of waste Grigatti [1]. Recycling organic waste including dung of dairy cattle, poultry waste and animal litter are used as main source of organic matter for supply of essential minerals needed to plants [2-4]. A key advantage for using composted material is its potential to resist against root diseases Raviv [5] and also composts from waste material have the potential to substitute a significant proportion of peat in the growth medium of potted ornamentals Papafotiou *et al*. [6].

Carnation (*Dianthus caryophyllus* L.), (family caryophyllaceae) native to Mediterranean region Salehi [7] is one among the most popular commercial cut flowers of the world and ranked second in commercial importance next only to rose. Though cut carnations are traded in the world market year round, Carnations are high in demand on Valentine's Day, Easter, Mother's Day and Christmas. Miniature carnations are now gaining popularity for their potential use in floral arrangement Anonymous [8].

Different types of factors affect the growth and development of carnation plants. Among them potting media is one of the most important factors which play a key role in quality production of carnation flower. For proper shoot and root growth, a root medium must serve four functions: 1) provide water, 2) supply nutrients, 3) permit gas exchange to and from the roots and 4) provide support for the plants Nelson [9]. Different growing media can be used to grow carnation while the physical and chemical properties of media like structure, texture, pH as well as nitrogen, phosphorus and potassium are the dominant factors for the growth and development of plant Larson [10]. These properties determine the availability of nutrients to plants, mobility of water into or through soil and penetration of roots in the soil. Soil mixes play an important role in pot plant production. Their chemical and physical properties determine the nutritional status of potting media to sustain better plant growth Gabriels *et al.* [11]. Composition and nutritional status of the media is reported by Khasa *et al*. [12] and Carlile [13] to be helpful for the production of good quality flowering plants with more number of flowers and greater size. Organic matter contents of the planting medium have a profound effect on its biological, chemical and physical properties. When after the decomposition of the organic matter, chemical elements become available to the plants. Organic matter provides food and energy to the micro organisms and they help to build good soil structure. All organic matter, except for a small fraction, comes from plants

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remain Kambooh [14]. The choice of the growing media can be made best by using detailed study of the physical and hydraulic characteristics of the growing media Raviv *et al*. [15].

The purpose of this study was to investigate the influence of different growing media with different combinations on the growth and flowering of a popular carnation plant grown as potted plant. Along with studying the morphological characteristics of carnation the chemical properties of media like availability of nutrients, electrical conductivity (EC), organic matter and pH were also evaluated. The chemical analysis of these medium are also correlated with growth and production performance of the carnation.

MATERIALS AND METHODS

This study was conducted at Floriculture Research Area, Institute of Horticultural Sciences, University of Agriculture, Faisalabad during 2009-2011 to evaluate the performance of different potting media for the commercial variety of carnation viz. 'Chaubad Mixed'. Different substrates: sand, silt, leaf manure, farmyard manure and garden soil were used as main source for preparation of media in different proportions and combinations to check the best suitable media for carnation growth and development. Different treatments combinations were, $\mathbf{T_0}$: Garden Soil (control), $\mathbf{T_1}$: Leaf compost + Silt + FYM (1:1:1), $\mathbf{T_2}$: Leaf compost + Silt (1:1), $\mathbf{T_3}$: Farm yard manure (FYM), $\mathbf{T_4}$: Silt, $\mathbf{T_5}$: = Leaf compost + Sand (1:1) on the growth and development of *Dianthus caryophyllus.*

Seedlings were purchased from the nursery having 4 leave stage and were transplanted in 10 inches plastic pots in the month of December. The Experiment was laid out in completely randomized design (CRD). Total six treatments were used where each treatment consisting of 9 plants was replicated three times. Data were collected fortnightly. Observations on the following parameters were recorded using the standard procedure: plant height (cm), number of branches/plant, length of branches (cm), number of leaves/plant, leaf area (cm^2), days to first flower emergence, number of flower/plant, flower diameter (cm) and quality of the flowers. The properties of each medium, including electrical conductivity (EC), organic matter, pH, total nitrogen, available phosphorous and available potassium were also determined. Significant means were compared by using Duncan's Multiple Range (DMR) test at 5% probability level.

Analysis of Media: Following information was procured in relation to each soil medium.

Electrical Conductivity (EC): Salinity was measured by conductivity meter (Model CM-1 Mark V) using a conductivity bridge. 1:1 (soil: water) suspension was prepared and filtered it in the Buchner funnel. Vacuumed pump was started, opened the solution section and added the suspension to Buchner funnel. Soil was filtered into the Buchner funnel till it started cracking. When the filtrate was cleared then it was transferred into a 50ml bottle, immersed the conductivity cell in the solution and reading was taken Bridge method 3a and 4b, U.S. Salanity Lb. staff [16]. Richards [17].

Media pH: The pH was measured by using pH meter (digital ion analyzer). For pH determination by 1:1 (Soil: water) dried growing media sample was taken and add distilled water. 50 g of air-dry soil of the media was taken into a 100ml glass beaker. 50ml distilled water was added using a graduated cylinder and mixed well with a glass rod and allowed standing for 30 minutes. Suspension was stirred after every 10 minutes during this period. Reading was taken by putting the combined electrode in suspension (about 3cm deep). Electrode was removed from the suspension, rinsed thoroughly with distilled water in a separate beaker and excess water was carefully dried Method-21a, U.S. Salinity Lab. Staff [16]. McLean [18].

Organic Matter: 1g air dry soil was taken into a 500ml beaker, 10ml of potassium dichromate solution and 20ml concentrated sulfuric acid were added and swirled the beaker to mix the suspension. After 30 minutes, 20ml of distilled water was added along with 10 ml concentrated orthophosphoric acid and allowed the mixture to cool. 10 to 15 drops of diphenylamine indicator were also used. Titrated the solution with 0.5 M ferrous ammonium sulfate solution and noted the reading till color changed from violet blue to green Walkely [19].

Total Nitrogen: Total nitrogen was determined by distillation of 2M KCL media extract. The media was digested in concentrated H_2SO_4 with a catalyst mixture to raise the boiling temperature and to promote the conversion from organic N to Ammonium-N. Ammonium-N from the digest was obtained by stem distillation using excess NaOH to raise the pH. The distillate was collected in saturated H_3BO_3 and then titrated with dilute H_2SO_4 to pH 5 and note the reading Jackson [20].

Available Phosphorous (ppm): The available phosphorous in the media was determined by Olsen *et al*. [21]. 2.5g air dried ground media soil was taken in conical flasks. Flasks were shaken for 30 minutes with shaker. The suspension was filtered through what man filter paper No. 42.5ml filtrate was pipette out. Color developing reagent @ 5ml was added in 250ml volumetric flask and the volume was made up to the mark. Bluish color was developed; concentration of phosphorous is directly proportional to intensity of blue color developed. Readings was taken on the spectrophotometer, model spectrum 21.

Available Potassium (ppm): The flame photometric method was used for estimation of available potassium. 5.0 g air dried ground soil sample was taken into a 250ml conical flask and extracting reagent @ 50ml was added. It was then shaken on reciprocating shaker for 30 minutes and filtered the extractable K^+ was determined by flame photometer in ppm. Meq / 1 pf K = Meq / 1 of K by calibration curve *x* 50ml of sample Method-18, United States Salinity Laboratory Staff [16].

RESULTS AND DISCUSSION

A comparative study on efficacy of various potting media was conducted and correlated between plant growing media, response in plants.

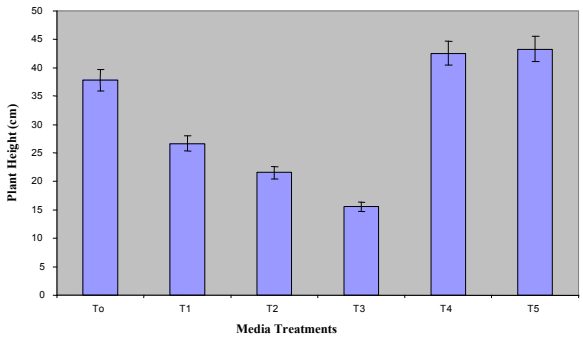
Morphological Traits

Plant Height (cm): Each treatment combination produced varying height in response. Treatment combination T_5 consisting of leaf compost + sand resulted in maximum plant height 43.33cm followed by T_4 (silt) 42.55cm and control 37.77cm while, 26.66cm plant height was observed in T_1 (leaf compost + silt + farm yard manure). The performance of treatment T_3 (farm yard manure) was not satisfactory as it resulted in minimum plant height 15.55cm from Table 1 and Fig. 1.

Results have indicated that leaf compost along with sand and silt alone exerts better qualitative and quantitative effects on plant height as compared to the other treatments. These observations are in line with the findings of Fred *et al.* [22] where they found that ornamental plants like chrysanthemum showed maximum plant height when grown in compost mixes. The results are also confirmed the findings of Fascella [23] who observed increase in number of stems and plant height of *Ruscus hypophyllum*.

Table 1: Comparison of mean values for plant height

Treatment	Means Original Order	Treatment	Means Ranked Order
T_o	37.77	T_5	43.33a
T_1	26.66	T_4	42.55a
T_2	21.55	T_o	37.77ab
T_3	15.55	T_1	26.66bc
T_4	42.55	T_2	21.55c
T_5	43.33	T_3	15.55c



To = Garden Soil, T1 = Leaf compost + silt + FYM (1:1:1), T2 = Leaf compost + silt (1:1), T3 = Farm yard manure (FYM), T4 = Silt, T5 = Leaf compost + sand (1:1)

Fig. 1: Evaluation of different potting media on plant height of Carnation (*Dianthus caryophyllus*)

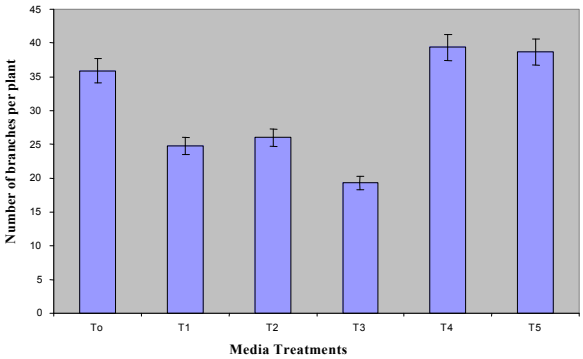
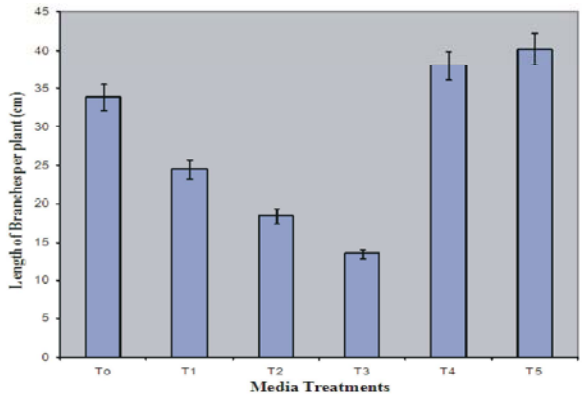


Fig. 2: Evaluation of different potting media on number of branches per plant of Carnation (*Dianthus caryophyllus*)

Number of Branches/Plant: Comparison of means regarding number of branches/plant produced in different substrate showed that in all growing media T_4 (silt) and T_5 (leaf compost + sand) produced almost same number of branches i.e., 39.33 and 38.66, followed by T_o (garden soil) having number of branches per plant 35.88. However, T_2 (leaf compost + silt) and T_1 (leaf compost + silt + farm yard manure) were statistically non significant with 25.99 and 24.77 number of branches per plant respectively. Whereas T_3 (farm yard manure) alone having lowest number of branches per plant 19.33 from Fig. 2.



To = Garden Soil, T1 = Leaf compost + silt + FYM (1:1:1), T2 = Leaf compost + silt (1:1), T3 = Farm yard manure (FYM), T4 = Silt, T5 = Leaf compost + sand (1:1)

Fig. 3: Evaluation of different potting media on length of branches/ plant of Carnation (*Dianthus caryophyllus*)

These results are in accordance with the findings of Riaz *et al.* [3] who noted the highest number of side branches in coconut compost when combined with silt + leaf manure.

Length of Branches/Plant (cm): Results showed that maximum length of branches was observed in T_5 (leaf compost + sand) 40.22 followed by T_4 (silt) 37.99cm. Treatment T_o (garden soil) also gave more length of branches per plant i.e.; 33.88cm. However, T_1 (leaf compost + silt + farm yard manure) and T_2 (leaf compost + silt) produced statistically difference results having 24.55 and 18.44cm length of branches per plant, respectively. While minimum (13.44cm) length of branches per plant was observed in treatment T_3 (farm yard manure). It is apparent of growth parameter, that T_3 exhibit lowest growth while T_5 (leaf compost + sand) presented best growth throughout the experiment mainly due to nutritional status of substrates from Fig. 3.

Similar trends have also been reported by Chen *et al.* [24] that obtained length of branches of Lilium by using perlite + vermiculite + sand as potting media.

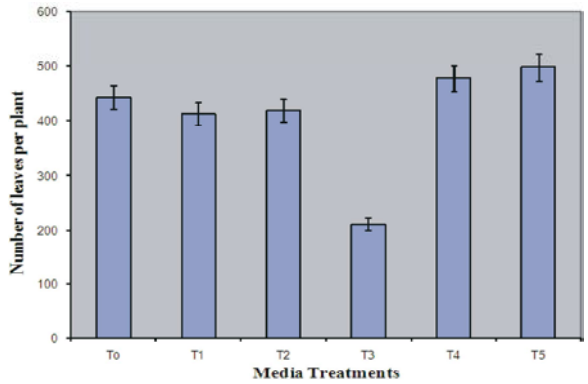
Number of Leaves/Plant: The treatment means exhibited that maximum number of leave (498.44) were produced in response of T_5 where leaf compost + sand (1:1) were used. The plants had maximum number of leaves in T_5 (leaf compost + sand 1:1) followed by T_4 (silt) which had 498.44 and 477.88 leaves respectively. While, T_o (garden soil) having 443.33 number of leaves/plant. The comparison indicated that T_2 (leaf compost + silt 1:1) and T_1 (leaf compost + silt + farm yard manure 1:1:1) with 419.33 and 413.44 leaves respectively were significantly at per with each other. The minimum numbers of leaves (210.88) were observed in T_3 where only farm yard manure alone was used. The main reason for minimum number of leaves in farm yard manure is lack of nutritional level i.e.; phosphorus 5 and potassium 138ppm from Fig. 4.

Above given results are found to be similar with the findings of Cardenas *et al.* [25] which indicated that when Carnation is grown in mixture of 65 and 35% burned rice husk substrate complemented with coconut coir and rice husk showed maximum growth rate for leaf area and number of leaves.

Leaf Area (cm^2): Leaf is the main source of food synthesize, which ultimately affects the plant development. By studying the mean values of leaf area of each treatment. It is apparent that maximum leaf area 4.45cm^2 was recorded in response of T_5 (leaf compost + sand 1:1), while minimum leaf area (2.25cm^2) was observed in treatment T_3 (farm yard manure). However, T_4 (silt) and T_o (garden soil) produced statistically similar results with 4.29 and 4.25cm^2 leaf area, respectively. While T_1 (leaf compost + silt + farm yard manure) and T_2 (leaf compost + silt) produced statistically difference results having 3.74 and 3.59cm^2 leaf area, respectively. It is apparent of growth parameter that T_5 (leaf compost + sand 1:1) exhibit best growth throughout the experiment mainly due to nutritional status of medium and plant leaf nutrients from Fig. 5.

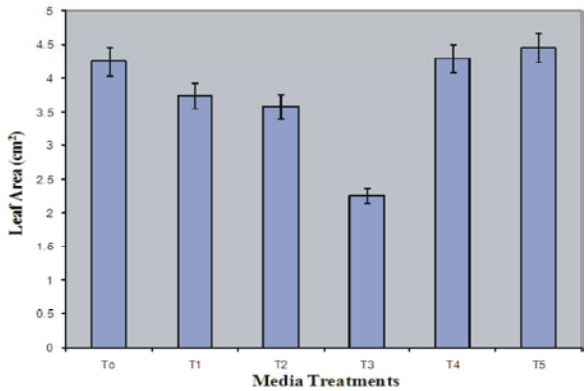
Above results about leaf area is similar to the findings of Cardenas *et al.* [25] for Carnation, which indicate that number of leaves and leaf area were more in burnt and composted rice husk complemented with coconut fiber.

Number of Flowers/Plant: Means comparison of treatments regarding number of flowers per plant depicted superiority of treatment T_5 (leaf compost + sand 1:1) over all other treatments. Treatment T_5 (leaf compost + sand) produced 89.55 flowers/plant while T_4 (silt) and T_o (garden soil) with 79.33 and 76.77 flowers respectively were significantly at par with each other. However, T_1 (leaf compost + silt + farm yard manure) and T_2 (leaf compost + silt) produced statistical significant difference results having 52.21 and 24.88 number of flowers, respectively. While the minimum number of flowers 10.22 was recorded in T_3 (farm yard manure) alone was used.



To = Garden Soil, T1 = Leaf compost + silt + FYM (1:1:1), T2 = Leaf compost + silt (1:1), T3 = Farm yard manure (FYM), T4 = Silt, T5 = Leaf compost + sand (1:1)

Fig. 4: Evaluation of different potting media on number of leaves/ plant of Carnation (*Dianthus caryophyllus*)



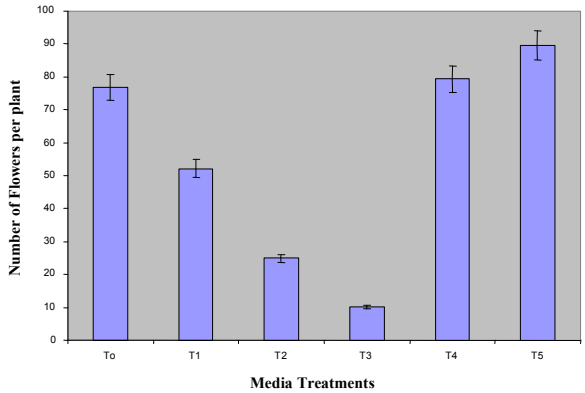
To = Garden Soil, T1 = Leaf compost + silt + FYM (1:1:1), T2 = Leaf compost + silt (1:1), T3 = Farm yard manure (FYM), T4 = Silt, T5 = Leaf compost + sand (1:1)

Fig. 5: Evaluation of different potting media on leaf area of Carnation (*Dianthus caryophyllus*)

Table 2: Comparison of mean values for number of flowers/plant

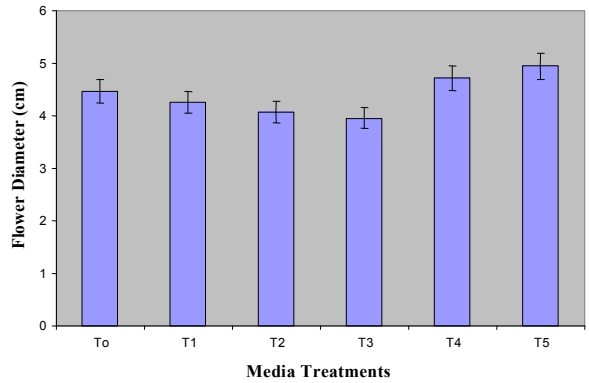
Treatment	Means Original Order	Treatment	Means Ranked Order
T_o	76.77	T_5	89.55a
T_1	52.21	T_4	79.33a
T_2	24.88	T_o	76.77a
T_3	10.22	T_1	52.21b
T_4	79.33	T_2	24.88c
T_5	89.55	T_3	10.22c

These results are in line with the findings of Shahzad [26] who obtained maximum number of flowers in marigold when rice husk, pine wood shaving, sludge and silt were used as growing media (Table 2 and Fig. 6).



To = Garden Soil, T1 = Leaf compost + silt + FYM (1:1:1), T2 = Leaf compost + silt (1:1), T3 = Farm yard manure (FYM), T4 = Silt, T5 = Leaf compost + sand (1:1)

Fig. 6: Evaluation of different potting media on number of flowers /plant of Carnation (*Dianthus caryophyllus*)



To = Garden Soil, T1 = Leaf compost + silt + FYM (1:1:1), T2 = Leaf compost + silt (1:1), T3 = Farm yard manure (FYM), T4 = Silt, T5 = Leaf compost + sand (1:1)

Fig. 7: Evaluation of different potting media on flower diameter (cm) of Carnation (*Dianthus caryophyllus*)

Flower Diameter (cm): Comparison of different growing media showed that T_5 (leaf compost + sand 1:1) produced maximum flower diameter (4.94cm) followed by T_4 (silt) having 4.72cm flower diameter. However, T_o (garden soil), T_1 (leaf compost + silt + farm yard manure), T_2 (leaf compost + silt) produced similar results with 4.46, 4.26 and 4.07cm flower diameter, respectively. While T_3 (farm yard manure) produced minimum flower diameter 3.95cm (Table 3 and Fig. 7).

These results are in agreement to that result of Tailin *et al.* [27] who obtained highest flower diameter of Dahlia by using leaf manure + sand as media.

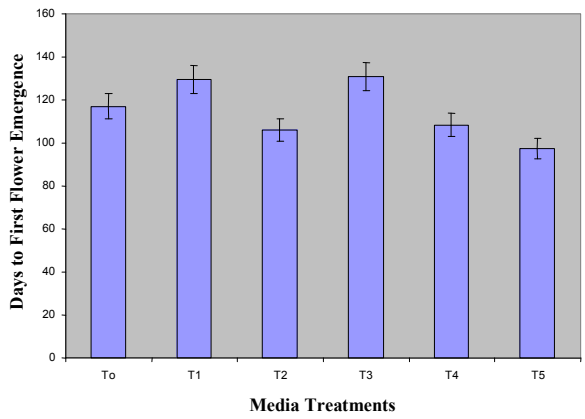
Table 3: Evaluation of different potting media on flower diameter (cm) of Carnation (*Dianthus caryophyllus)* (a) Analysis of variance (ANOVA) for flower diameter (cm)

SOV	df	SS	MS	F - value
Treatments	5	2.1710	0.4342	1.97NS
Error	12	2.6420	0.2201	
Total	17	4.8134		

NS = Non significant (P>0.05)

(b) Comparison of mean values for flower diameter (cm)

Treatment	Means Original Order	Treatment	Means Ranked Order
T_o	4.46	T_5	4.94a
T_1	4.26	T_4	4.72ab
T_2	4.07	T_o	4.46ab
T_3	3.95	T_1	4.26ab
T_4	4.72	T_2	4.07ab
T_5	4.94	T_3	3.95b



To = Garden Soil, T1 = Leaf compost + silt + FYM (1:1:1), T2 = Leaf compost + silt (1:1), T3 = Farm yard manure (FYM), T4 = Silt, T5 = Leaf compost + sand (1:1)

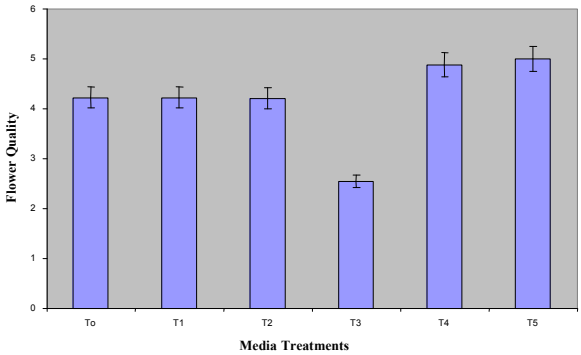
Fig. 8: Evaluation of different potting media on number of days to first flower emergence of Carnation (*Dianthus caryophyllus*)

Days to First Flower Emergence: Results depicted highly significant differences among the treatments in Table 4.1.8 (a) when T_5 (leaf compost + sand 1:1) was used which produced flower in minimum days than all other treatments. The maximum significant (P< 0.05) higher number of days 131 or delayed flowering was taken in T_3 where farm yard manure alone was used from Fig. 8.

These results are in line with the findings of Grassotti *et al.* [28] who observed the reduce time to flowering in media containing coconut fiber together are mixed with clay pellets or peat.

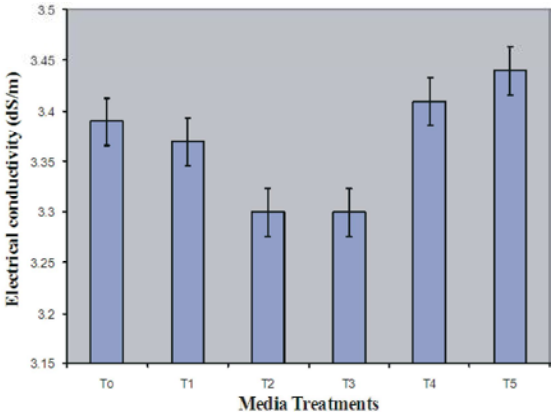
Table 4: Comparison of mean values for quality of carnation flower

Treatment	Means Original Order	Treatment	Means Ranked Order
T_o	4.22	T_5	5a
T_1	4.22	T_4	4.88a
T_2	3.21	T_o	4.22ab
T_3	2.55	T_1	4.22ab
T_4	4.88	T_2	3.21bc
T_5	5.00		



To = Garden Soil, T1 = Leaf compost + silt + FYM (1:1:1), T2 = Leaf compost + silt (1:1), T3 = Farm yard manure (FYM), T4 = Silt, T5 = Leaf compost + sand (1:1)

Fig. 9: Evaluation of different potting media on quality of flower of Carnation (*Dianthus caryophyllus)*



To = Garden Soil, T1 = Leaf compost + silt + FYM (1:1:1), T2 = Leaf compost + silt (1:1), T3 = Farm yard manure (FYM), T4 = Silt, T5 = Leaf compost + sand (1:1)

Fig. 10: Evaluation of potting media electrical conductivity (EC) of Carnation (*Dianthus caryophyllus*)

Quality of the Flower: Comparison of different growing media revealed that T_5 (leaf compost + sand 1:1) produced excellent quality flower with a rating of 5 followed by T_4 (silt) which having 4.88 quality rating of the flower. T_o (garden soil) and T_1 (leaf compost + silt + farm yard

manure) 4.22 were statistically at par with each other showing non significant difference in quality of flower. So, it was observed that T_o (garden soil) and T_1(leaf compost + silt + sand 1:1:1) did not exhibit considerable variations in the flower quality when grown in different substrates. The plants grown in different substrates respond non-significant and this showed that the flower quality is not affected with the growing medium. Treatment T_2 (leaf compost + silt 1:1) produced less quality flowers with 3.21 while T_3 (farm yard manure) produced minimum 2.55 quality rating of flowers from Table 4 and Fig. 9. These results are in line with the findings of Grassotti *et al*. [28] who observed days to flower quality of gladiolus and lily.

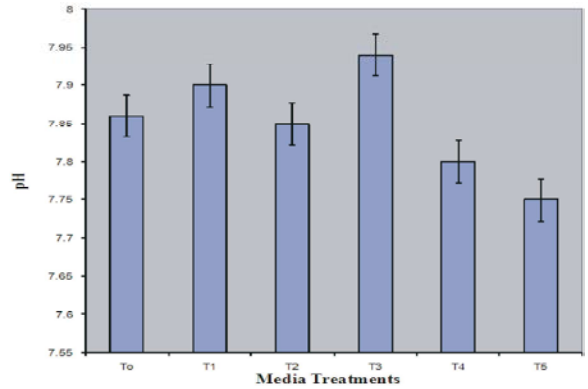
Chemical Properties of Media

Electrical Conductivity (EC): It was noted that T_5 (leaf compost + sand 1:1) got the maximum (3.44 dS/m) followed by T_4 (silt), T_o (garden soil) and T_1 (leaf compost + silt + farm yard manure) were statistically at par with each other showed non significant difference having 3.41, 3.39 and 3.37 dS/m EC of media, respectively. Minimum value of EC (3.30 dS/m) was observed both in T_2 (leaf compost + silt) and T_3 (farm yard manure) from Fig. 10.

Results are in accordance with the findings of Sonneveld *et al*. [29] that pH strongly affect on number and size of flower, lowest pH value increase 16% size of flower than higher pH.

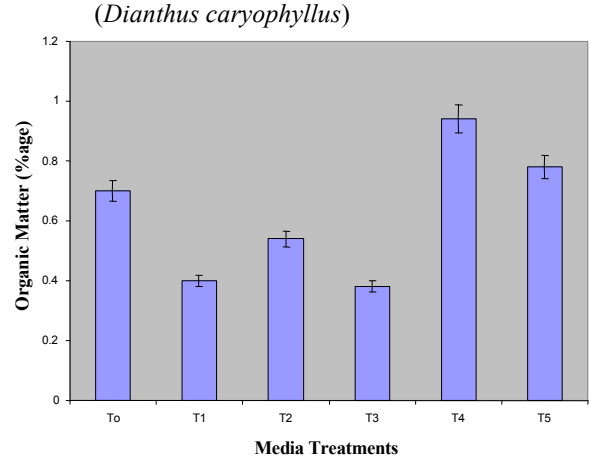
pH of Media: Treatment T_3 (farm yard manure) produced maximum value of pH of growing media (7.94) followed by T_1 (leaf compost + silt + farm yard manure) 7.90 pH value and T_o (garden soil), T_2 (leaf compost + silt) and T_4 (silt) with 7.86, 7.85 and 7.80 pH values, respectively. Overall response of carnation for different growth parameter varied with the pH of media. Maximum value for plant height, number of branches/plant, length of branches/plant, number of leaves/plant, leaf area, number of flowers/plant, flower quality, flower diameter and least days to first flower emergence was observed in media containing leaf compost + sand having pH 7.75 from Fig. 11.

These results are supported with Altland [30] who reported reduced growth of Japanese maple (*Acer paloiatiioi var. atropurpureum Thunb.*), hydrangea (*Hydrangea macrophylla Thunb*) and leueothoe (*Leueothoe axillaries Lam*) caused by a pH induced reduction of available nitrogen phosphorus and micro nutrients in growing media.



To = Garden Soil, T1 = Leaf compost + silt + FYM (1:1:1), T2 = Leaf compost + silt (1:1), T3 = Farm yard manure (FYM), T4 = Silt, T5 = Leaf compost + sand (1:1)

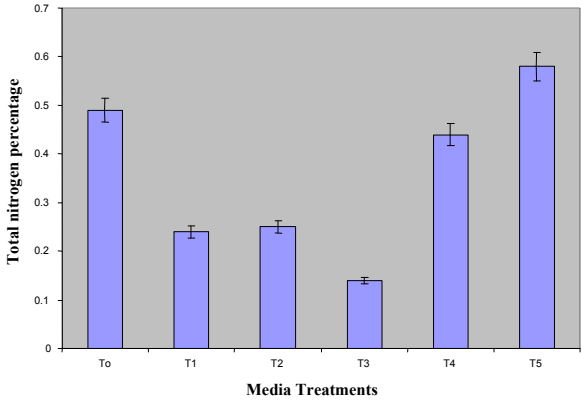
Fig. 11: Evaluation of potting media pH of Carnation (*Dianthus caryophyllus*)



To = Garden Soil, T1 = Leaf compost + silt + FYM (1:1:1), T2 = Leaf compost + silt (1:1), T3 = Farm yard manure (FYM), T4 = Silt, T5 = Leaf compost + sand (1:1)

Fig. 12: Evaluation of potting media organic matter of Carnation (*Dianthus caryophyllus*)

Organic Matter (% Age): It was noted that T_4 (silt) got the maximum (0.94%) organic matter and T_5 (leaf compost + sand 1:1) occupied second position as compared to the rest of the treatments. However T_o (garden soil) almost having similar organic matter which is 0.70%. Treatment T_2 (leaf compost + silt) also gave more available organic matter. The minimum available organic matter 0.38% was recorded in treatment T_3 (farm yard manure) from Fig. 12. These results are in line with the findings of Aoki and Endo [31] who observed rapid growth of young cyclamen plants in terms of plant height, leaf number and leaf length with 160 mg phosphorus 100^{-1}.



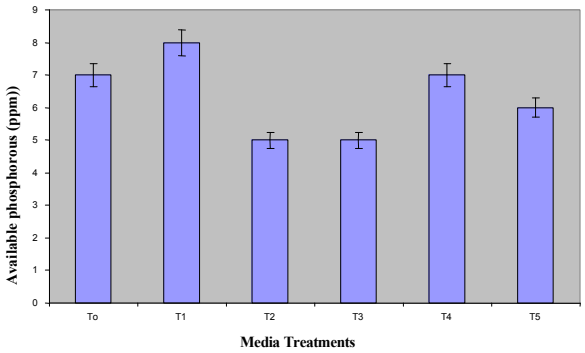
To = Garden Soil, T1 = Leaf compost + silt + FYM (1:1:1), T2 = Leaf compost + silt (1:1), T3 = Farm yard manure (FYM), T4 = Silt, T5 = Leaf compost + sand (1:1)

Fig. 13: Evaluation of potting media total nitrogen percentage of Carnation (*Dianthus caryophyllus*)

Total Nitrogen Percentage: Results showed superiority of T_5 over other treatments, T where leaf compost + sand used has maximum 0.58% nitrogen followed by T_o (garden soil) and T_4 (silt) with 0.49 and 0.44% nitrogen. The lowest nitrogen 0.14% was observed in T_3 where farm yard manure is present. Nitrogen is one of the important elements required for plant growth and reproduction. It ranks after carbon, hydrogen and oxygen in total quantity needed and is the mineral element most demanded by plants. It is important part of chlorophyll, DNA and RNA and is also needed in periods of rapid plant growth from Fig. 13.

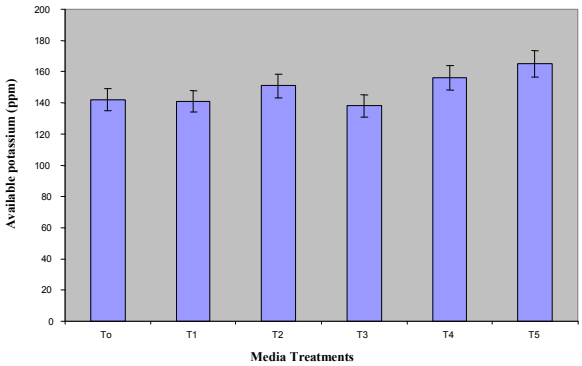
These results are in line with the findings of Klock [32] who showed that dianthus and petunia growth was greater in 100% than 0% compost. Initial nitrogen (N), phosphorous (P), potassium (K), calcium (Ca), magnesium (Mg) and soluble salt concentrations linearly increased as the percentage of compost in the medium increased from 0 to 100%.

Available Phosphorus (ppm): Comparison of various substrates showed that T_1 (leaf compost + silt + farm yard manure) produced maximum available phosphorus 8ppm and T_o (garden soil) and T_4 (silt) with 7ppm occupied second position as compared to the rest of substrate. The minimum value 5ppm of phosphorus was recorded in T_2 (leaf compost + silt) and T_3 (farm yard manure). While T_5 (leaf compost + sand) possess more available phosphorus from Fig. 14.



To = Garden Soil, T1 = Leaf compost + silt + FYM (1:1:1), T2 = Leaf compost + silt (1:1), T3 = Farm yard manure (FYM), T4 = Silt, T5 = Leaf compost + sand (1:1)

Fig. 14: Evaluation of potting media available phosphorus of Carnation (*Dianthus caryophyllus*)



To = Garden Soil, T1 = Leaf compost + silt + FYM (1:1:1), T2 = Leaf compost + silt (1:1), T3 = Farm yard manure (FYM), T4 = Silt, T5 = Leaf compost + sand (1:1)

Fig. 15: Evaluation of potting media available potassium of Carnation (Dianthus caryophyllus)

Growth parameters like shoot and root growth, canopy distribution and leaf tissue nutrient content showed maximum response in plants with high level of phosphorus in the growing media. Foliage plants receiving high phosphorus levels exhibit a higher shoot/ root ration [33].

Available Potassium (ppm): Comparison of different growing media revealed that T_5 (leaf compost + sand) produced the maximum (165ppm) available potassium as compared to the rest of substrates. Treatment T_4 (silt), T_2 (leaf compost + silt), T_o (garden soil) and T_1 (leaf compost + silt + farm yard manure) produced 156, 151,

142 and 141ppm in the form of available potassium respectively. While the minimum available potassium 138ppm was recorded in T_3 (farm yard manure) from Fig. 15.

Increased level of potassium allowed more carbohydrate translocation to the root system which increases plant growth in some ornamental plants Loh *et al.* [34]. These results are in line with the findings of De pascale and Paradiso [35] they showed leaf manure significantly increased potassium uptake compared to the mineral fertilizer treatment. Hence leaf manure is considered an efficient source of plant nutrients.

CONCLUSION

It was evident that when farm yard manure used as substrate produced the least results regarding all plant growth parameters its availability to plant was restricted due to higher level of pH and EC in the growing media. Therefore, we concluded that plant growth in farm yard manure was lowest than all other treatments.

From the all above discussion it was observed that T_5 fulfills the proper nutrients i.e.; nitrogen and potassium, optimum range of pH as well as soil structure requirements of *Dianthus caryophyllus* growth in the substrate. Thus it is suggested that T_5 (leaf compost + sand 1:1) may be further exploited as a standard substrate for *Dianthus caryophyllus* to maintain best growth and flowering.

REFERENCES

1. Grigatti, M., 2008. Growth and nutrational status of bedding plants on compost-based growing media. Acta Hort., pp: 779-614.
2. Bilderback, T., 1982. Container Soil and Soilless Media North Carolina Agri Ext. Serv. NCPM No.9, Raleigh, N.C.
3. Riaz, A., M. Arshad, A. Younis, A. Raza and M. Hameed, 2008. Effect of different growing media on the growth and flowering of *Zinnia elegans* cv. Blue Point. Pakistan J. Bot., 40(4): 1579-1585.
4. Younis, A., M. Ahmad, A. Riaz and M.A. Khan, 2007. Effect of different potting media on the growth and flowering of *Dahlia coccinia* cv. Mignon. Acta Hort., 804: 191-196.
5. Raviv, M., 2008. The use of compost in growing media as suppressive agent against soil borne diseases. Acta Hort., 779: 39-49.
6. Papafotiou, M., M. Phsyhalou, G. Kargas, I. Chatzipavlidis and J. Chornopoulos, 2004. Olive-mill wastes compost as growing medium component for the production of poinsettia. Sci. Hort., 102: 167-175.
7. Salehi, H., 2006. Can a general shoot proliferation and rooting medium be used for a number of carnation cultivars?. Afr. J. Biotechnol., 5(1): 25-30.
8. Anonymous, 1989. Floricultural Crops. 1988 summary, National Agricultural Statistics Service, 1989. USDA, Washington DC.
9. Nelson, P.V., 1991. Greenhouse Operation and Management. 4th Ed. Reston Publishing Co., Reston, Virginia.
10. Larson, E.L., 1980. Introduction to Floriculture. Academic Press London, pp: 607.
11. Gabriels, R., O. Verdonck and O. Mekers. 1986. Substrate requirements for pot plants in re-circulating water culture. Acta Hort., 178: 93-100.
12. Khasa, D.P., M. Fung and B. Logan, 2005. Early growth response of container grown selected woody boreal seedling in amended composite tailing and tailing sand. Biores. Tech., 96(7): 857-864.
13. Carlile, W.R., 2008. The Use of Composted Materials in Growing Media. Proc. IS on Growing Media. Acta Hort., 77: 321-328.
14. Kambooh, C.M.S., 1984. Desi Khadein. Zarat Nama, 23(24): 26-28.
15. Raviv, M., J.H. Lieth and R. Wallach, 2001. The effect of root-zone physical properties of coir and uc mix on performance of cut rose (cv. Kardinal). Acta Hort., 554: 231-238.
16. U.S. Salinity Lab. Staff, 1954. Diagnosis and Improvement of Saline and Alkali Soil. Richards (Ed.) USDA Agric. Handbook. USA.
17. Richards, L.A., 1954. Diagnosis and Improvement of Saline and Alkali Soils. *USDA Agric. Handbook* 60. Washington, D.C.
18. McLean, E.O., 1982. Soil pH and lime requirement, In: A.L. Page, (Ed). Methods of Soil Analysis, Part 2: Chemical and microbiological properties. Am. Soc. Agron., Madison, WI, U.S.A, pp: 199-224.
19. Walkley, A., 1947. A critical examination of a rapid method for determining organic carbon in soils: Effect of variations in digestion conditions and of organic soil constituents. Soil Sci., 63: 251-263.
20. Jackson, M.L., 1982. Soil Chemical Analysis. Constable and Co. Ltd., London. UK.

21. Olsen, S.A.R., M.D. Sant, H.R. Gislerod and K. Solbraa, 1954. Nitrogen balance in bark composts used as growing media. Acta Hort., 150: 193-202.
22. Fred D.R., M.G. Harris, W. Roger and W.S. Richard 1997. Plant growth in Potting media using compost. *Horticulture Research Note*. Department of Horticulture College of tropical Agriculture and Human Resources University of Hawaii at Manco.
23. Fascella, G., G.V. Zizzo, C. Costantino and S. Agnello. 2003. Effect of different substrates on soilless cultivation of *Ruscus hypoglossum* for cut foliage production Acta Hort., (ISHS), 614: 211-215.
24. Chen, Y.L., L.H. Kang and B. Dell, 2006. Inoculation of *Eucalyptus urophylla* with Spores of Scleroderma in a nursery in south China: Composition of field soil and potting mix. Forest Ecology and Management, 222: 439-449.
25. Cardenas, M.C.A., I.F.R. Gomez, V.J.F. Roncancio, B.C. Cordoba and P.W. Canola, 2006. Growth analysis of standard carnation cv. 'Nelson' in different substrates. Acta Hort., 718(17): 623-630.
26. Shahzad, F., 2009. Studying the performance of marigold (*Tegetes erecta*) as influence by different growing media. M.Sc. thesis, Inst. Hort. Sci., Univ. Agri., Faisalabad, Pakistan.
27. Tailin, Z., S. Bailin, Q. Qixia and J. Renjuan, 2003. Cultivation experiments on several kinds of herbaceous flowers. Zhejiang Forestry College, 20(1): 108-110.
28. Grassotti, A., B. Nesi, M. Maletta and G. Magnani. 2003. Effects of growing media and planting time on Lily hybrids in soil less culture. Acta Hort., 609: 395-399.
29. Sonneveld, C. and W. Voogt. 1997. Effects of pH value and Mn application on yield and nutrient absorption with rock wool grown gerbera (reffereed). Acta Hort., 450(15): 139-148.
30. Altland, J.E., 2006. Substrate pH, a tricky topic. Digger., 50: 42-47.
31. Aoki, K. and M. Endo, 1999. The phosphorous efficiency of various growth media for cyclamen. Bulletin of the Chiba Perfectural Agricultural Experiment Station, 30(10): 1-8.
32. Klock, K.A. and G.E. Fitzpatrick, 1997. Growth of impatiens 'accent red' in three compost products. Compost Sci. and Util., 5(4): 26-30.
33. Joiner, J.N., C.R. Johnson and J.K. Krantz, 1980. Effect of light and nitrogen and potassium levels on growth and length compensation point of *Ficus benjamina* L. J. Amer. Soc. Hort. Sci., 105(2): 170- 173.
34. Loh, F.C.W., J.C. Grabosky and N.L. Bassuk, 2003. Growth response of *Ficus benjamina* to limited soil volume and soil dilution in skeletal soil container study. Urban Forestry and Urban Greening, 2(1): 53-62.
35. De Pascale, S. and R. Paradiso, 2001. Water and nutrient uptake of roses growing in two inert media. Acta Hort., 548: 631-640.