Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

**E-ISSN:** 2278-4136
**P-ISSN:** 2349-8234
www.phytojournal.com
JPP 2020; 9(2): 417-421
Received: 07-01-2020
Accepted: 09-02-2020

**Rajneesh Rawat**
Department of Forestry, College of Forestry, Ranichauri VCSG Uttarakhand University of Horticulture and Forestry, Bharsar, Uttarakhand, India

**Amol Vasishth**
Department of Forestry, College of Forestry, Ranichauri VCSG Uttarakhand University of Horticulture and Forestry, Bharsar, Uttarakhand, India

**Vinod Kumar**
Department of Forestry, College of Forestry, Ranichauri VCSG Uttarakhand University of Horticulture and Forestry, Bharsar, Uttarakhand, India

**Corresponding Author:**
**Rajneesh Rawat**
Department of Forestry, College of Forestry, Ranichauri VCSG Uttarakhand University of Horticulture and Forestry, Bharsar, Uttarakhand, India

# Effect of growing media on growth parameters of two important aromatic crops of Garhwal Himalaya

**Rajneesh Rawat, Amol Vasishth and Vinod Kumar**

**Abstract**
Vegetative propagation of medicinal and aromatic plants with green cutting is mainly used due to low seed germination and long duration of reproduction period. The aim of the investigation was to determine the effect of vermicompost, cocopeat and soil on *Rosmarinus officinalis* and *Pelargonium graveolens* cuttings. The investigation was conducted in the polyhouse of Medicinal and Aromatic Plants block of College of Forestry, Ranichauri, Tehri Garhwal Uttrakhand, India during February to May 2019. Eight treatment combinations were made for both species. The experiment was laid out in Complete Randomized Design (CRD) with three replications. Data were collected on Survival percentage, number of sprouts, number of roots, root length, shoot length, fresh weight and dry weight at 60 and 90 DAP. The treatment Soil + cocopeat (2:1) resulted significantly higher values of growth parameters in Rosemary and Cocopeat + vermicompost (2:1) recorded maximum values for Geranium cuttings, whereas cuttings grown with soil recorded minimum growth performance for both species.

**Keywords:** Rosmary, geranium, cuttings, growing media, vegetative growth

## Introduction
Rosemary (*Rosmarinus officinalis* L.) is one of the most important medicinal and aromatic, evergreen, shrubby crop which belongs to the mint family, lamiaceae. The name rosemary comes from the Latin word "Ros" meaning dew and "marinus" meaning from the sea, which means "Dew of the sea" (Singletary, 2016) [22] Rosemary is perennial, an ornamental-medicinally significant crop all over the world and originally native to the Mediterranean region. Rosemary has a woody texture but, like other herbs, does not actually contain woody tissues. This plant can reach 1.5m (5ft) tall, rarely 2m (6 ft 7 in) and has green needle-like leaves, 2-4 cm long and 2-5 mm broad (Ashrafi and Sarem 2012) [3] the upper surface of the leaf is dark green whereas it is white below; leaves are resinous. Branches are rigid with fissured bark and stem square, woody and brown. Pale blue small flowers appear in cymose inflorescence and in temperate climate rosemary bloom in spring and summer, but it can also bloom in warm climate (Sasikumar 2004) [19].
Rosemary propagation is done through either seed or stem cutting. Seeds of rosemary are rarely used in propagation as they are slow to germinate, taking 3–4 weeks before emergence with a poor germination rate of 10–20 %. Cutting is a well-known common and relatively cheap method used in the propagation of many ornamental plant species. It overcomes the difficulties of propagation by plant seeds (Elhaak *et al*. (2015). Propagation of plants from cuttings enables a large percentage of the cuttings to produce roots quickly. Therefore, propagation of rosemary by cuttings was tried in the present study.
*Pelargonium graveolens* L. is commonly known as rose scented Geranium as the leaves of the plant produce the fragrance of rose. It belongs to family Geraniaceae. Geranium is most important, perennial, high-value aromatic shrub that can reach a height of up to 1.5 m and has spread of 1m. The leaves may be large or small, entire or deeply toothed, green, grey, soft to the touch, and strongly rose scented. The flowers are five petalled and colour vary from whitish to pale pink vary in size from 0.5-4 cm, the plant flowering season from August to January. Its hairy stems are herbaceous when young and become woody with age (Sharopov *et al.*, 2014) [20]. It is native to South Africa and extensively grown in Morocco, France, Russia, China, Congo, Egypt and India. During early 20th century rose scented geranium was first time grown in Neelgiri and Shevroy hills of South India and later it has been cultivated in the different parts of India from tropical to temperate region with an elevation of 700 to 2200 masl and the most favorable elevation is between 1200 to 1800 masl having annual rainfall 1000 to 1500 mm.

The well drained loam and sandy loam soil with sufficient amount of organic matter is ideal for the cultivation of Rose-scented geranium. (Bijalwan *et al.* 2014) [5]. Essential oil of geranium is obtained by steam or hydro-distillation of aerial parts; the main constituents of essential oil are citonellol, geraniol, isomenthone, citronellyl formate and geranyl formate. These ingredients are used in soap, shampoo, tooth paste, hair oil, perfume, cosmetic cream and in medicinal and aroma therapy industries all over the world (Kaul *et al*. 1997) [12]. Essential oil has great demand in national and international markets. Rose-scented geranium is being cultivated in hilly tracks of north Uttarakhand and South India. It is a good source of income generation to the farmers (Verma *et al.* 2010) [25].

## Materials and Methods

The experiment was conducted at poly house of medicinal and aromatic plants section, College of Forestry, Ranichauri, Tehri Garhwal. The experiment was laid out in Completely Randomized Design (CRD) with main factors viz. Soil + Cocopeat (2:1), cocopeat + vermicompost (2:1), Soil + vermicompost (2:1) and only soil as control with three replications. Thirty cuttings per treatment were used in a root trainer. Monthly observations were recorded at an interval of 30, 60, and 90 days after planting. Observations on survival percentage, number of sprouts, number of roots, root length, shoot length, fresh and dry weight of roots were recorded. At the time of recording of observations, cutting were carefully uprooted and washed.

**Experimental details are given as below**

- **Crop:** Rosemary and Geranium.
- **Design of Experiment:** Completely Randomized Design
- **Number of Treatments:** 8
- **Number of Replication:** 3
- **Container:** Root trainer
- **Growing Media:** vermicompost, coco peat and soil
- **Total Number of cuttings:** 2x4x3x10 = 240
- **Place:** Polyhouse.

Treatment details of growing media

| Sr. No. | Treatments | Ratio |
|---|---|---|
| 1 | $T_1$ (Rosemary) Soil + Cocopeat | 2:1 |
| 2 | $T_2$ (Rosemary) Cocopeat + Vermicompost | 1:1 |
| 3 | $T_3$ (Rosemary) Soil + Vermicompost | 2:1 |
| 4 | $T_4$ (Rosemary) Soil | Control |
| 5 | $T_5$ (Geranium) Soil + Cocopeat | 2:1 |
| 6 | $T_6$ (Geranium) Cocopeat + Vermicompost | 1:1 |
| 7 | $T_7$ (Geranium) Soil + Vermicompost | 2:1 |
| 8 | $T_8$ (Geranium) Soil | Control |

**Observations recorded**

**I. Survival percentage**

Survival percentage of rooted cuttings was calculated for each treatment separately at 90 days after planting by using following formulae:

$$\text{Survival percentage of cuttings} = \frac{T-Mp}{T} \times 100$$

Where, T = Total number of rooted cuttings
Mp = Dried cuttings

**II. Root length per cutting (cm)**

The root length of cuttings was recorded for each treatment from randomly selected five rooted cuttings at 30, 60 and 90 days after planting and then average was calculated.

**III. Shoot length per cutting (cm)**

The shoot length of five randomly selected cuttings was measured from the base of shoot to the shoot tip at 30, 60 and 90 days after planting of cutting with the help of centimeter scale.

**IV. Number of roots per cutting**

The number of roots per cutting was counted for each treatment from randomly selected five rooted cuttings and observations were recorded at 30, 60 and 90 days after planting and then average was calculated.

**V. Number of sprouts per cutting**

The total numbers of sprouts in all five cuttings were randomly selected and cuttings were counted at 30, 60 and 90 days after planting and then average was calculated.

**VI. Fresh weight of roots per cutting (mg)**

The fresh weight of rooted cutting recorded for each treatment randomly selected five rooted cuttings and roots were detached from the uprooted cuttings and fresh weight was taken with the help of electronic balance.

**VII. Dry weight of roots per cutting (mg)**

Roots from five cuttings were dried in oven at 70±2 $^0$C for 24 hours and then average dry weight of roots was recorded.

**Statistical analysis**

The statistical analysis of experimental data collected on different parameters was done by applying ANOVA by using STPR-3 software for Complete Randomized Design (CRD). It is statistical software which was developed by the Department of Mathematics and Department of Statistics, GBPUA&T, Pantnagar (U.S. Nagar).

## Results and Discussions

**Effect of Growing media on growth parameters of Rosemary and Geranium**

**A. Survival percentage**

It is evident from the perusal of data that survival percentage was significantly influenced by different growing media (Table 1). The highest survival percentage (86.7%) of Rosemary was observed in the cuttings grown in $T_1$ (soil + Coco peat) which were significantly higher than other growing media. This may be due growing media improved water relationship, nutrient retention allows free air movement, retains moisture and nutrients for growth of the plants probably due to optimum bulk density, potentiality of adequate water absorption of growing media. These results are similar to the findings of Bisht *et al*. (2017) [6], Madhu bala *et al.* (2013) and Rani *et al*. (2005) [16] in lilium.

The growing medium comprising of coco peat + vermicompost ($T_6$) also resulted in higher survival percentage (86.7%) of Geranium cuttings which was significantly higher than all other growing media. This may be due to combination of coco peat and vermicompost might have induced better absorption of nutrients, food material and moisture from the soil and ultimately leading to higher establishment percentage. This finding is in agreement with the results obtained by Singh *et al*. (2007) [21], Maurya *et al*. (2012) [14] with organic media and Rymbai *et al*. (2012) [18] with cocopeat and moss in guava.

The lowest survival percentage of Rosemary (70%) and Geranium (66.7%) was recorded in cuttings grown in soil, which was significantly lower than all other treatments of growing media.

**B. Number of sprouts per cutting**

The number of sprouts per cutting was significantly influenced by different growing media at 60 and 90 DAP (Table 1). The maximum number of sprouts (6.1) and (9.7) was found in the cuttings planted in soil + coco peat medium ($T_6$), which was significantly superior to all other growing media treatments in Rosemary. This observation matched with the result obtained by Moslem Sedaghat *et al*. (2017). Swetha (2005) [23] also reported that rooting was improved in Indian lavender by using cocopeat substrate. The growing media consisting of coco peat + vermicompost also produced more number of sprouts (4.4), which was statistically at par with $T_5$ soil + coco peat (4.1) at 60 DAP and (7.1) number of sprouts at 90 DAP in Geranium cuttings. This might be due to Vermicompost act as a rich source of nutrients with good water retention capacity. This observation matched with the result obtained by Kademani *et al.* (2017) [11] in Sarpagandha with different rooting substrate mixed with vermicompost. While cuttings grown in soil recorded lowest number of sprouts in both species which were significantly lower than all other growing media treatments. The minimum number of sprouts recorded in soil for both species.

**C. Root length per cutting (cm)**

It is clear from the perusal of data that the root length was significantly influenced by different growing media at 60 and 90 DAP in both species. In 30 days after planting no rooting was observed in both cuttings. At 60 and 90 DAP the maximum root length (8.6 cm), (13.2 cm) was observed in the cuttings planted in soil + coco peat which was significantly superior to all other growing media treatments. Coco peat mixed with soil showed more root length in comparison to cuttings grown with vermicompost mixed with soil. On the other hand, cocopeat is known to have rather high water holding capacity, better aeration which enhanced roots growth. Similar observations were recorded by Abad *et al*. (2002) [1] and Awang *et al*. (2009) [4]

Whereas Geranium cuttings grown in coco peat + vermicompost recorded maximum root length (9.4 cm), (14.9 cm) per cutting which was statistically superior over other treatments at 60 and 90 DAP. Similar observations were noted by Verma *et al*. (2017) [24]. This may be due to vermicompost granules may develop soil aggregate. Soil aggregation will improve permeability and air flow in the polybags. Vermicompost may decrease fluctuation of soil temperature, root initiation and root growth become easier to the particular depth so that plant grows well and may absorb more water and nutrients.

However, the minimum root length for Rosemary and Geranium was recorded in cuttings which were planted in soil medium and was significantly lower than all other growing media treatments.

**Table 1:** Effect of growing media on survival percent and growth performance of Rosemary and geranium cuttings.

| Treatments | Survival percentage (90 DAP) | No. of sprouts | | Root length | | Shoot length | |
|---|---|---|---|---|---|---|---|
| | | 60 DAP | 90 DAP | 60 DAP | 90 DAP | 60 DAP | 90 DAP |
| $T_1$ (Rosemary) soil+cocopeat | 86.7 | 6.1 | 9.7 | 8.6 | 13.2 | 9.6 | 12.2 |
| $T_2$ (Rosemary) cocopeat+vermicompost | 80.0 | 5.0 | 8.1 | 7.8 | 11.2 | 9.1 | 12.1 |
| $T_3$ (Rosemary) soil+vermicompost | 76.7 | 4.9 | 7.0 | 6.7 | 11.1 | 8.4 | 11.7 |
| $T_4$ (Rosemary) soil | 70.0 | 4.7 | 6.9 | 6.4 | 10.0 | 7.5 | 10.3 |
| $T_5$ (Geranium) soil+cocopeat | 83.3 | 4.1 | 6.5 | 8.2 | 13.9 | 18.4 | 23.1 |
| $T_6$ (Geranium) cocopeat+vermicompost | 86.7 | 4.4 | 7.1 | 9.4 | 14.9 | 20.5 | 23.4 |
| $T_7$ (Geranium) soil+vermicompost | 76.7 | 3.3 | 5.8 | 5.5 | 9.8 | 16.1 | 20.4 |
| $T_8$ (Geranium) soil | 66.7 | 3.1 | 4.7 | 3.6 | 8.1 | 15.3 | 20.0 |

**D. Shoot length per cutting (cm)**

The growing media significantly influenced the shoot length at 60 and 90 days after planting of cuttings. In 30 days after planting no growth was observed in shoot length of cuttings.

The results in respect of shoot length were significantly influenced by various growing media treatments. At 60 DAP the maximum shoot length (9.6 cm) was attained by the rooted plants, which were raised in soil + coco peat which was statistically at par with $T_2$ coco peat + vermicompost (9.1 cm) and (12.2 cm) at 90 DAP which was statistically at par with $T_2$ coco peat + vermicompost (12.1 cm) and $T_3$ soil + vermicompost (11.7 cm) in rosemary cuttings.

The maximum shoot length was observed in coco peat + vermicompost (20.5 cm) and was significantly higher than rest of the growing media treatments in Geranium cuttings at 60 DAP and (23.4 cm) which was statistically at par with $T_5$ soil + coco peat (23.1 cm) at 90 DAP. The increase in shoot length may be due to the presence of some growth-promoting substances in worm-processed material (vermicompost). The vermicompost also contained a considerable amount of some essential macronutrients which might be responsible for better plant growth. Similar result was obtained by Hota *et al*. (2018) [10]

However, the minimum shoot length for Rosemary and Geranium was recorded in cuttings which were planted in soil medium and was significantly lower than all other growing media treatments.

**E. Number of roots per cuttings**

The data on the number of roots per cuttings are depicted in the Table 2. No rooting was observed in both species cuttings after 30 days of planting. At 60 days after planting, the result revealed that the maximum numbers (30.6) of roots per cutting were recorded in $T_1$ soil + coco peat which was significantly superior over other treatments. Similarly, at 90 days after planting the maximum number (51.1) of roots per cutting were recorded in $T_1$ soil + coco peat which was statistically at par with $T_2$ coco peat + vermicompost (51.0) in Rosemary It may be due to the combination of (soil + coco peat) attributing to proper aeration and high water holding capacity which helped better root initiation Rymbai *et al*. (2012) [18] noted similar result with different combination of rooting substrate viz. (sphagnum moss + cocopeat).

Whereas in Geranium the treatment $T_6$ coco peat + vermicompost recorded maximum number of roots (33.3) which was statistically at par with $T_5$ soil + coco peat (32.8) at 60 DAP and again in $T_5$ (50.5) at 90 DAP. The excellent plant growth in vermicompost was possibly due to the presence of some plant growth promoters which improved the physico-chemical as well as biological properties of soil, increasing ventilation by increasing the porosity and affluent source of

nutrient elements i.e. nitrogen and phosphorus. The findings supported by Hota *et al*. (2018) [10] and chopde *et al*. (1999) [7]. However, the minimum number of roots for Rosemary and Geranium was recorded in cuttings which were raised in soil medium and was significantly lower than all other growing media treatment.

**F. Fresh weight of roots per cutting (mg)**

Treatments of this study exhibited differences at 60 and 90 DAP in comparison to 30 DAP. At 30 DAP, no result was realistic in fresh weight of roots for Rosemary and Geranium cuttings (Table - 2).

The fresh weight of rooted cuttings of Rosemary was significantly influenced by different growing media at 60 and 90 DAP. The maximum fresh weight of rooted cuttings was recorded of 155.6 mg and 194.4 mg was obtained from cuttings grown in $T_1$ (soil + coco peat), which was significantly superior to rest of the treatments. Similar results were also obtained by Nagar *et al*. (2017) [15], Abirami *et al*. (2010) [2] in nutmeg and Yadav *et al*. (2012) [26] in acid lime with different combinations of rooting substrate with cocopeat. This may be attributed to general improvement in the physical and chemical properties of the rooting medium.

The growing media $T_6$ coco peat + vermicompost produced significantly higher fresh weight (126.7 mg, 132.2 mg) which was significantly superior over other treatments of Geranium cuttings at 60 and 90 DAP 9table 2). It might be due to nutrients shortfall of one growing media may be compensated by the characteristics property of other media. As soil which has poor drainage properties might have compensated by good aeration and porosity character of coco peat. The results are in confirmatory with the reports of Renuka *et al*. (2015) [17] in carnation and Kumar *et al*. (2011) [13] in patchouli cuttings.

However, the fresh weight of roots for Rosemary and Geranium was recorded in cuttings which were raised in soil medium and was significantly lower than all other growing media treatments.

**Table 2:** Effect of growing media on roots number and root biomass of Rosemary and Geranium cuttings.

| Treatments | Number of roots | | Fresh weight(mg) | | Dry weight (mg) | |
|---|---|---|---|---|---|---|
| | 60 DAP | 90 DAP | 60 DAP | 90 DAP | 60 DAP | 90 DAP |
| $T_1$ (Rosemary) soil+cocopeat | 30.6 | 51.1 | 155.6 | 194.4 | 82.2 | 115.6 |
| $T_2$ (Rosemary) cocopeat+vermicompost | 25.6 | 51.0 | 123.3 | 134.4 | 62.2 | 71.1 |
| $T_3$ (Rosemary) soil+vermicompost | 25.5 | 42.2 | 119.8 | 131.1 | 55.6 | 63.3 |
| $T_4$ (Rosemary) soil | 24.4 | 39.2 | 97.8 | 103.3 | 50.0 | 56.7 |
| $T_5$ (Geranium) soil+cocopeat | 32.8 | 48.1 | 113.3 | 128.9 | 62.2 | 64.5 |
| $T_6$ (Geranium) cocopeat+vermicompost | 33.3 | 50.5 | 126.7 | 132.2 | 63.3 | 68.9 |
| $T_7$ (Geranium) soil+vermicompost | 30.0 | 43.1 | 112.2 | 124.4 | 58.9 | 61.1 |
| $T_8$ (Geranium) soil | 17.8 | 30.8 | 68.9 | 86.7 | 37.8 | 46.7 |

**G. Dry weight of roots per cutting (mg)**

It is clear from the data that dry weight of rooted cuttings were remarkably influenced by different growing media at 60 and 90 DAP (Table 2). The highest dry weight (82.2 mg), (115.6 mg) of Rosemary was noted in cuttings planted in $T_1$ **(**soil + coco peat), which was significantly superior to all other growing media treatments with respect to dry weight of rooted cuttings. Similar result was noted by Nagar *et al*. (2017) [15] in papaya with combination of different rooting substrate. This may be attributed to the improvement in the physical and chemical properties of the rooting medium (Dileep *et al*. 1994) [8].

The highest dry weight (63.3 mg) of roots per cutting was recorded under $T_6$ coco peat + vermicompost which was statistically at par with $T_5$ soil + coco peat (62.2 mg) at 60 DAP and (68.9 mg) at 90 DAP which was superior to the rest of treatments in Geranium cuttings. Similar result was noted by Verma *et al*. (2017) [24]. However the lowest dry weight of roots per cutting was recorded in soil for rosemary and geranium.

**Conclusion**

Among the different rooting media i.e. coco peat, vermicompost and soil, soil and coco peat combination in Rosemary and coco peat and vermicompost combination in Geranium registered the highest survival percentage (86.7), number of roots, root length, shoot length, number of sprouts, fresh and dry weight of roots. This may be due to cocopeat and vermicompost improved water relationship, better absorption of nutrients, food material, and nutrient retention allows free air movement, and ultimately leading to higher establishment percentage. This may be concluded that soil and Coco peat mixture for Rosemary and Coco peat and vermicompost mixture for Geranium can be used for better growth performance in the field.

**References**


1. Abad M, Noguera P, Puchades R, Maquieira A, Noguera V. Physicochemical and chemical properties of some coconut dusts for use as a peat substitute for containerized ornamental plants. Bio Resource Technolgy. 2002; 82:241-245.
2. Abirami K, Rema PA, Mathew. Effect of different propagation media on seed germination, seedling growth and vigour of nutmeg. Journal of Medicinal Plants Research. 2010; 4(19):2054-2058.
3. Ashrafi SJ, Sarem H. Cultivation of Rosemary as an ornamental-medicinal plant and managing its root rot disease in northeast of Iran. Journal of Medicinal Plants Research. 2012; 6(47):5789-5796.
4. Awang Y, Shaharom AS, Mohamad RB, Selamat A. Chemical and physical characteristics of cocopeat-based media mixtures and their effects on the growth and development of *Celosia cristata*. American Journal of Agricultural and Biological Sciences. 2009; 4(1):63-71
5. Bijalwan A, Dobriyal JR, Manmohan. Rose Scented Geranium (RSG): An Important Plant for Aromatic Industries in India Science, Scientific India. 2014; 2(4):31.
6. Bisht, Deepti, Kumar A, Singh N. Effect of growing media on flowering characters of chrysanthemum cv. Mother Teresa. Journal of Ornamental Horticulture. 2012; 15(1):27-31
7. Chopde N, Patil BN, Pagar PC, Ram G. Effect of different pot mixtures on germination and growth of

custard apple (*Annona squamosa* L.) Journal of soils and crops. 1999; 9(1):69-71.
8. Dileep M, Sudhakara K, Santhoshkumar AV, Nazeema KK, Ashokan PK. Effect of seed size, rooting medium and fertilizers on the growth of seedlings of silk cotton (*Ceiba pentandra* Linn.). Indian Journal of Forestry. 1994; 17(4):293-300.
9. Elhaak MA, Matter MZ, Zayed MA, Gad DA. Propagation Principles in Using Indole-3-Butyric Acid for rooting of rosemary stem cutting. Journal of Horticulture, 2014.
10. Hota SN, Karna AK, Dakhad BK, Jain PK. Influence of growing media on germination, growth and survival of jamun (*Syzygium cumini* L. Skeels) Bulletin of Environment, Pharmacology and Life Sciences. 2018, 130-133.
11. Kademani AJ, Mallikarjunagowda AP, Umesha K, Anilkumar S. Effect of different propagating media and plant growth promoting Rhizobacteria on Rooting of Stem Cuttings and Survival Rate of Cuttings in Sarpagandha (*Rauvolfia tetraphylla*) International Journal of Pure Applied Bioscience. 2017; 5(6):1436-1440
12. Kaul PN, Rao BRR, Bhattaoharya AK, Singh K, Singh CP. Effect of partial shade on essential oils of three geranium (*Pelargonium* species) cultivars. Indian Perfumer. 1997; 41(1):1-4
13. Kumar N, Sen D, Singh V, Kumar S. Effect of growing media on rooting and growth of patchouli (*Pogostemon cablin*) cuttings in subtropical humid region of Arunachal Pradesh. Environment and Ecology. 2011; 29(2):568-570.
14. Maurya RK, Ray NR, Chavda JC, Chauhan VB, Patil AK. Evaluation of different organic media and water holding materials with IBA on rooting and survival of air layering in guava (*Psidium guajava* L. cv. Allahabad Safeda). Asian Journal of Horticulture. 2012; 7(1):44-47.
15. Nagar SK, Vihol NJ, Husain S, Nagar PK. Effect of different growing media on growth of seedlings of papaya (*Carica papaya* L.) Cv. Madhu bindu under net house conditions, 2017.
16. Rani N, Kumar R, Dhatt KK. Effect of nitrogen levels and growing media on growth, flowering and bulb production of Lilium cultivars. Journal of Ornamental Horticulture. 2005; 8(1):36-40
17. Renuka K, Chandrasekhar R, Pratap M. Effect of different media treatments on rooting of carnation (*Dainathus cryophyllus* L.) cuttings of cv. BALTICO under poly house conditions. The Asian Journal of Horticulture. 2015, 118-121.
18. Rymbai H, Reddy SG, Reddy KCS. Effect of Cocopeat and Sphagnum Moss on guava air layers and plantlets survival under open and polyhouse nursery. Agriculture Science Digest. 2012; 32(3):241-243.
19. Sasikumar B. Handbook of herbs and spices, Wood head Publishing Series in Food Science, Technology and Nutrition, 2004, 243-255.
20. Sharopov, Farukh S, Zhang H, Setzer, William N. Composition of geranium (*Pelargonium graveolens*) essential oil from Tajikistan. American Journal of Essential Oils and Natural Products. 2014; 2(2):13-16
21. Singh P, Chandrakar J, Singh AK, Jain V, Agrawal S. Effect on Rooting in Guava cv. L-49 through PGR and Organic Media under Chhattisgarh condition. Acta Horticulturae. 2007; 735:197-200.
22. Singletary K. Rosemary an Overview of Potential Health Benefits, Culinary Spices Series. 2016, 102-112.
23. Swetha H. Propagation of Indian lavender (*Bursera delpechiana* Poiss. ex Engl.) through cuttings under mist. M.Sc. (Ag.) Thesis. University of Agricultural Sciences, Dharwad, India, 2005.
24. Verma PPS, Padalia RC, Singh VR. Influence of vermicompost with FYM and soil on propagation of marjorum (*Majorana hortensis* L.) and oregano (*Origanum vulgare*) with green cuttings. Journal of Medicinal Plants Studies. 2017; 5(3):284-287.
25. Verma RS, Verma RK, Yadav AK, Chauhan A. Changes in essential oil composition of rose-scented geranium (*Pelargonium graveolens* L' Herit. ex Ait.) due to date of transplanting under hill conditions of Uttarakhand. Indian Journal of Natural Products and Resources. 2010; 1(3):367-370
26. Yadav, Kumar R, Jain MC, Jhakar RP. Effect of media on growth and development of acid lime (*Citrus aurantifolia* Swingle) seedling with or without Azotobactor. African Journal of Agricultural Research. 2012; 7(48):6421-6426.