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Original Research Article

Individual and combined effect of different growing media on growth and establishment of new Indian oregano (*Origanum vulgare* L.)

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Abstract

Owing to its medicinal attributes and appealing taste, the market for oregano is steadily increasing worldwide. Consequently, there is an immense need to enhance its production to meet this growing demand. For plant cultivation, a suitable growth medium is essential as it serves as a source and sink for essential nutrients required for plant growth and development. Recognizing the importance of boosting oregano production, an experiment was conducted to unveil the individual and combined performance of various growth media, namely soil, vermicompost, rooting hormone, and cocopeat. The findings of the experiment revealed that all the growth media effectively supported the plant's growth and establishment by providing necessary nutrients. However, it was observed that a combination of vermicompost and rooting hormone had a particularly significant positive impact on various agronomical attributes. This combination resulted in enhanced root and shoot growth, indicating that vermicompost primarily promotes the development of roots, shoots, and leaves while rooting hormone positively influences root weight and overall plant development. As a result, this combination contributed to the establishment and growth of oregano seedlings. By implementing these findings, farmers can enhance the production of oregano, meeting the rising demand and ensuring a sustainable supply of this valuable herb.

Keywords: Oregano, Soil, Vermicompost, Rooting hormone, Cocopeat.

Introduction

In recent years, medicinal and healthcare properties of various plants, taste, consumption of medicinal herbs and natural antioxidants have increased worldwide (Raut and Karuppayil, 2014). Oregano, a versatile healing and health-promoting herb renowned for its distinctive and robust flavor, is cherished worldwide in culinary traditions. Its potent taste feels sour and peppery, making it a favorite among chefs and home cooks. This is a perennial shrub found throughout Mediterranean areas and most parts of the Euro-Siberian region but particularly thrives well in hilly regions (Shabih *et al*., 2022). Oregano exhibits adaptability to arid and calcareous soils. Oregano maintains its taste remarkably well upon drying, providing a convenient option for culinary applications. At the same time, oregano can be utilized either fresh or dried. The dried form is more widely accessible and often preferred owing to its concentrated flavor. Notably, oregano holds significant economic importance, both seasoning and essential oil. Beyond its culinary appeal, oregano boasts an array of beneficial properties. It serves as a rich source of antioxidants and antimicrobial compounds, including phenolics such as rosmarinic acid, caffeic acid, and hydroxycinnamic acid. These elements support the herb's ability to shield the body against oxidative stress. Oregano contains essential oils, carvacrol, γ-terpinene, p-cymene, thymol, myrcene, and α-pinene, which has many pharmacological and medicinal applications (PDR, 2004; Murillo-Amador *et al*., 2015). Due to the vast medical and culinary application the global demand for oregano is assumed to rise by a compound annual growth rate (CAGR) of 6.4% (Persistence Market Research, Accessed on 22/06/2023). In India, oregano is primarily grown in Karnataka, Assam, Jammu and Kashmir, Tamil Nadu, Meghalaya, Uttarakhand, Uttar Pradesh, and hilly areas of Madhya Pradesh. However, commercial production of oregano in India faces challenges due to the deficiency of suitable varieties, appropriate management practices, and optimized growth media enriched

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with nutrients. Previous studies have established that the growth medium, comprising soil and nutrient amendments, plays a crucial role in determining any plant's germination, establishment, growth, and yield prospect because the plant satisfies its nutritional needs from the growth medium (Morgan and Connolly, 2013). Currently, the application of chemical fertilizers is in trend to meet the growth requirements of plants. Still, over a period of time, it is affecting the soil quality, as well as the production of crops (Khan *et al*., 2022). Therefore, the use of organic growth medium has gained attention for achieving the desirable soil properties, including nutrient availability, water holding capacity, cation exchange capacity, and lower bulk density, as well as fosters beneficial microorganisms for increasing the production of oregano (Drinkwater *et al*., 1995). In agriculture, the soil, vermicompost, and cocopeat are being used as the growing media for various crops. These media are organic and serve as sinks of nutrients, water, and air, and also sustain all types of microbial life and thereby cycle the nutrients in an ecosystem and maintain sustainability. On the other hand, the rooting hormone, basically indole butyric acid (IBA), is well characterized for its root proliferation property, which assists the growth and development of plants. Solving the problem of increasing demand for oregano and knowing the importance of growth media for oregano production, the current investigation intended to identify the best suitable organic growing medium for oregano seedling establishment and production. An experiment was set up for evaluating different growth media such as soil, cocopeat, vermicompost, and rooting hormone, along with their individual and combined influence on the growth and agronomic aspects of oregano.

Materials and Methods

Experimental site

The current research was accomplished at CSIR-Central Institute of Medicinal and Aromatic Plants, Research Centre, Pantnagar (coordinates 29◦N, 79.38◦E), located at an elevation of 243.84 m masl in the foothills of north India. The experimental site is characterized as subtropical as the maximum temperature ranges between 35 to 45°C and the minimum between 2 to 5°C with an average rainfall of 1350 mm. The soil used in the study was collected from the farm of the research center and is characterized as fertile, having clay loam texture and neutral pH (pH 7.1), average in organic carbon (0.58%), average in available phosphorus (15 kg ha^{-1}), potassium (152 kg ha^{-1}) and low in available nitrogen (145 kg ha^{-1}).

Experiment design

For unveiling the impacts of the individual and combined effect of growth media such as soil (S), cocopeat (CP), vermicompost (VC), and rooting hormone (RH) on oregano growth and establishment, a pot study was set up during November 2022 in completely randomized design (CRD) with 12 treatments viz. T_1: Only S; T_2: Only VC; T_3: Only CP; T_4: S+VC; T_5: S+CP; T_6: S+RH; T_7: VC+RH; T_8:CP+RH; T_9:S+VC+RH; T_{10}:S+CP+RH; T_{11}:S+VC+CP;T_{12}:S+VC+CP+RH. The experiment was conducted in triplicates. About 8 to 10 cm cuttings were used from a mother plantation of oregano plants (*Origanum vulgare* var. CIM Sudeeksha). The bottom of the cuttings were initially kept in the water and finally planted in the pots prepared with different growth media. In the case of root hormone treatment, cuttings were first treated with rooting hormone and then it was planted in the pots. During the crop cultivation period, the pots were irrigated and weeded when required.

Sampling and analysis

The oregano crop was harvested after 30 days of planting from each plot of all treatments. All the growth-related and agronomical attributes such as number of roots $plant^{-1}$, root length, plant height, number of leaves $plant^{-1}$, fresh weight of root $plant^{-1}$, fresh weight of shoot $plant^{-1}$, dry weight of root $plant^{-1}$, and dry weight of shoot $plant^{-1}$ were determined and recorded as per the standard procedures.

Statistical analysis

Intended to determine the significance and variance among treatments, an analysis of variance (ANOVA) was performed. All the quantitative data were subjected to one-way ANOVA by using SPSS software at $p < 0.005$ level of significance. Further, on the basis of the relative impact of treatments on growth associated parameters of oregano, the best treatment was determined with cluster and principal component analysis.

Results and Discussion

Using an appropriate growth medium with surplus nutrients is necessary because growth media directly affects the growth and development of plants. Good media encourages the plant by supplying it with sufficient nutrients, water and gaseous exchange. The results of the current investigation established a remarkable influence of different growth mediums (soil, cocopeat, rooting hormone, and vermicompost) on various agronomical traits of oregano (Table 1). All the used growth media provided supported to the plants and provided nutrients, thereby assisting in growth. Concerning the individual impact of growth medium (among T_1–T_3), treatment T_2 (VC) demonstrated the highest root length, plant height, and number of leaves, i.e., 8.30, 8.96, and 19.00 cm, respectively. Treatment T_3 (CP) exhibited the highest number of roots $plant^{-1}$, fresh and dry weight of roots, i.e., 46.50, 3.46 and 0.35 g, respectively. The treatment T_1 (Soil) demonstrates the highest fresh

Table 1: Effect of different growing media on growth and establishment of oregano cuttings

Treatments	*No. of roots plant^{-1}*	*Root length (cm)*	*Plant height (cm)*	*No. of leaves plant^{-1}*	*Fresh wt. of roots plant^{-1} (g)*	*Fresh wt. of shoot plant^{-1} (g)*	*Dry wt. of root plant^{-1} (g)*	*Dry wt. of shoot plant^{-1} (g)*
T_1	26.00e	3.25i	8.05bc	15.00e	1.14h	5.09c	0.23e	1.26a
T_2	43.25ab	8.30b	8.96a	19.00b	2.35e	4.52d	0.23e	0.88d
T_3	46.50a	6.63ef	7.80bc	17.00cd	3.46b	3.18f	0.35b	0.64f
T_4	43.50ab	7.00de	8.43ab	19.25ab	2.55d	5.09c	0.27d	1.06b
T_5	30.25d	6.20f	7.18c	17.50c	0.92i	3.25f	0.12h	0.73e
T_6	21.50f	4.13h	7.75bc	15.00e	0.44j	5.75b	0.05i	1.05b
T_7	46.50a	10.88a	8.13b	20.50a	4.35a	6.89a	0.50a	1.29a
T_8	38.00c	7.50cd	7.18c	17.50c	3.03c	4.76cd	0.32c	1.00bc
T_9	30.25d	5.38g	7.83bc	17.50c	1.96f	5.11c	0.23e	0.97c
T_{10}	33.25d	5.40g	7.98bc	16.00de	1.80f	4.66d	0.19f	0.88d
T_{11}	44.00ab	8.20b	8.00bc	19.25ab	1.57g	3.87e	0.16g	1.02bc
T_{12}	42.25b	8.00bc	7.78bc	19.00b	2.68d	3.67e	0.29d	0.66f

T_1: Only S; T_2: Only VC; T_3: Only CP; T_4: S+VC; T_5: S+CP; T_6: S+RH; T_7: VC+RH; T_8: CP+RH; T_9: S+VC+RH; T_{10}: S+CP+RH; T_{11}: S+VC+CP;T_{12}: S+VC+CP+RH

[#]VC: vermicompost; CP: cocopeat; RH: rooting hormone; S: soil

[*]Means followed by the same letter do not differ significantly according to Duncan's test ($p < 0.05$)

and dry weight of shoot plant^{-1}, i.e., 5.09 and 1.26 g. Vermicompost is made up of diverse organic waste and thereby rich in organic matter and offers high porosity, a low C:N ratio, steady and slow supply of nutrient content and, thereby assisting plant growth. At the same time, cocopeat is composed of fibers of coco. It offers high porosity with loose and airy soil, which favors root growth and proliferation. These results implicate that vermicompost favors the length of root and shoot, whereas cocopeat is more involved in the bulking of the plant. Similarly, Khan *et al*. (2019) documented the improvement potential of cocopeat for growth-attributing characteristics in *Ipomoea aquatica*. Apart from this, Raju *et al.* (2023) also determined the comparative influence of vermicompost and coco peat and they also found similar results where cucumber grown in vermicompost demonstrated superior growth parameters over plants grown in cocopeat. Considering the combined influence of growth medium with soil (among T_4–T_6), treatment T_4 (soil with vermicompost) demonstrated a superior impact on all parameters except fresh weight of shoot plant^{-1}, which also confirms the crucial role of vermicompost in the growth and establishment of oregano. Apart from this, among the combination of VC, RH, and CP (T_7 and T_8), T_7 (VC with RH) exhibited remarkable influence on agronomical attributes such as number of roots plant^{-1}, root length, plant height, number of leaves plant^{-1}, fresh weight of root plant^{-1}, fresh weight of shoot plant^{-1}, dry weight of root plant^{-1}, and dry weight of shoot plant^{-1} i.e., 46.50, 10.88, 8.13 cm, 20.50, 4.35, 6.89, 0.50 and 1.29 g, respectively. Apart from the positive influence of vermicompost and cocopeat, rooting hormone is also characterized by the luxurious root development in the plants, also well documented by Topacoglu *et al*. (2016) in *Ficus benjamina* L. cuttings. Apart from this, Rawat *et al*. (2020) also documented the positive root development potential of rooting hormones in various concentrations in aromatic crops.

Comparing the effect of the combination of multiple growth medium (among T_9–T_{12}), T_{11} (S+VC+CP) demonstrated the highest number of roots plant^{-1}, root length, plant height, number of leaves plant^{-1}, dry weight of shoot plant^{-1}, i.e., 44.00, 8.20, 8.00 cm, 19.25 and 1.02 g, respectively, whereas, fresh and dry weight of root plant^{-1} was recorded highest for T12 (S+VC+CP+RH), i.e., 2.68 and 0.29 g. Moreover, the fresh weight of shoot plant^{-1} was the maximum recorded for T_9 (S+VC+RH), i.e., 5.11 g. Among all the treatments, treatment T_7 (VC+RH) demonstrated a prolific effect on all agronomical attributes except plant height. The present study also aligns with the findings of Naik *et al.* (2022), who analyzed the impact of five different growth mediums on the growth of mustard and found comparatively better results in vermicompost on growth as well as yield attributes. Similarly, Tiwari *et al*. (2020) also assessed the performance of individual and combined effects of different growth mediums for the propagation of patchouli cutting and concluded that the mixture of soil and FYM is best for its cultivation. The reason behind the success of treatments T_7 (VC+RH) could be the rich organic matter in vermicompost, which acts as a reservoir for nutrients, providing a slow-release source of essential elements that plants require for growth for a long period. Apart from this, organic matter also has the ability to absorb and retain moisture, preventing excessive

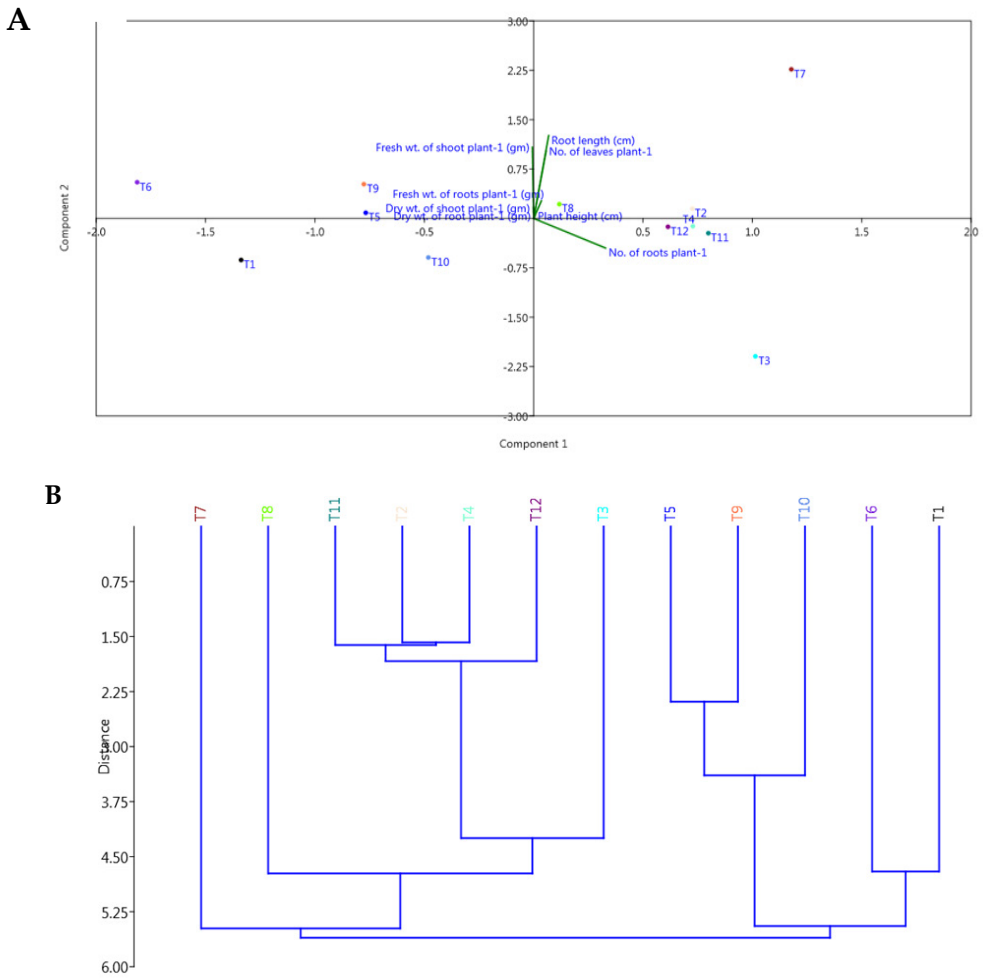

Figure 1: Relative performance assessment of various growth media through A) Principal component analysis B) Cluster analysis

evaporation and maintaining optimal moisture level. This improved water retention capacity benefits plant growth by ensuring a steady supply of water. In contrast, the rooting hormone is predominantly associated with promoting the weight and overall development of both roots, which positively influences the establishment and growth of oregano seedlings. The combination of rooting hormone and vermicompost significantly enhanced shoot and root growth, as vermicompost was primarily effective in enhancing the growth of roots, shoots, and the number of leaves.

Principal component analysis and clustering study

To determine the individual and combined influence of various growth media on the growth and agronomic aspects of oregano, principal component analysis was employed. Principal component analysis is very useful in analyzing large data and interpreting the results in a more efficient way. It confirmed the prolific consequence of the growth medium on agronomic parameters of oregano (Figure 1). Among all treatments, treatment T_7 (VC+RH) demonstrated the most promising outcomes and confirmed their promising potential in the growth and expansion of oregano. In agreement with the present study, Upadhyay *et al*. (2022) also examined the effect of seed-amended bioinoculants on the growth and agronomic attributes of rice. In addition, cluster analysis also supported the outcome of principal component analysis as it has also demonstrated the clustering of treatments T_7 (VC+RH) separate clusters and validated the potential of treatments T7 in the growth and expansion of oregano. Similar to the present study, Khan *et al*. (2023) also employed the same method for evaluating the comparative effect of bioinoculants on the growth and yield of kidney beans and determined the best inoculant.

Conclusion

The rising market for oregano, both for domestic consumption and industrial applications, has led to an increased interest in this versatile herb. The study

underscores the importance of selecting suitable organic growth media for oregano production. The outcome of the study discovered that mixing rooting hormone with vermicompost is a promising approach to enhance oregano growth, shoot and root development, and overall establishment. The study also suggests an assumption that vermicompost is primarily effective in improving the growth of roots, shoots, and the number of leaves, while rooting hormone is predominantly associated with promoting the weight and overall development of roots. These findings provide valuable insights for improving oregano cultivation and meeting the increasing global demand for this versatile herb.

Authors Contribution

Planning and execution of the experiment and manuscript preparation were carried out under the guidance of DK. AK did data analysis, review collection and manuscript writing. AKT supervision of experiment and data collection. SS. Editing of the manuscript did experimental data compilation was done by VKT. Finalization of the manuscript was done under the guidance of RCP. All authors contributed to the article and approved the submitted version.

Conflict of Interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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