**Effect of Different Growing Media on Propagation of *Croton variegatum* Semi hardwoodCuttings at Jhapa, Nepal**

# **ABSTRACT**

*Codiaeum variegatum*, commonly known as garden croton or variegated croton, is a member of the Euphorbiaceae family and is popular for its colorful ornamental foliage. An experiment was carried out at Gauradaha Agriculture Campus, Gauradaha, Jhapa, in 2024 to study the effect of different growing media on propagation of croton under partially shaded condition. Propagation through semi-hardwood cuttings is a common method, but success rates are often low due to inappropriate or suboptimal growing media. The aim of this study was to determine the effect of different media on root and shoot growth of croton. The experiment was laid out in Complete Randomized Design (CRD) with seven treatments and three replications. The treatments were soil (control), sand, sand and peatmoss (3:1), soil and perlite (1:1), mixture of sand, soil and perlite (1:1:1) and sand, soil and peatmoss (1:1:1). Different observations, root number and length, shoot number and shoot length, success percentage were recorded. Statistically superior result in root length (4.62 ± 0.15a), shoot number (4.80 ± 0.05a), shoot length (4.80 ± 0.05a) was observed in combination of soil + sand + peatmoss. However, root numbers were observed maximum in the treatment sand + peatmoss (10.40± 0.22a) at 35DAP, while soil and FYM showed lowest growth in terms of all factor through the period recorded. The combination of sand + soil + peatmoss (1:1:1) and soil + peatmoss (3:1) showed the highest success rate, which was 100%. Therefore, this research showed that combination of sand + soil + peatmoss was found to be best for the overall performance of croton plant propagated through semi hardwood cuttings in comparison to other media used in this research and is recommended in the tropic climatic condition of Jhapa.

**GRAPHICAL ABSTRACT**

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Cutting Preparation Plantation Root initiation

**Keywords**: *Codiaeum variegatum, cuttings, media, rooting, shooting*

1. **INTRODUCTION**

##

## **1.1 Background information**

*Codiaeum variegatum*, commonly known as garden croton or variegated croton, is a member of the Euphorbiaceae family. There are around 322 genera and 8910 species in the family Euphorbiaceae (El- Gedawey, 2021). Due to its thick, leathery, glabrous, and waxy foliage in a variety of forms, as well as its colorful ornamental foliage, this plant is highly popular indoors as well as outdoor. It is frequently used as a hedge, a potted specimen for a courtyard, or in shrubberies. Foliage plants are often used as indoor plants because of their attractive foliage and their ability to survive and grow under limited indoor light (Anjana et al., 2017). Crotons have been popular in tropical gardens for centuries and grow into shrubs and small trees. Leaf colors range from reds, oranges and yellows to green with all combinations of variegated colors. Leaf shapes vary from broad and elliptical to narrow and almost linear. Leaf blades range from flat to cork-screw-shaped. Variegation is the occurrence of pattern, results of differences in the amount or composition of chlorophyll although other pigments i.e. anthocyanin and carotenoids and the variegation appearance can be altered by environmental factors, particularly light intensity. There are numerous medical benefits associated with croton leaf extracts, such as purgative, sedative, antifungal, and anti-cancer effects (Bakheet et al., 2018). Croton is also a good natural source of terpenes, flavonoids, and alkaloid’s secondary metabolites. (Mario et al., 2008; Bakheet et al., 2018).

Any material used to pot or root plants is referred to as a medium (Owusu & Kuavedzi., 2020). Media is not just the place for the growth of plant it also acts as a source of nutrient for plant growth. Quality of seedling is also influenced by the media composition (Wilson et al., 2001). To produce high-quality horticulture crops, the right medium must be used. It has a direct impact on the creation of the broad functional roots system later on. An ideal growth medium would give the plants enough anchoring or support, act as a reservoir for nutrients and water, diffuse oxygen to the root, and enable gaseous exchange between the roots and the surrounding atmosphere (Abade et al., 2002). In present study, soil, sand, peatmoss, perlite and farmyard manure were used in different proportions. Soilless media are also used along with soil as growing media along with soil because of its tremendous benefits i.e., good water holding capacity, porosity, aeration and free from water logging conditions. Peatmoss has low bulk density and excellent moisture-holding capacity. Perlite retains little water, has good aeration and drainage qualities, and is frequently used to lessen soil compaction in potting mixes. Farmyard manure is another promising growing medium that readily provides the plant with all of its necessary nutrients.

 The choice and arrangement of medium components determine how well any vegetative propagation will root. Aeration and drainage must be provided in sufficient amounts by the right rooting components in order to promote faster and higher-quality root formation. 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, 2005).

* 1. **Research Problem**
* Propagation of croton is one of the hardest to root at high temperature (El- Gedawey, 2021).
* Cuttings do not propagate without a proper growing media (Limbu et al., 2025)
* Though agricultural strategy is now much on ornamental plants production for local and exportation (Sana et al., 2012). The result of the slow rate of multiplication, this made it very high in demand (Bakheet et al., 2018).

**1.3 Significance of Research**

* This study helps toinvestigate and compare the effectiveness of different rooting media in promoting successful root development.
* This study helps in assessing the propagation efficiency and ensure rooting and shooting percentage.

**2. MATERIALS AND METHOD**

**2.1 Research Site**The experiment was conducted on the research field of Gauradaha Agriculture Campus, Gauradaha, Jhapa District in the Koshi provience at an altitude of about 79m above the sea level.It has annual rainfall is about 2,000 mm and maximum temperature is recorded 42º C in summer and 10ºC in winter. The campus is located at 26°33’42’’ N latitude and 87°43’13.6’’ E longitude in the eastern part of Nepal. The experiment was conducted during the period from April to July 2024.

**2.2 Experimental Details**

The experimental setup of this study was Completely Randomized Designs (CRD) with single factor i.e. rooting media (M). There were total of 7 treatment combinations and 21 plots altogether in the experiment. Treatments were assigned to the experimental plots randomly. Samples were taken from 3 randomly selected cuttings from each plot that had 15 cutting each and the arrangement of polybags was done as shown in (Fig. 2).

 **Fig 1. Administrative map of Gauradaha, Jhapa, Nepal**

**2.2.1 Treatment details**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| T1R1 | T2R1 | T5R1 | T4R1 | T6R1 | T4R3 | T6R2 |
| T2R2 | T6R3 | T1R2 | T7R3 | T2R3 | T3R2 | T5R3 |
| T3R3 | T1R3 | T4R2 | T7R2 | T3R1 | T7R1 | T5R2 |

 **Fig. 2. Arrangement of polybags in CRD design**

**Table 1: Composition and proportion of different media**

|  |  |  |
| --- | --- | --- |
| Media (Treatment) | Media formulation | Proportion(v/v) |
| T1 | Sand | 1 |
| T2 | Soil | 1 |
| T3 | Sand and Peatmoss | 3:1 |
| T4 | Soil and Perlite | 1:1 |
| T5 | Soil and FYM | 1:1 |
| T6 | Sand, Soil and Perlite | 1:1:1 |
| T7 | Sand, Soil and Peatmoss | 1:1:1 |

**2.2.2 Experimental materials**

**Soil:** Soil texture is also an important physical property of the soil that plays a key role in deciding seed germination and rooting of cutting. It should be fine enough to retain some moisture around the cutting and coarse enough to allow free draining.

**Sand:** Sand is composed of small rock and mineral particles, primarily quartz, with grain sizes ranging from 0.0625 mm to 2 mm. Its color varies based on mineral content, with common hues being white, yellow, and black. Sand has high porosity and permeability, allowing water to pass through easily. It is non-cohesive, making it shift under pressure unless moistened. The sand should be washed and sterilized before use.

**Peat moss:** It is the dark brown fibrous product of sphagnum moss and other organic materials that decompose in peat bogs over thousands of years. It helps in fast vegetative growth and is commonly used for growing newly rooted cuttings or newly germinated seeds. It is used in combination with other materials in order to increase the water holding capacity.

**Perlite:** It is an amorphous volcanic glass with a comparatively highwater content. It has the peculiar ability to expand significantly when heated enough and occurs naturally. Once processed, its low density makes it a valuable commercial product. Perlite is light in weight and has multiple uses in horticulture, including beginning cuttings, hydroponics, and as a soil supplement or medium on its own. When used as amendment, it helps keep soil from being compacted because of its high permeability and low water retention. The rooting, vegetative, and flowering characteristics of floricultural crops such as croton, carnations, lilium, hibiscus, and bougainvillea were significantly impacted by these characteristics.

**FYM:** Well decomposed farmyard manure was brought from local household farm and stem cuttings of croton were collected from premise of the campus. FYM was sterilized in direct sunlight for 1 week before use.

**2.2.3 Cutting Preparation**

15cm long cuttings were taken from the semi hardwood part of a stem leaving extreme bottom and tip portions of the shoot. The cuttings were prepared to different nodes (three to four). Slant cut of 45° was given at the basal part of the cutting. Leaves were removed from cuttings and then placed in the jute sack by soaking it in water inorder to maintain the moisture in the cutting before planting as it dries really quickly. 1000ppm IBA was prepared by taking 1 gm of IBA and mixing it to 1 liter of water. Cuttings were dipped for 10 sec in the rooting solution and then planted in the polybag in slant position. After planting cuttings were kept moist by watering but not overwatered to protect from rotting. Water was placed only on the bottom media avoiding the upper part of the cutting using watering can.

**2.3 Observation Variables**

**Number of roots:** The number of roots was counted using the destructive sampling method first after 14 days of planting, and then again after seven days of the first and second days of data collection, at 21, 28 and 35 days after planting, according to (Kuavedzi & Owusu, 2020). Lastly, average of three samples were taken and recorded in excel.

**Number of shoots:** The number of shoots per plant was counted at 14, 21, 28, 35 days after planting (Owusu & Kuavedzi., 2020). Three plants from each plot were selected randomly and number of shoots was counted.

**Average root length**: The sample was uprooted after selection, and its root length was measured using a 15 cm scale first on the day 15 days after plantation (DAP), then again at 7 days between the first, second and third data collection. The average of the three samples was then computed and entered into Excel.

**Average length of shoots:** Shoot of the three cutting from each plot was selected and from each cutting shoot length was measured using 15 centimeter scale and their average was taken.

**Success percentage:** It was calculated by using the following formula:

 Success (%) = Total number of shooted cuttings / Total no of cuttings \* 100

**2.4 Data analysis**

The soil data was subjected to descriptive analysis while the data collected from field experiment were subjected to analysis of variance as per the design Gomez and Gomez, (1984) using R – Stat version 4.1.1. Data registered as percentage were subjected to appropriate data transformation before analysis of variance conducted. Least Significant Difference (LSD) at 5% and Duncan Multiple Range Test (DMRT), as mean separation technique was applied to identify the most efficient treatment in the rooting and shooting behavior of *C. variegatum.*

1. **RESULTS AND DISCUSSION**
	1. **Number of Roots**

Rooting media had significant effects on root development (p < 0.05). The effect of growing media on the number of roots counted at 14, 21, 28, and 35 DAP are shown in Table 2. The result show that growth media had no significant effect on number of roots at 14 and 21 DAP. It was however observed that there was significant difference in number of roots counted at 28DAP and 35DAP. Highest number of roots at 28 and 35DAP were (8.0 ± 0.00a) and (10.40± 0.22a) respectively which was recorded in the combination of sand and peatmoss (3:1) combination followed by sand (8.67$\pm $0.33ab) and the mixture of sand + perlite (1:1) (8.00 ± 2.00ab). These findings concur with those of Safaa et al. (2020) who found that maximum number of roots was observed in combination of sand + vermiculite + peatmoss followed by sand and peatmoss in stem cutting of *Ficus benenjamina*. In a study on croton plants in Egypt, the combinations of sand + peatmoss + sawdust, peatmoss + perlite, and sand + peatmoss + clay improved the root length and fresh and dry weights of the plant roots (Sakr et al., 2007). Cuttings rooted in perlite and peat moss or sand and peat moss form well-branched, slender, flexible roots that are ideal for repotting and digging (Hartman et al., 1997).

Soil alone and along with FYM (1:1) showed the lowest number of roots throughout the growth period. The research conducted in West Bengal, India in propagation of stevia plant found that minimum number of cuttings with roots was found with soil as growing media whereas maximum was found in sand medium (Manohar et al., 2022). (Singh, 2018) also noted maximum number of roots in sand medium conducted on the research of stem cutting of mulberry. Soil alone or mixed with FYM is inherently fertile with nutrients that supports rooting and continuous growth of the cuttings. Ogao-Ogao et al. (2017) contradict with our research finding where soil alone and combination with FYM yielded lowest during the entire research period. This may be due to high temperature during planting of cutting in Jhapa as high temperatures exacerbate the stress caused by waterlogging, possibly as a result of increased oxygen consumption and depletion (Ashraf, 2012). Furthermore, nutrient imbalances and hazardous byproducts could arise from the fast breakdown of FYM brought on by the tropical heat which released more nutrient and caused the plant root to rot before it emerged (Das & Avasthe, 2020).

 **Table 2: Effect of different media on number of roots of Croton variegatum**

|  |  |
| --- | --- |
| **Treatment** | **Number of roots** |
| **14 DAP** | **21 DAP** | **28 DAP** | **35 DAP** |
| **Sand** | 1.45 ± 0.07c (2.11) | 1.63 ± 0.059d (2.67) | 5.78 ± 0.61b | 8.67$\pm $0.33ab |
| **Soil** | 1.10 ± 0.05d (1.22) | 1.56 ± 0.035d (2.44) | 2.78 ± 0.29d | 6.89 ± 1.66b |
| **Sand + Peatmoss (3:1)** | 1.99 ± 0.04a (4.00) | 2.26 ± 0.064a (5.11) | 8.0 ± 0.00a | 10.40± 0.22a |
| **Sand + Perlite (1: 1)** | 1.59 ± 0.06bc (2.56) | 1.90 ± 0.13bc (3.67) | 4.46 ± 0.33c | 8.00 ± 2.00ab |
| **Soil + FYM (1:1)** | 1.00 ± 0.00d (1.00) | 1.00± 0.00e(1.00) | 1.11 ± 0.11e | 1.00 ± 0.00c |
| **Sand +Soil + Perlite (1:1:1)** | 1.54 ± 0.15bc (2.44) | 1.72 ± 0.09cd (3.00) | 5.0 ± 0.00bc | 5.00 ± 2.03b |
| **Sand + Soil + Peatmoss (1:1:1)** | 1.78 ± 0.12ab (3.22) | 2.15 ± 0.12ab (4.67) | 7.78 ± 0.29a | 7.78 ± 2.52a |
| **F-Test** | \*\*\* | \*\*\* | \*\*\* | \*\*\* |
| **CV** | 10.38 | 8.49 | 10.75 | 24.73 |
| **LSD** | 0.27 | 0.26 | 0.94 | 3.14 |
| **Mean** | 1.49(2.36) | 1.78(3.22) | 5.01 | 7.33 |

\*Statistically significant at p<0.05, CV: Coefficient of Variance, DAP: Days After Plantation, LSD: Least Significance Difference

**3.2 Length of Roots**

The analysis of the variance of data illustrated that there was a significant difference in the length of roots on media composition (Table 3). The data showed, growing the cutting in thecombination of sand + soil + peatmoss (4.62 ± 0.15a) cm gave the maximum root length followed by sand (4.05 ± 0.10ab) cm and then the combination of sand + soil + peatmoss (4.62 ± 0.15a) cm gave the maximum root length followed by sand (4.05 ± 0.10ab) cm and then the combination of sand + peatmoss (3:1) (3.94 ± 0.36bc) cm along with Soil + perlite (1:1) (3.41 ± 0.13cd) cm which was recorded at 35 DAP. These treatments had favorable effect on increasing the length of roots. When the plant was observed at 15 DAP the combination of sand + soil + peatmoss (1:1:1) showed the

longest root (2.39 ± 0.02a) cm followed by sand + peatmoss (3:1) (2.10 ± 0.00a) cm which was similar to the finding of the study done in Egypt that showed tallest roots in the mixtures of sand + sawdust + peatmoss and peatmoss + perlite in the first season whereas in 2nd season sand + soil + peatmoss showed maximum root length on substrate but along the course of time sand showed the maximum length of root (Sakr et al., 2007). Singh and Nair (2003) also stated that on some foliage plants, found that the length of roots was maximum with the mixture of soil, sand, and compost at the ratio of 2:1:1. Manohar et al. (2022) obtained longest root in the sand on the cutting of stevia plant.

The minimum root length was observed in soil and FYM combination which may be due to numerous factors that contributed to the poor rooting and shooting of stem cuttings grown in tropical regions in soil and farmyard manure (FYM). Root development is impacted by reduced aeration caused by compacted soil (Pandey & Bennett, 2023). Waterlogging from the soil-FYM mixture's excessive moisture retention prevents root growth even more. High temperatures exacerbate the stress caused by waterlogging, possibly as a result of increased oxygen consumption and depletion (Ashraf, 2012). Additionally, waterlogging impacts the nutrients that are available in the soil. This results in an imbalance of the nutrients that plants take up, which causes both toxic build-ups and shortages of various plant nutrients (Jimenez et al., 2015). Furthermore, nutrient imbalances and hazardous byproducts could arise from the fast breakdown of FYM brought on by the tropical heat (Das & Avasthe, 2020).

 **Table 3: Effect of different media on root length of Croton variegatum**

|  |  |
| --- | --- |
| **Treatment** | **Length of roots(cm)** |
| **14 DAP** | **21 DAP** | **28 DAP** | **35 DAP** |
| **Sand** | 1.92 ± 0.49ab | 1.41 ± 0.03bc (2.01) | 1.69 ± 0.04b (2.87) | 4.05 ± 0.10ab |
| **Soil** | 0.46 ± 0.25d | 0.81 ± 0.15d (0.72) | 1.10 ± 0.02c (1.23) | 1.51 ± 0.12e |
| **Sand + Peatmoss (3:1)**  | 2.10 ± 0.00a | 1.52 ± 0.05ab (2.33) | 1.73 ± 0.09b (3.02) | 3.94 ± 0.36bc |
| **Soil+ Perlite (1:1)** | 1.18 ± 0.12c | 1.25 ± 0.04bc (1.58) | 1.20 ± 0.09c (1.47) | 3.41 ± 0.13cd |
| **Soil + FYM (1:1)** | 0.17± 0.01d | 0.70 ± 0.18d (0.57) | 0.74 ± 0.14d (0.59) | 0.64 ± 0.22f |
| **Sand + Soil + Perlite (1:1:1)** | 1.30 ± 0.14bc | 1.16 ± 0.03c (1.35) | 1.33 ± 0.03c (1.78) | 2.87 ± 0.09d |
| **Sand + Soil + Peatmoss (1:1:1)** | 2.39 ± 0.02a | 1.78 ± 0.05a (3.17) | 1.97 ± 0.01a (3.89) | 4.62 ± 0.15a |
| **F Test** | \*\*\* | \*\*\* | \*\*\* | \*\*\* |
| **CV** | 28.36 | 13.79 | 9.81 | 11.17 |
| **LSD** | 0.67 | 0.29 | 0.25 | 0.58 |
| **Mean** | 1.36 | 1.23(1.67) | 1.39(2.12) | 3.00 |

\*Statistically significant at p<0.05, CV: Coefficient of Variance, DAP: Days After Plantation, LSD: Least Significance Difference

**3.3 Number of Shoots**

Different treatment had significant difference(P=0.05) in the number of shoots of croton plant which is shown in Table no 4. Maximum number of shoots was seen in combination of sand + soil + peatmoss (2.20 ± 0.15a) and sand + soil + perlite (1:1:1) (2.18 ± 0.22a) followed by soil+ perlite (1:1) (2.09 ± 0.14a) when observed in 35DAP. It is in conformity with the research carried in

Yemen observed on *Bougainvilla spectabila* showed maximum number of shoots per rooted cutting in combination of sand + soil + peatmoss (Eed et al., 2015). Rajkumar et al. (2017), observed the proportion of vermiculite to perlite produced clean, well-drained media that is beneficial for improved root and shoot development in pomegranate cuttings. When compared to propagating in sand, Hammo et al. (2009) observed that using peatmoss medium caused a considerable increase in all shoot tip cutting features.

Lowest number of shoots was observed in the combination of soil and FYM (1.21 ± 0.21b) followed by soil alone (1.62 ± 0.11ab) when observed in 35DAP. These two medium showed significant difference among the other medium throughout the growth period which is in close conformity with the research study conducted in horticulture research station Pakistan, where minimum number of shoots and length of shoot were found in control soil as compared to other treatments in jojoba cuttings (Bashir et al., 2007).

 **Table 4: Effect of different media on number of shoots of Croton variegatum**

|  |  |
| --- | --- |
| **Treatment** | **Number of Shoots** |
| **14 DAP** | **21 DAP** | **28 DAP** | **35 DAP** |
| **Sand** | 2.22 ± 0.11bc | 1.55 ± 0.13ab (2.44) | 1.72 ± 0.14a (3.00) | 1.72 ± 0.27ab (3.11) |
| **Soil** | 1.11 ± 0.11d | 1.37 ± 0.40b (1.89) | 1.27 ± 0.15bc (1.67) | 1.62 ± 0.11ab (2.67) |
| **Sand + Peatmoss (3:1)** | 3.11 ± 0.11a | 1.52 ± 0.06ab (2.33) | 1.65 ± 0.12abc (2.78) | 1.85 ± 0.07a (3.44) |
| **Soil + Perlite (1:1)** | 1.89 ± 0.22c | 1.65 ± 0.12a (2.78) | 1.69 ± 0.08ab (2.89) | 2.09 ± 0.14a (4.44) |
| **Soil + FYM (1:1)** | 1.00 ± 0.00d | 1.00 ± 0.00c (1.00) | 1.22 ± 0.15c (1.56) | 1.21 ± 0.21b (1.56) |
| **Sand + Soil +Perlite (1:1:1)** | 2.22 ± 0.29bc | 1.66 ± 0.08a (2.78) | 1.86 ± 0.17a (3.56) | 2.18 ± 0.22a (4.85) |
| **Sand + Soil + Peatmoss (1:1:1)** | 2.67 ± 0.19ab | 1.73 ± 0.00a (3.00) | 1.85 ± 0.07a(3.44) | 2.20 ± 0.15a(4.89) |
| **F Test** | \*\*\* | \*\*\* | \* | \* |
| **CV** | 14.76 | 9.54 | 14.55 | 17.17 |
| **LSD** | 0.52 | 0.25 | 0.41 | 0.55 |
| **Mean** | 2.03 | 1.50(2.31) | 1.61(2.69) | 1.84(3.57) |

\*Statistically significant at p<0.05, CV: Coefficient of Variance, DAP: Days After Plantation, LSD: Least Significance Difference

**3.4 Length of Shoots**

The analysis of the variance of data illustrated that there was a significant difference in the length of shoots on media composition (Table 5). The results showed that Soil and Soil + FYM growing media were significant different from all other medias in terms of shoot length at 14 and 21DAP in the length of shoots measured at 28DAP and 35DAP. The combination of sand+ soil + peatmoss (4.80 ± 0.05a) cm along with (3.72 ± 0.09**b**) cm produced maximum shoot length when

observed at 35DAP which is similar to the finding of Hammo et al. (2009) who observed that using peatmoss medium caused a considerable increase in all shoot tip part. In comparison to all other growth media in propagation of *P. patchouli*, FYM & soil growing media showed overall superiority in all growth parameter tested which is contradictory to the finding of this result (Tiwari et al., 2020). Manohar et al. (2022) obtained longest root and shoot in the sand medium in stevia plant.

 **Table 5: Effect of different media on shoot length of Croton variegatum**

|  |  |
| --- | --- |
| **Treatment** | **Length of Shoots(cm)** |
| **14 DAP** | **21 DAP** | **28 DAP** | **35 DAP** |
| **Sand** | 1.29 ± 0.02a (1.69) | 1.37 ± 0.10c | 1.31 ± 0.02b (1.73) | 3.46 ± 0.31b |
| **Soil** | 0.95 ± 0.04c (0.91) | 1.01 ± 0.01d | 1.19 ± 0.07b (1.42) | 1.95 ± 0.29c |
| **Sand + Peatmoss (3:1)** | 1.36 ± 0.05a(1.87) | 1.69 ± 0.03b | 1.53 ± 0.08a (2.35) | 3.72 ± 0.09b |
| **Soil + Perlite (1:1)** | 1.09 ± 0.05b(1.21) | 1.30 ± 0.04c | 1.17 ± 0.04b (1.38) | 3.66 ± 0.14**b** |
| **Soil + FYM (1:1)** | 0.65 ± 0.02d (0.42) | 0.27 ± 0.10e | 0.94 ± 0.05c (0.90) | 1.00 ± 0.00d |
| **Sand + Soil + Perlite (1:1:1)** | 1.08 ± 0.03b (1.74) | 1.21 ± 0.06cd | 1.21 ± 0.03b (1.47) | 2.43 ± 0.05c |
| **Sand + Soil + Peatmoss (1:1:1)** | 1.37 ± 0.007a (1.89) | 2.22 ± 0.05a | 1.57 ± 0.01a (2.46) | 4.80 ± 0.05a |
| **F Test** | \*\*\* | \*\*\* | \*\*\* | \*\*\* |
| **CV** | 5.99 | 9.13 | 7.02 | 10.40 |
| **LSD** | 0.11 | 0.20 | 0.15 | 0.54 |
| **Mean** | 1.11(1.31) | 1.29 | 1.27(1.67) | 3.00 |

\*Statistically significant at p<0.05, CV: Coefficient of Variance, DAP: Days After Plantation, LSD: Least Significance Difference

**3.5 Survival Percentage**

Percentage survival of the cuttings of *Croton variegatum* showed substantial variations among the different rooting media (p < 0.05) which is shown in Table no. 6. Survival percentage was found to be maximum 100% in the combination of sand + soil + peatmoss (1:1:1), sand + peatmoss (3:1) followed by sand 86.67% which is somewhat similar to the finding obtained in jojoba cuttings, where 95% survival was observed in the combination of peatmoss + vermiculite + perlite followed by 89% in peatmoss and

sand (Eed, 2016). Papaya obtained maximum survival in the sand + soil + vermicompost (Bhardwaj, 2014). Plant lemon -1 variety of lemon was found with low survival in soil medium followed by the combination of sand + soil + FYM medium which is similar to the finding of this research (Kumar et al., 2015). The season and a number of other variables, including temperature, humidity, light, and the availability of nutrients, may have impact on the cutting survival rate. Depending on the species and a suitable climate, the percentage of sprouted cuttings can be increased (Kibbler et al., 2004).

 **Table 6: Effect of different media on survival percentage of Croton variegatum**

|  |  |
| --- | --- |
| **Treatment** | **Survival Percentage at 35 DAP (%)** |
| **Sand** | 86.67 ± 3.84ab |
| **Soil** | 33.33 ± 3.84d  |
| **Sand + Peatmoss (3:1)** | 100.00 ± 0.00a |
| **Soil + Perlite (1:1)** | 71.11 ± 5.87c |
| **Soil + FYM (1:1)** | 26.67 ± 0.00d |
| **Sand + Soil + Perlite (1:1:1)** | 75.56 ± 8.89bc |
| **Sand + Soil + Peatmoss (1:1:1)** | 100.00 ± 0.00a |
| **F- test** | **\*\*\*** |
| **CV** | 11.11 |
| **LSD** | 13.71 |
| **Mean** | 70.47 |

\*Statistically significant at p<0.05, CV: Coefficient of Variance, DAP: Days After Plantation, LSD: Least Significance Difference

**4. CONCLUSION**

Vegetative propagation using stem cuttings is a practical method for producing elite plant materials in large quantities because the germination rate of seeds in *C. variegatum* is extremely slow. This study assessed the impact of various growth media on the rooting and shooting capabilities of stem cuttings from *C. variegatum*. The findings demonstrated that growth media had a major impact on the number of roots, shoots, and survival of *C. variegatum* stem cuttings. Based on this research the composition of sand + soil + peatmoss (1:1:1) showed the maximum growth on root, shoot parameter along with the survival percentage and is recommended.

**5. DECLARATIONS**

**5.1 Data of Availability**

The data that supports the findings of this study are available on request from the corresponding author.

**DISCLAIMER (ARTIFICIAL INTELLIGENCE)**

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during writing or editing of this manuscript.

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**COMPETING INTERESTS**

Authors have declared that no competing interests exist.

***Authors’ contributions***

This work was carried out in collaboration among all authors. Authors BAand RS contributed to the conceptualization and methodology of the study. Authors BA, and RS were involved in software validation. Author BA provided resources. Author RS handled visualization. Authors BA and RS contributed to writing and editing the manuscript. Authors BAand RS were responsible for funding acquisition. All authors read and approved the final manuscript.

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