Research Article

Impact of Different Potting Media on Growth of Rough Lemon (*Citrus Jambhiri Lush*)

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Abstract | This study aimed to compare the effects of potting media with different compositions on growth of rough lemon (*Citrus jambhiri* L) rootstock. Potting media has vital role in the production of healthy and vigorous plants in the nursery. The trial was designed with seven treatment combinations of growing substrates that was five times repeated for each treatment in Completely Randomized Design (CRD). The rough lemon rootstock was tested for growth with all different types of media as T_1 = Soil + silt + sand (2:1:1), T_2 = Rice husk + sand + soil (2:1:1), T_3 = Bagass + sand + soil (2:1:1), T_4 = Wheat straw + sand + soil (2:1:1), T_5 = Rice husk + sand + soil (1:1:2), T_6 = Bagass + sand + soil (1:1:2) and T_7 = Wheat straw + sand + soil (1:1:2) respectively. The observation was recorded for plant height, stem thickness, number of branches, number of leaves, fresh plant weight, dry plant weight, fresh root weight, dry root weight, root length, root diameter, leaf area and chlorophyll contents. The results from this study indicated that in term of stem thickness(2.98mm), more no. of leaves (15), root fresh weight (1.39g), root length (25.5 cm), No. of branches (4) root diameter (4.47 mm) and maximum chlorophyll contents were observed in T1. Overall various potting media concentrations significantly influenced all the growth parameters of rough lemon citrus rootstock. The growing substances comprising Soil + silt + sand (2:1:1), and Rice husk + sand + soil (2:1:1), shows the prominently significant impact on rough lemon, in contrast to others media. In this experiment, an eight-month-old seedling of uniform height were used. The container was a 14″x8″ size plastic bag.

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1. Introduction

Citrus is an important group of fruits of subtropical and tropical regions. This plant is characterized by its slow growth rate and commercially it is reproduced through grafting or budding on seedling rootstocks. At the national level in Pakistan, 95% of citrus is produced in Punjab and out of which 70% is kinnow (Chaudhry *et al.*, 2004).

Growing media are an important component for horticultural crop production. The substrates elevate

and anchor root, provide air gaps for ventilation and preserve adequate accessible water for the plant to expand and grow (Ayoola and Adeyeye, 2010). Citrus plant growth and quality are heavily influenced by the potting medium used (Tariq *et al.*, 2012). Media is utilized as a censor to efficiently develop seedlings (James and Michael, 2009). Media plays an important role in seed germination and development, as well as maintaining their equilibrium with the roots system (Bhardwaj, 2014). There are different growing substrates used for propagation such as peat moss, wheat straw, rice husk, coconut coir, etc in Pakistan.

Wheat straw is an important byproduct in agriculture that is not used as an industrial raw material on a large scale, However, a small portion is used as domestic fuel, animal feed, or raw resource for the paper industry (Lequart *et al.*, 1999). The most common used substrate is peat moss. The industrial usage of peat media or moss is non-recyclable and expensive, but low-cost alternatives are generated by using greater nutritional media, which have numerous advantageous features and can minimize the need for fertilization, irrigation rates, and other costs (Tariq *et al.*, 2012). Farmyard manure was the primary organic source of required minerals for the plant. Massive applications of organic matter are required for successful vegetable and fruit development (Chaudhary, 1996).

Potting combinations have their own significance as they improve the yield and quality of plants and prevent plants from several diseases (Kashihara *et al.*, 2011). The growth of plants is directly controlled by nutrient-rich media. There are satisfactory potting media in the market, but due to their high prices they are difficult for growers to purchase and use on commercial scale (Khan *et al.*, 2006).

In prelude the importance of growing media, there is very little work done on it in Pakistan. This study intended to identify appropriate growing media and its impact on growth and performance of rough lemon root stock.

2. Materials and Methods

The research trial was performed at Citrus Research Institute, Sargodha in the year 2019-20. The research study aimed to evaluate the impact of different potting media to the growth and productivity of rough lemon (*Citrus jambhiri* L). Potting media was prepared at different proportions according to the given treatment plan and replicated five times.

2.1 Treatment plan

T_1 = *Soil + silt + sand (2:1:1)*
T_2 = *Rice husk + sand + soil (2:1:1)*
T_3 = *Bagass + sand + soil (2:1:1)*
T_4 = *Wheat straw + sand + soil (2:1:1)*
T_5 = *Rice husk + sand + soil (1:1:2)*
T_6 = *Bagass + sand + soil*
T_7 = *Wheat straw + sand + soil*

Plant height and root length were measured with measuring tape. Plant thickness and root diameter were measured with Vernier caliper. Plant dry weight and fresh weight were measured with Sartorius balance. Chlorophyll was observed by Chlorophyll meter.

2.2 Media preparation

For the preparation of media three different types of basic materials were used i.e., wheat straw, bagaas, and rice husk. These media were weighed on an electrical balance in required amounts. For further process, an equal quantity of urea was added into these media and it was covered properly and left for decomposition in a black polythene sheet. After few days molasses treatment was done to these media and then again it was left for decomposing. Five applications with urea were done within the gap of 15-20 days and then it was finally prepared. When the different media was fully prepared then it was mixed with different concentrations of soil, silt, and sand in different ratios (Table 1).

2.3 Pot size and plant age

In this experiment, of 14″x8″ size polythene bags filled with different media were used. Then eight months old seedlings of uniform height were transplanted.

2.4 Media analysis

2.4.1 pH and EC of saturated soil (media)

At the start of the experiment, the chemical properties of all substrates were tested at Citrus Research Institute. The pH was measured through a digital pH meter and EC (Electrical Conductivity) was measured with the help of electrical conductivity (EC Tester-11) until the end of the experiment to maintain their optimum level.

2.5 Soil media organic matter determination

Soil organic matter was determined by following the

method as described by Walkley and Black (1947). Organic matter was calculated by the formula:

$$OM\ (\%) = \frac{V(blank) - V(sample)}{W} \times 0.698$$

2.6 Statistical analysis

The experiment was carried out using a Complete Randomized Design (CRD). The data was statistically analyzed using the (ANOVA) technique. The least significant differences test was used to compare the means at a 5% level of significance (Table 2).

3. Results and Discussion

3.1 Plant height (cm)

The plant's height is an important indicator to define plant vigor. The results of the current study show that there is a significant ($p \leq 0.05$) difference between different combinations of soil media treatments that were applied to citrus rootstock rough lemon. The maximum plant height (25.2cm) was measured in T_1 and followed by T_5 (22.9 cm) in T_5 While, the medium response regarding plant height were recorded in T_2 and T_7, (22.4), and (20.4 cm), respectively (Table 3).

However, minimum plant height (19.4cm) was observed in T_3 with different combinations of soil media) and (16.9 cm) were founded in T_6. The results shows that different combination of soil media perform better but T_1 treatment is vigorous as compare to other because of the greater nutrient supply. It is indicated that different soil media in different combinations have different effects on plant height. An optimal plant height production requires an equilibrium growth medium with a high nutrient supply. Different combinations of media significantly increased plant height of various indoor and outdoor plants, under the same studies (Saleh, 2000; Garcia-Correa *et al.*, 2001) (Table 3).

3.2 Stem thickness (mm)

The results regarding citrus rootstock Rough lemon (*Citrus jambhiri* L.) shows the significant effect with the combinations of different soil (Media). All the different treatments of soil media and citrus rootstock variety Rough lemon showed significant ($p \leq 0.05$) impact on stem thickness. In Rough lemon citrus rootstock stem thickness (3.27 mm) were recorded with various concentration of soil media, T_1 displayed in (Table 2) followed by (2.98) was recorded in T_2. While T_4 and T_5 treatments showed the stem thickness (2.48±0.12 cd) and (2.76±0.16 bd) mm. The results shows that different soil Media combination achieve superior results but T_1 treatment is assertive particularly in comparison to other in which stem thickness is increasing rapidly compared to others because of the greater nutrient supply which in these therapies finally results in higher photo-synthetically functional leaves producing a good seedlings circumference. It was obviously found

Table 1: Details of micro or micronutrients used in the potting media for each treatment.

Treatments	Macronutrients of media			Micro nutrient analysis 18 December 2019	
	Nitrogen (%)	Phosphorous (P mg kg^{-1})	Potassium (k mg kg^{-1})	Fe (k mg kg^{-1})	Zn (k mg kg^{-1})
T1	2.2	8.964	100	2.389	0.382
T2	2.41	19.764	540	5.804	1.4192
T3	1.76	18.684	260	3.035	1.3687
T4	2.62	15.12	540	5.62	1.6066
T5	2.06	14.148	420	5.028	1.062
T6	1.36	10.26	200	2.299	0.8274
T7	1.72	12.2	300	1.49	0.4874

Table 2: Physico chemical properties of media to be used in the experiment.

Chemical analysis	Soil (media) analysis						
	T1 = (2:1:1) soil + silt + sand	T2 = (2:1:1) Rice husk + sand + soil	T3 = (2:1:1) Bagass + sand + soil	T4 = (2:1:1) Wheat straw + sand + soil	T5 = (1:1:2) Rice husk + sand + soil	T6 = (1:1:2) Bagass + sand + soil	T7 = (1:1:2) Wheat straw + sand + soil
pH	7.61	6.90	7.29	6.45	7.39	7.88	7.47
EC	1.35	1.99	2.35	1.57	2.01	2.67	1.79
OM	1.32	5.37	5.83	5.58	2.98	3.42	3.55

Note: Where EC: Electrical conductivity (dS m^{-1}); OM: Organic Matter (%).

Table 3: Mean value of studied parameters under different potting media on the growth of Rough lemon (*Citrus jambhiri* Lush).

Treatment	Plant height (cm)	Stem thickness (mm)	Number of branches per plant	Number of leaves per plant
T_1 = Soil + silt + sand (2:1:1)	25.2a	3.27a	4 ab	15 a
T_2 = Rice husk + sand +soil (2:1:1)	22.4 ab	2.98 ab	1 b	12 ab
T_3 = Bagass + sand + soil (2:1:1)	19.4 bc	2.81bc	2 b	13 ab
T_4 = Wheat straw + sand + soil (2:1:1)	20.5 ac	2.48 cd	1 b	11 ab
T_5 = Rice husk + sand + soil (1:1:2)	22.9 ab	2.76 bd	3 a	13 ab
T_6 = Bagass + sand + soil (1:1:2)	16.9 c	2.30 d	1 b	10 b
T_7 = Wheat straw + sand + soil (1:1:2)	20.4 ac	2.68 bd	2 b	12 ab

that different soil media in various combinations have dissimilar descriptive and analytical effects on thickness of stem. Boughalleb *et al.* (2011) concluded that combination of media and raising N increased the stem thickness of plants. Similar finding were reported by (Watfa, 2009). Found that all combination of different mediums and balance fertilization of NPK treatments significantly increased the stem thickness of plants.

3.3 Number of branches

The response of different combinations of soil media has significant influence on number of branches of citrus rootstock Rough lemon (Table 3). The highest number of branches 4 was observed in T_1 followed by T_5 3 with the application of soil media. Similarly, the minimum number of branches was found 1 in T_2. The findings indicate that different combination of soil media produce better results but T_5 treatment is growth supportive in contrast with those where the number of branches is gradually increase due to physiological changes and nutrients balance that help in vegetative plant growth. The numerous soil media have a particular consistency influence and quantity on the number of branches in different combinations. Different experiments results show that development of branches were better with different physiological approaches and nutritional mixture of media (Lebon *et al.*, 2004). The same results was also describe (Husen and Pal, 2007).

3.4 Number of leaves

The number of leaves per plant is a significant physiological parameter. The results regarding citrus rootstock Rough lemon shows the significant effect with the combinations of different soil media that are presented in Table 3. The highest number of leaves 15 was counted in T_1 followed by T_3 13 and T_5 13 (Table 2). However, the lowest number of leaves 10 was observed in T_6. Different studies, taken together have shown that using organic substances such as leaf manure in soil mixtures has increased the number of leaves (Parasana *et al.*, 2013). The same behavior was observed that in potting mixtures organic materials controls the available water resources and nutrients and enhances the seedling production and in addition to improved water holding capacity and number of leaves, manure may have released nutrients for growth in the mixture (Peter-Onoh *et al.*, 2014).

3.5 Plant fresh weight (g)

The plant fresh weight is a vital parameter. The data presented in (Figure 1) shows that the response of different combinations of soil media a significant influence on citrus rootstock Rough lemon. The findings suggest that various soil media combinations produce improved outcomes but T_1 produced more fresh weight than other plants due to massive improvement in the rooting medium physicochemical properties that increase plant fresh weight whereas lowest plant fresh weight was observed in T4 as shown in Figure 1. Combine effect of different combination of media and NPK fertilizer mixture influence on the seedling and increased the plant fresh weight (Watfa, 2009). The same behavior was also observed in different species exhibit the faster growth and high plant fresh weight as well as favorable seedling quality in growing media (Singh *et al.*, 2008).

3.6 Plant dry weight (g)

Combination of different soil media significantly effected Rough lemon rootstock performance (Figure 2). The maximum plant dry weight (2.75 g) was observed in T_1. Similarly, the minimum plant dry weight was found (1.06) in T_4 as shown in Figure 2. Combine effect of different combination of media and NPK fertilizer mixture influence on the seedling and increased the plant dry weight (Watfa, 2009). The same behavior was also observed in different species

exhibit the faster growth and high plant dry weight as well as favorable seedling quality in growing media (Singh *et al.*, 2008).

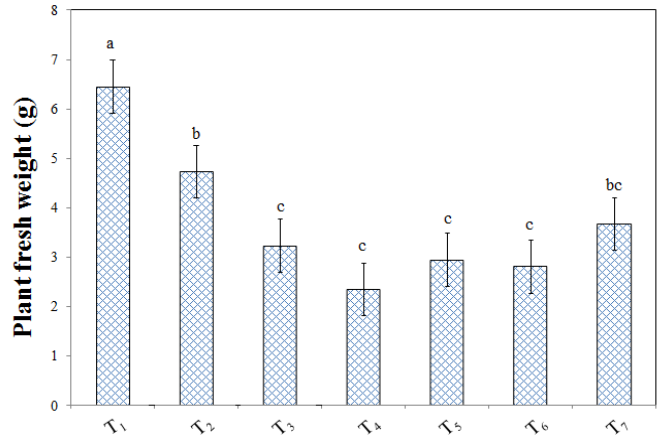

Figure 1: Plant fresh weight (g) under different potting media on the growth of Rough lemon (*Citrus jambhiri* Lush).

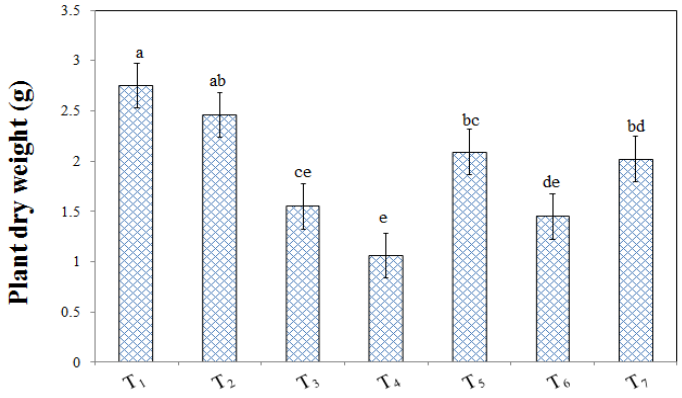

Figure 2: Plant dry weight (g) under different potting media on the growth of Rough lemon (*Citrus jambhiri* Lush).

3.7 Root fresh weight

The root fresh weight is a mandatory parameter. The data presented shows the response of different combinations of soil (Media) a significant influence on citrus rootstock rough lemon (*Citrus jambhiri* L.). The maximum root fresh weight (1.39) was observed in T_1 as reflected in Figure 3 while, the intermediate response regarding root fresh weight were recorded in T_2 and T_3 (0.91) and (0.61) g respectively. However, the minimum root fresh weight (0.47g) was observed in T_4 as shown in Figure 3. The results shows that different combination of soil media perform better but T_1 treatment is productive as compare to other in which the root fresh weight is gradually increased due to interaction of genetic, environment and evolutionary biology. It was clearly indicated that different soil media in different combinations have different qualitative and quantities effects on root fresh weight. Different growing media enhance the physico-chemical properties of soil that support in the growth and development mechanism and increase the root fresh weight. However, finding results are also described by (Parasana *et al.*, 2013) seedling grown in a mixture of different potting media that shows the maximum root fresh weight.

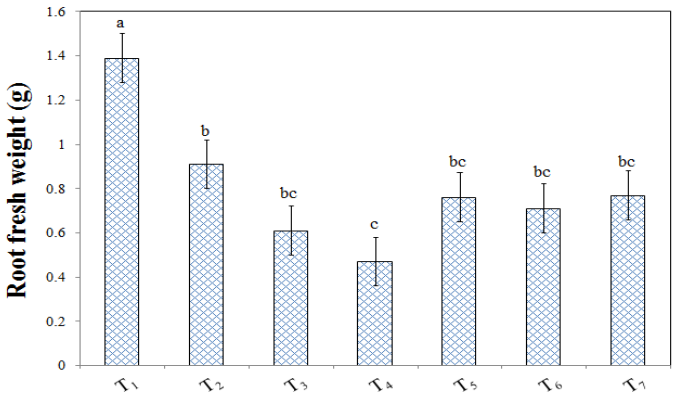

Figure 3: Root fresh weight (g) under different potting media on the growth of Rough lemon (*Citrus jambhiri* Lush).

3.8 Root dry weight

The root dry weight is a major structural parameter. The citrus rootstock rough lemon showed the significant effect with the combinations of different soil media that are presented in Figure 4. Data reveals that maximum root dry weight was observed in (1.05g) T6 and minimum dry weight was obtained in (0.36 g) with the application of soil media T_3 as shown in Figure 4. The results shows that different soil media combination achieved good results but T_1 treatment particularly performed better as root dry weight increased rapidly because of nutrition and biochemical changes in the plant. It was obviously found that different soil media in various combinations has different, descriptive and analytical effects on root dry weight. The better performance of seedling root dry weight could be due to improvement of physical status such as less compactness and increased aeration of the medium (Osaigbovo and Nwaoguala, 2011). Organic matter has also been described to resist compaction and to maintain water while maintaining air and root growth as described (Khan *et al.*, 2006).

3.9 Root length (cm)

The root length is an important parameter. The data presented in (Figure 5) shows that the response of

different combinations of soil media has significantly influenced the Rough lemon. The maximum root length (25.5cm) was observed in T_1. Similarly, the minimum root length was found (7.7) in T_2 as displayed in Figure 5. The findings indicate that different combination of soil media produce finer results but T_1 treatment is productive in contrast with those where the root length is gradually increase due to attributed to massive improvement in the rooting medium physico chemical properties that increase the root length. The numerous soil media have a particular consistency influence and quantity on the root length in different combinations. Various experimental findings shows that different physiological strategies and the nutritional mix of the media were better for the development of branches (Lebon *et al.*, 2004). The same results were also described (Husen and Pal, 2007). The interactive impact of branch location and auxin treatments on branch parameter was important.

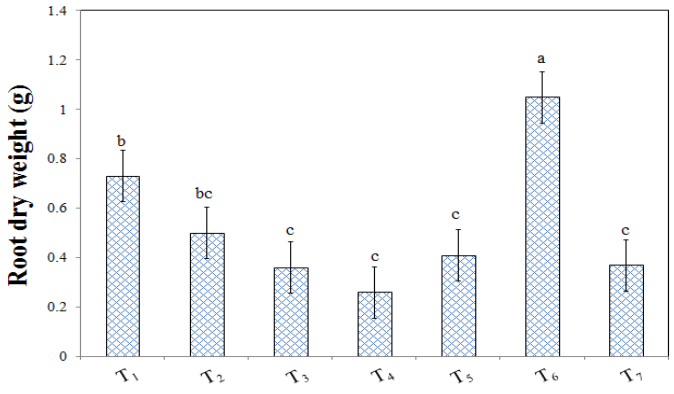

Figure 4: Root dry weight (g) under different potting media on the growth of Rough lemon (*Citrus jambhiri* Lush).

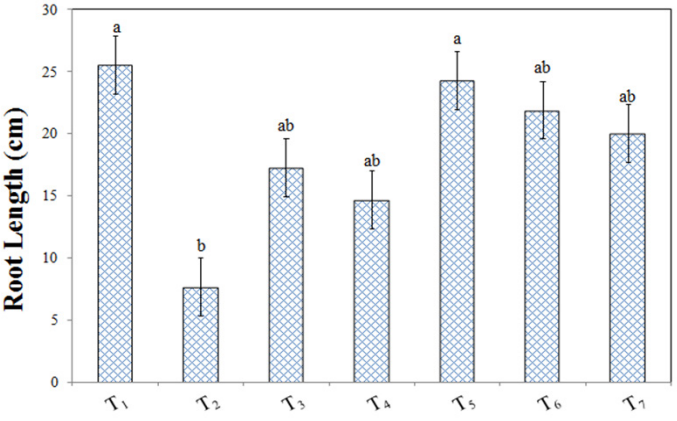

Figure 5: Root length (cm) under different potting media on the growth of Rough lemon (*Citrus jambhiri* Lush).

3.10 Root diameter (mm)

The results regarding citrus rootstock Rough lemon show the significant effect with the combinations of different soil media that are presented in Figure 6. Current study revealed that there is a diverse ($p \leq 0.05$) difference among various combinations of soil media treatments that are treated with citrus rootstock Rough lemon. The results suggest that different soil media combinations have a better outcome but T_1 treatment is more nutritive than other soils media in which the root diameter is progressively higher due to nutritive value and biochemical changes in the plant. The maximum root diameter (4.47) mm was counted in T_1 followed by (4.02) mm in T_6 While the intermediate response regarding root diameter was recorded in T_5 showed in Figure 6. However, the minimum root diameter (1.11) mm was observed in T_2 and (1.99) mm were founded in T_4 shown in Figure 6. The results was observed that the better growth of seedlings at nursery stage as well as in the field by using different organic potting media mixture (Woods *et al.*, 1998). The same results was also described by (Shiralipour *et al.*, 1992). Decrease in root diameter using poor quality of potting media and imbalance nutrients availability.

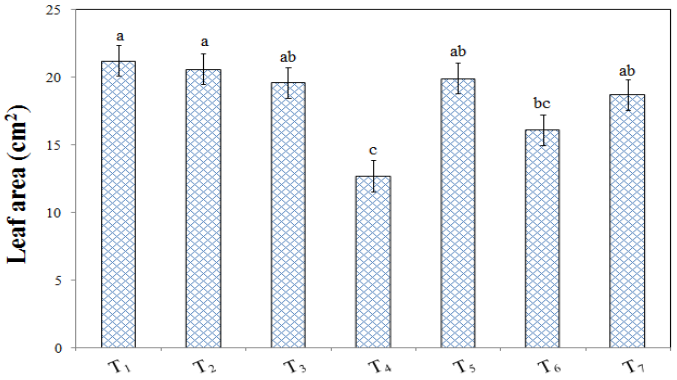

Figure 6: Root diameter (mm) under different potting media on the growth of Rough lemon.

3.11 Leaf area (cm²)

The leaf area is another important parameter. The data presented in (Figure 7) shows that the response of different combinations of soil media a significant influence on citrus rootstock Rough lemon. All the different treatments of soil media and variety of citrus rootstock rough lemon showed significant ($p \leq 0.05$) impact on leaf area. The findings suggest that various soil media combinations produce improved outcomes but T_1 treatment responded greater than others due to water holding capacity, porosity, soil ventilation and supply of considerable amount of nutrient, particularly

nitrogen and micronutrients for good root and shoot may be attributed to the beneficial effect of this media while minimum leaf area was obtained in T_4.

The combination of different growing media has effect of pant growth and grater leaf surface area found in seedling (Cicek *et al.*, 2010). Same results were described by seedling performed best when grown in mixture of media and combination of NPK fertilizer rate significantly increased the leaf area (Davis *et al.*, 2009).

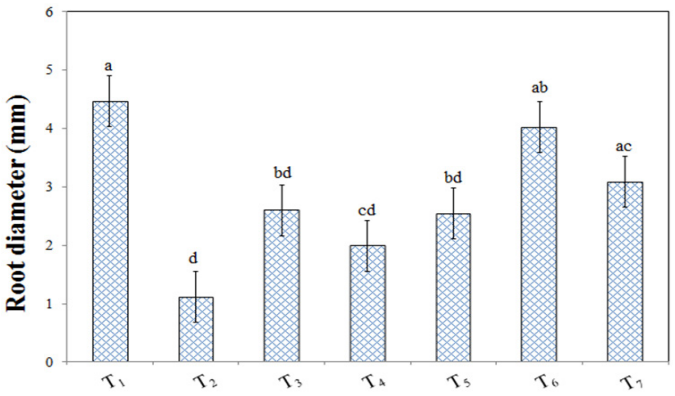

Figure 7: Leaf area (cm²) under different potting media on the growth of Rough lemon (*Citrus jambhiri* Lush).

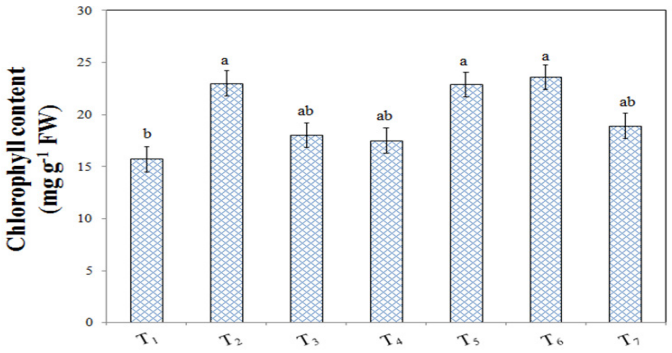

Figure 8: Chlorophyll content (mg g^{-1} FW) under different potting media on the growth of Rough lemon (*Citrus jambhiri* Lush).

3.12 Chlorophyll content (mg g^{-1} FW)

The results regarding citrus rootstock Rough lemon show the significant effect with the combinations of different soil media) that are presented in Figure 8. The chlorophyll content is a vital parameter. For expressing the effect of different levels of soil media with citrus rootstock the experiment was studied. Given data shows that non-significant ($p \leq 0.05$) results regarding chlorophyll content. The maximum chlorophyll content (21.2) mg g^{-1} FW was observed in T_1. Similarly, the minimum chlorophyll content was found (12.7) in T_4. The chlorophyll content of leaves was significantly affected by the potting media as well as its interaction with the varieties ($P<0.05$) (Farooq *et al.*, 2018). Same results were attained by (Saleh *et al.*, 2000). Supplied with compound fertilizer and mixture of media such increase in chlorophyll content was associated with high leaf N%.

Conclusions and Recommendations

The goal of research work was to assess the effect of various potting media on the growth of rough lemon (*Citrus jambhiri* L.). The present study results show that various concentrations of different potting media show significant influences on almost all the growth parameters of the citrus rootstock of rough lemon (*Citrus jambhiri* L.). However, Soil + silt + sand (2:1:1) and Rice husk + sand + soil (2:1:1), showed highly significant impact on the growth of rough lemon rootstock.

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Novelty Statement

This research would enhance healthy citrus nursery production by utilizing 7 different growing media combinations utilizing different contents. Such combinations were not used before in Pakistan. Success rate of transplanting of rough lemon nursery would be profitable to citrus growers.

Author's Contribution

All the authors in experiment contributed equally.

Conflict of interest

The authors have declared no conflict of interest.

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