Int.J.Curr.Microbiol.App.Sci (2024) *13*(10): 147-152

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 13 Number 10 (2024)**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2024.1310.019

Effect of Different Media on the Rootstock Growth of Rangpur Lime (*Citrus limonia* Osbeck) Seedlings

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Keywords

Growing Media, Rangpur lime rootstock, Vermicompost, FYM

Article Info

Received:
13 August 2024
Accepted:
21 September 2024
Available Online:
10 October 2024

A B S T R A C T

The present investigation entitled "Effect of different media on the rootstock growth of Rangpur lime (*Citrus limonia* Osbeck) seedlings" was carried out at Fruit Nursery, Department of Fruit Science, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, during the year 2023-24 with the objective to study the effect of different media on growth of Rangpur lime. The Rangpur lime crop was used to grown and treatment was replicated three times in Randomized Block Design. In an investigation there were nine treatment of growing media i.e., T_1 - Vermicompost : FYM : Fly Ash, T_2 - Leaf Mould : FYM : Fly Ash, T_3- Cocopeat : FYM : Fly Ash, T_4 - Cocopeat : Vermicompost : Fly Ash, T_5 - Vermicompost : Leaf Mould : Fly Ash, T_6- Cocopeat : Leaf Mould : Fly Ash, T_7- Vermicompost : FYM : Cocopeat : Fly Ash, T_8 - Vermicompost : FYM : Leaf Mould : Fly Ash, T_9 - Soil : Silt : FYM (Control). The seedling growth parameters i.e., height of Rangpur lime rootstock (cm), number of leaves per seedling, leaf area per seedling (cm^2), stem diameter of Rangpur lime (mm), root length (cm), fresh root biomass (g), fresh plant biomass (g), fresh weight of root and plant (g), dry weight of root and plant (g) this all observations are taken after transplanting and this were significantly superior in the treatment T_7- Vermicompost : FYM : Cocopeat : Fly Ash (1:1:1:1), it was observed that the height of the Rangpur lime rootstock (58.48 cm), number of leaves per seedling of Rangpur lime (58.87), leaf area per seedling (31.20 cm^2) and stem diameter of Rangpur lime (6.97 mm) all showed superior performance compared to other treatments which was observed 150 DAT. After 150 DAT observations of Rangpur lime rootstock were recorded i.e. root length (24.38 cm), fresh root biomass (5.40 g), fresh plant biomass (24.37 g), fresh weight of root and plant (29.36 g) and dry weight of root and plant (20.76 g).

Introduction

Fruits play a crucial role in our diets and economies. Citrus and its related genera, which are part of the Aurantioideae sub-family within the Rutaceae family, are known for their distinctive features, including oil glands, raised ovaries on floral discs, translucent dots on leaves, and axile placentation in fruits. The citrus genus, along with its related species, encompasses important fruit crops like mandarins, oranges, lemons, limes, and

grapefruit. These fruits flourish in areas between latitudes 0 and 40 degrees north and south of the equator, adapting well to a variety of soil and climate conditions.

Mandarin botanically belongs to the Kingdom: Plantae, Division: Agnoliophyta, Class: Magnoliopsida, Subclass: Rosidae, Order: Sapindales, Family: Rutaceae and Genus: Citrus, Species: reticulate.

Rootstocks are crucial for citrus growers as they influence tree growth and fruit quality in several ways. They help control tree size, vigor, and canopy structure, which affects yield and simplifies orchard management. Additionally, rootstocks enhance fruit traits such as size, color, flavor, and nutritional content. Some rootstocks also encourage early fruit production, adaptability to different environmental conditions, and provide resistance to diseases and environmental stresses.

Rangpur lime (*Citrus limonia* Osbeck) is a citrus fruit from India, known for being a natural hybrid of acid limes (*Citrus aurantifolia* Swingle) and mandarins (*Citrus reticulata* Blanco). This variety is highly productive, producing well-flavored and very acidic fruits. Globally, it is an important rootstock due to its strong resistance to the tristeza virus and greater tolerance to salinity compared to other citrus rootstocks. Additionally, it shows resistance to greening disease and the tristeza virus (Nagpal, 1959).

The growing media is crucial for seed germination and the subsequent growth of seedlings, providing them with essential nutrients and structural support. It is important that the media also possesses adequate water-holding capacity to promote proper seedling development.

Fly ash is a complex material consisting of both amorphous and crystalline phases (El-Mogazi *et al.,* 1988; Mattigod *et al.,* 1990). It provides most essential elements needed for plant growth and metabolism, except for nitrogen and available phosphorus, along with several non-essential elements that can be harmful to plants (Plank and Martens, 1973, 1974; El-Mogazi *et al.,* 1988; Singh and Yunus, 2000).

Materials and Methods

The experiment entitled "Effect of different media on the rootstock growth of Rangpur lime seedlings" was carried out at Fruit Nursery, Department of Fruit Science, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, during the year 2023-24 with the objectives to study the effect of different media on growth of Rangpur lime. The experiment was laid out in Randomized Block Design (RBD) with three replications comprising of nine treatment combinations viz., T_1 - Vermicompost : FYM : Fly Ash (2:2:1), T_2 - Leaf Mould : FYM : Fly Ash (2:2:1), T_3 - Cocopeat : FYM : Fly Ash (2:2:1), T_4 - Cocopeat : Vermicompost : Fly Ash, T_5 - Vermicompost : Leaf Mould : Fly Ash (2:2:1), T_6 - Cocopeat : Leaf Mould : Fly Ash (2:2:1), T_7 - Vermicompost : FYM : Cocopeat : Fly Ash (1:1:1:1), T_8 - Vermicompost : FYM : Leaf Mould : Fly Ash (1:1:1:1), T_9 - Soil : Silt : FYM (2:1:1) (Control). Polybag size 6x9'' were used for raising of the Rangpur lime seedlings.

During experiment suitable combination of planting media were used. Instead of soil, fly ash is used in the combination in the small quantity (i.e 20% Fly Ash). The polythene bags were filled with appropriate rooting media which was prepared according to treatment.

Different combinations of potting media was prepared in the month of july particularly 1st week of july. By using this media above sized polybags was filled with the different media. During filling the bags 20% fly ash was used.6 month old seedlings of Rangpur lime which were procured were raised in greenhouse at the Fruit Nursery, Department of Fruit Science. Equal sized, healthy and vigorous seedlings were selected for study. To record the data on various growth parameters selected representative Rangpur lime seedlings used for each replication was significantly superior for the Rangpur lime rootstock. After Rangpur lime seedlings were transplanted, observations were made at 30, 60, 90, 120, and 150 DAT.

These observations included the height of the Rangpur lime rootstock (cm), number of leaves per seedling, Leaf area per seedling (cm^2) and stem diameter of Rangpur lime (mm). After 150 DAT observations of Rangpur lime rootstock were recorded i.e. root length (cm), fresh root biomass (5.40 g), fresh plant biomass (g), fresh weight of root and plant (g) and dry weight of root and plant (g).

Results and Discussion

Shoot Parameters

Data pertaining to growth seedling parameter influenced by various treatment combination has been given in Table 1, Table 2 and Table 3.

Growth Parameters

Height of Rangpur lime rootstock (cm)

It is evident from the result presented in Table 1 that the different media combination significantly influenced on the height of Rangpur lime rootstock. The data presented in Table 1. indicated that the height of Rangpur lime rootstock (cm) influenced by the different media combination was found to be significant at all the stages of growth i.e., 30, 60, 90, 120, 150 DAT.

Significantly maximum height of Rangpur lime (42.91 cm, 46.04 cm, 51.97 cm, 55.43 cm, 58.48 cm at 30, 60, 90, 120, 150 DAT respectively) was recorded in the treatment T_7 i.e. Vermicompost : FYM : Cocopeat : Fly Ash in ratio of 1:1:1:1 followed by FYM : Soil : Silt (Control). Whereas, minimum height of Rangpur lime (34.19 cm, 35.75 cm, 36.92 cm, 40.95 cm in the treatment of T_2 i.e. Leaf mould : FYM : Fly ash in the ratio of 2 : 2 : 1.

The above results might be due to growing medium provides appropriate condition for the proper development and growth of rootstock. Cocopeat have high water holding capacity, high cation exchange capacity and increases the porosity of the potting mix. The result was supported with the finding of proved that Soil+ FYM+ cocopeat (2:1:1).

Vermicompost has been found to have a considerable potential for improving plant growth when used as a component of horticultural soil or container media (Atiyeh *et al.,* 2000). The possible reason may be the sufficient availability of plant nutrients in available form during different growth period, which ultimately leads to promote seedling girth of Rangpur lime. A similar result was obtained by Bhardwaj *et al.,* (2014) in seedling growth of papaya. The beneficial effect of fly ash at lower dose (10-30%) have already been observed by Swain *et al.,* (2013) in pomegranate, Swain *et al.,* (2012) and Sethi (1996) in guava and Kuchanwar and Matte (1997) in groundnut.

Number of leaves per seedling

Table 1 depicts that the different media combination had a major impact on the number of leaves per seedling of Rangpur lime rootstock i.e. 30, 60, 90, 120 150 DAT and was found to be maximum (33.05, 36.18, 41.29, 48.35, 58.87) in treatment T_7 i.e. Vermicompost : FYM : Cocopeat : Fly Ash in ratio of 1:1:1:1. Wheareas minimum number of leaves (14.91, 18.42, 22.08, 32.18, 43.32) in the treatment of T_2 i.e. Leaf mould: FYM : Fly ash in the ratio of 2 : 2 : 1.

Table.1 Effect of different media combination on height of Rangpur lime rootstock and number of leaves per seedling of Rangpur lime

Treatment	Height of Rangpur lime(cm)					Number of leaves per seedling				
	Days After Transplanting (DAT)					Days After Transplanting (DAT)				
	30	60	90	120	150	30	60	90	120	150
T_1	36.96	40.02	41.37	43.55	48.44	19.26	23.41	27.03	34.76	48.46
T_2	34.19	35.75	36.92	40.95	42.89	14.91	18.42	22.08	32.18	43.32
T_3	36.56	38.88	39.77	41.12	44.61	18.92	22.29	26.35	33.90	45.48
T_4	39.06	44.44	46.89	48.53	52.03	25.03	28.18	34.33	41.06	51.44
T_5	38.90	43.30	45.92	47.47	50.39	25.26	27.78	33.21	40.02	50.66
T_6	37.55	41.41	43.40	45.36	49.45	21.99	26.14	30.50	37.36	49.30
T_7	42.91	46.04	51.97	55.43	58.48	33.05	36.18	41.29	48.35	58.87
T_8	40.69	45.29	49.90	51.25	53.96	28.18	31.70	36.16	43.37	53.68
T_9	41.96	45.47	50.67	53.57	55.54	31.36	35.48	39.89	46.76	57.38
SE(m) ±	0.47	0.61	0.78	0.53	0.76	0.55	0.71	0.70	0.58	0.85
CD at 5%	1.37	1.78	2.29	1.55	2.22	1.61	2.08	2.04	1.68	2.48

Table.2 Effect of different media combination on leaf area per seedling and stem diameter of Rangpur lime

Treatment	Leaf area per seedling (cm^2)					Stem diameter of Rangpur lime(mm)				
	Days After Transplanting (DAT)					Days After Transplanting (DAT)				
	30	60	90	120	150	30	60	90	120	150
T_1	20.68	21.68	22.23	23.20	24.06	1.40	2.45	3.61	4.72	5.73
T_2	18.60	19.47	19.61	20.60	21.51	1.33	2.30	3.38	4.31	5.46
T_3	19.45	20.39	21.29	22.25	23.19	1.36	2.38	3.56	4.60	5.63
T_4	24.21	25.19	26.14	26.87	27.78	1.95	2.94	4.36	5.37	6.39
T_5	22.41	23.50	24.37	25.19	26.10	1.73	2.85	4.23	5.20	6.25
T_6	21.90	22.93	23.99	24.67	25.67	1.51	2.65	3.85	4.91	6.13
T_7	27.21	28.21	29.17	30.15	31.20	2.80	3.84	4.87	6.26	6.97
T_8	24.70	25.95	26.63	27.60	28.30	2.48	3.34	4.35	5.73	6.48
T_9	26.78	27.76	28.70	29.69	30.39	2.68	3.76	4.78	6.21	6.93
SE(m) ±	0.32	0.38	0.48	0.45	0.47	0.05	0.03	0.04	0.10	0.06
CD at 5%	0.94	1.10	1.40	1.32	1.36	0.16	0.10	0.12	0.03	0.19

Table.3 Effect of different media combination on root parameters of Rangpur lime

Treatment	Root length (cm)	Fresh Root biomass (g)	Fresh Plant biomass (g)	Fresh weight (g)	Dry weight (g)
T_1	20.04	3.37	16.29	19.51	14.34
T_2	19.74	2.77	14.36	16.76	10.84
T_3	20.60	2.91	15.53	18.79	13.58
T_4	22.79	4.73	20.14	26.01	17.75
T_5	22.70	4.24	19.86	23.11	16.62
T_6	21.59	3.87	17.26	20.52	16.10
T_7	24.38	5.40	24.37	29.36	20.76
T_8	23.30	4.86	22.67	27.31	18.98
T_9	24.03	5.17	23.94	28.94	20.17
SE(m) ±	0.43	0.01	0.32	0.29	0.73
CD at 5%	1.25	0.03	0.93	0.86	2.15

The above results might be due to growing medium provides appropriate condition for the proper development and growth of rootstock. FYM is partially composed of cow dung, urine, bedding and straw. FYM contains about 0.4- 1.5% nitrogen, 0.3-0.9% phosphoric acid and 0.3-1.9% potash.

Vermicompost is a peat-like nutrient-rich growing material that is a rich source of nitrogen 0.51-1.61%, phosphorous 0.19-1.02%, potassium 0.15- 0.73%, and calcium 1.18-7.61% with low C: N ratio (Adhikary, 2012). The increase in the number of leaves with Soil: FYM : Cocopeat (2:1:1) over other media may be due to the increase in the height of rough lemon seedlings.

Leaf area per seedling (cm^2)

The leaf area per seedling, influenced by various media combinations, showed significant differences at all growth stages presented in Table 2. The highest leaf area per seedling (27.21, 28.21, 29.17, 30.15, 31.20 cm^2 at 30, 60, 90, 120, and 150 DAT, respectively) was observed in the treatment T_7, which consisted of Vermicompost : FYM : Cocopeat : Fly Ash (1:1:1:1). In contrast, the lowest leaf area per seedling in Rangpur lime was recorded (18.60, 19.47, 19.61, 20.60, 21.51 cm^2) in the treatment of T_2 i.e. Leaf mould : FYM : Fly ash in the ratio of 2 : 2 : 1.

Higher leaf area was recorded with growing media having soil, FYM and cocopeat. Growth media

containing cocopeat have been reported to improve leaf area in pothos (*Epipremnum aureum* Lindl.) due to the superior root development in these mixtures (Khayyat, 2007).

Stem diameter of Rangpur lime (mm)

The stem diameter per seedling of Rangpur lime rootstock was significantly influenced by the different media combination i.e. 30, 60, 90, 120,150 DAT and was found to be maximum (2.80, 3.84, 4.87, 6.26, 6.97 mm) in treatment T_7 i.e. Vermicompost : FYM :Cocopeat : Fly Ash (1:1:1:1).

Whereas minimum number of leaves was observed in the treatment of T_2 i.e. Leaf mould : FYM : Fly ash in the ratio of 2 : 2 : 1 (1.33, 2.30, 3.38, 4.31, 5.46 mm) which was presented in Table 2.

The possible reason may be the sufficient availability of plant nutrients in available form during different growth period, which ultimately leads to promote seedling girth of Rangpur lime. A similar result was obtained by Bhardwaj *et al.,* (2014) in seedling growth of papaya.

Root Parameters

Maximum root length (24.38 cm), fresh root biomass (5.40 g), fresh plant biomass (24.37 g), fresh weight of root and plant (29.36 g), dry weight of root and plant (20.46 g) was found to be maximum in treatment T_7 i.e. Vermicompost : FYM : Cocopeat : Fly Ash in the ratio of 1:1:1:1 which was superior over rest of the treatment and minimum was recorded in treatment T_2 i.e. Leaf Mould : FYM : Fly Ash. The recorded data for each treatment is presented in Table 3.

Easy availability of nutrient, aeration leads to proper gas exchange by maintaining sufficient oxygen supply to the root. Simultaneously removal of respiratory CO2 helped in root elongation (Heikanen, 1993).

The increased nutrient availability due to enrichment with fly ash, farmyard manure and vermicompost and soil which composed of various easily available cations and anions, organic carbon content in the pot mixture was also enhanced due to organic substations in different proportion. The vermicompost also provide close contact between seed and media; increases steady moisture supply facilitates root respiration and encourages overall root growth, as reported by Chatterjee and Choudhuri (2007).

The increase in biomass weight might be due to high moisture content and vigour of seed and may be due to the media viz; vermicompost which have growth regulating substances such as humic acid, auxin, gibberellin as well as due to more supply of nutrients to seedling. Similar results were also obtained by Bhardwaj (2014); Ramteke *et al.,* (2016) in papaya and Abirami *et al.,* (2010) in nutmeg.

It is concluded from the present study evident that treatment T_7 i.e. Vermicompost : FYM : Cocopeat : Fly Ash (1:1:1:1) was the possible reason may be the sufficient availability of plant nutrients in available form during different growth period, which ultimately leads to promote seedling growth of Rangpur lime. Combined application of vermicompost and cocopeat showed significant effect on seedling growth parameters and plant biomass probably due to the synergistic combination of both the factor is improvement of physical condition of the media and nutritional factor.

Acknowledgement

I am thankful to the the Department of Fruit Science, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra for providing the necessary facilities to carry out the experimental work.

Author Contributions

Amruta G. Madane: Investigation, formal analysis, writing—original draft. S. V. Gholap: Validation, methodology, writing—reviewing. Priya Suresh Gawande:—Formal analysis, writing—review and editing. S. G. Bharad: Investigation, writing—reviewing. U. A. Raut: Resources, investigation writing—reviewing. Bhagyashri S. Raut: Validation, formal analysis, writing—reviewing.

Data Availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethical Approval Not applicable.

Consent to Participate Not applicable.

Consent to Publish Not applicable.

Conflict of Interest The authors declare no competing interests.

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How to cite this article:

Amruta Ghanashyam Madane, S. V. Gholap, Priya Suresh Gawande, S. G. Bharad, U. A. Raut and Bhagyashri S. Raut. 2024. Effect of Different Media on the Rootstock Growth of Rangpur Lime (*Citrus limonia* Osbeck) Seedlings. *Int.J.Curr.Microbiol.App.Sci.* 13(10): 147-152. **doi:** https://doi.org/10.20546/ijcmas.2024.1310.019