Effect of Different Growing Media on Establishment of Kagzi lime (*Citrus aurantifolia*Swingle) in Prayagrajagroclimatic Condition

Abstract

The cultivation of acid lime (*Citrus aurantifolia*Swingle), commonly known as Kagzi lime, is of significant economic importance in many tropical and subtropical regions worldwide. This citrus fruit is esteemed for its tart flavor, aromatic qualities, and versatility in culinary and medicinal applications. Maximizing the yield and quality of acid lime crops is a primary concern for growers, necessitating research into various factors influencing seed germination and plant vigor. *Citrus aurantiifolia*, commonly known as acid lime, is a small evergreen tree belonging to the Rutaceae family.An experiment was conducted in the department of horticulture, Sam Hhigginbottom University of Agriculture, Technology & Sciences, Prayagraj during winter (2023-24). The experiment was arranged based on RBD having 7 treatment and 3 replications. The treatment T_6 Soil + FYM + Vermicompost + vermiculite (1:2:2:1) was found significant compared to other treatment combinations, which recorded highest mean value of plant height(27.72 cm), number of leaves per plant (19.60), stem girth (7.25 cm), leaf area (4.95 cm^2), chlorophyll content SPAD (51.03) were also obtained from treatment T_6 Soil + FYM + Vermicompost + vermiculite (1:2:2:1)followed by T_4 Soil + FYM + Vermicompost + vermiculite (1:1:2:1) and lowest was obtained from T_0 (control).

Keywords: Vermicompost, vermicullite, leaf area, SPAD.

INTRODUCTION

Kagzi lime (*Citrus aurantifolia*) typically reaching heights of 6 to 13 feet (2 to 4 meters), it boasts a dense, thorny canopy. Its glossy, dark green leaves are ovate to elliptical and emit a citrusy aroma when crushed**(Souci *et al*.2000)**. Acid lime bears small, fragrant white flowers with five petals, often appearing singly or in clusters at leaf axils. These hermaphroditic flowers facilitate self-pollination.[15-18] The fruit is spherical to oval, measuring 3 to 6 centimeters in diameter, with a thin, smooth, glossy peel abundant in oil glands. When ripe, it transitions from green to yellow, containing juicy, acidic pulp ranging from pale yellow to green and numerous seeds within. Acid lime thrives in warm, subtropical climates, exhibiting a fast growth rate in well-drained soil and ample sunlight. Its shallow, fibrous root system aids in water and nutrient absorption**(Singh and Singh 2005)**. Valued for its tart flavor and aromatic qualities, acid lime serves as both a decorative and productive tree in gardens and orchards worldwide.

Lime is well-known across the globe for its sour, acidic juice and unique floral smells. The small fruitedkagzi lime, commonly known in the United States as ‘Mexican or main lime’ and in India as ‘Kagzi Lime’ is one of the most frequently cultivated lime varieties. Improved kagzi lime cultivars such as Pramalini, Vikram, Sai Sarbati, PhuleSarbati, PKM1, and Balajihave been introduced in Maharashtra and Uttar Pradesh. Moreover, highest TSS content and juice content is recorded in the Vikram cultivar of acid lime. Above all, this cultivar is most suitable and easily grown under the agro-climatic situations of Prayagraj. Kagzilime juice is a popular and affordable pleasant beverage that is high in Vitamin-C. Lime also contains Vitamin-C (62.9mg/100mL), vitamin B1,

vitamin B2, calcium, phosphorus, and iron. However, the fruit is highly valued in Indian cuisine not only for its nutritional and medicinal qualities, but also for its culinary and value-added products such as squash, syrups, cordials, citric acid production, pickles, and cosmetic and nutraceutical applications. Lime is an acidic fruit that has a high concentration of Vitamin-C, citric acid, starch, and minerals such as calcium and phosphorus. Additionally, it may be used to create beverages such as limeade and lime rickey. It is an essential component of almost all herbal cosmetics. It is used to make lime soda, lime cordial, lime oil, calcium nitrate dehydrated lime extract, lime polish, lime pickle, preserves, jellies, marmalades, as well as alcoholic and non-alcoholic drinks.

"Generally, kagzi lime is regenerated through seeds, but there is a problem of nonuniformity of progeny and high chance of viral disease contamination by this method"**(Babu, 2001)**."For overcoming this problem, the vegetative multiplication through cutting is only practicable and widely used option for augmenting natural regeneration and for large scale cultivation programmes. Owing to high intensity of polyembroyny (90-100%) and least chance of contamination of viral diseasesin Kagzi-lime, the stem cutting is suitable method for regeneration for the species. It is inexpensive, rapid and simple and does not require the special techniques as required in other vegetative methods".**(Babu, 2001)**

"Under south, central and north Indian conditions, normally kagzi lime produces three distinct bahar (crop) viz., Mrig, Haste and Ambebahar. The varieties like Kagzilimbu, Pat limbu and Godhadilimbu were cultivated in the Maharashtra State"**(Cheema, *et al*. 1954)**. "However, there are some types which produce fruit almost throught the year (Baramsi) and are highly value for summer crop. The citrus industry of Marathwada region have heavy demand for supply of improved kagzi lime seedlings to cultivators. It also indicated great scope for improvement in yield and fruit quality by clone's selection from the innumerable seedlings already available under cultivation"**(Jature and Chakrawar, 1981)**.Considering the importance of kagzi lime a survey was undertaken to study growth and yield attributes of various local genotypes.

MATERIALS AND METHODS

DATA ANALYSIS:

The data was analyzed using STAR.

The details of the various materials used and methods adopted in carrying out the experiment are presented below:

EXPERIMENTAL SITE:

The research was carried out during the year 2023-2024 in the Department of Horticulture, Sam Higginbottom Universityof Agriculture Technology & Sciences Prayagraj in the months of October 2023 to February 2024. The experiment was conducted on Kagzi lime. All the facilities necessary for cultivation, including labourwere made in the department.

Layout and treatment combination

Studies on **Establishment of Kagzi lime (*Citrus aurantifolia*Swingle) in PrayagrajAgroclimactic Condition**was carried out during 2023-24 at Horticulture Research Farm of Naini Agricultural Institute, SHUATS, Prayagraj, (Uttar Pradesh). The experiment was laid out in Randomized Block Design viz. Treatments at 7 levels viz. T0: control, T1: Soil + FYM + Vermicompost + vermiculite (1:1:1:1), T2: Soil + FYM + Vermicompost + vermiculite (2:1:1:1), T3: Soil + FYM + Vermicompost + vermiculite (1:2:1:1), T4: Soil + FYM + Vermicompost + vermiculite (1:1:2:1), T5: Soil + FYM + Vermicompost + vermiculite (1:1:1:2), T6: Soil + FYM + Vermicompost + vermiculite (1:2:2:1). The transplanting was done on 20/12/2023 in field condition.

CLIMATE:

The prayagraj District comes under subtropical belt in the southeast of U.P. which experience extremely hot summer and fairly cold winter. During the winter months (Dec.-Jan) temperature falls 2-5^{0}C or even low, while in summer months (May-June) it reaches as high as 49^{0}C. Hot blowing winds are regular feature during the summers and an occasional spell of frost may be during winters. Most of the rainfall is received in the middle of July to end of September after which the intensity of rainfall decreases. The mean annual rainfall is about 850-1100mm. However, occasional precipitation is also not uncommon during winter months.

RUNNING STATUS -

GrowthParameters:

1. Plantheight (cm)
2. Number of leaves per plant
3. Stemgirth (mm)
4. Leafarea (cm2)
5. Leafareaindex
6. Chlorophyllcontent (SPAD value)
7. Rootlength
8. No. of secondaryroots

EconomicParameters :

1. Cost of cultivation (Rs/ ha)
2. Grossreturn (Rs/ha)
3. Net return (Rs/ha)
4. B:C ratio

RESULTS AND DISCUSSION

The tabulated data were statistically analyzed with a view to find out the significant effect of different factors which are present in the appendix. The data present

in the tabular forms shows the relevant standard error of mean deviation S. (±) and the critical difference (C.D) at 5% level of significance, wherever necessary. The results emanating from the present studies are presented under appropriate heading:

- The maximum plant height of kagzi lime was recorded in treatment T_6 (Soil + FYM + Vermicompost + vermiculite 1:2:2:1) with (27.72) cm followed by treatment T_4 (Soil + FYM + Vermicompost + vermiculite 1:1:2:1) with (27.37) cm and the minimum plant height was recorded in T_0 (control) with (20.38) cm.
- The maximum no. of leaves of kagzi lime was recorded in treatment T_6 (Soil + FYM + Vermicompost + vermiculite 1:2:2:1) with (19.19) followed by treatment T_4 (Soil + FYM + Vermicompost + vermiculite 1:1:2:1) with (19.07) and the minimum no. of leaves was recorded in T_0 (control) with (17.13).
- The maximum stem girth (mm) of kagzi lime was recorded in treatment T_6 (Soil + FYM + Vermicompost + vermiculite 1:2:2:1) with (7.25) followed by treatment T_4 (Soil + FYM + Vermicompost + vermiculite 1:1:2:1) with (7.05) and the minimum stem girth (mm) was recorded in T_0 (control) with (5.01).
- The maximum leaf area (cm^2) ofkagzi lime was recorded in treatment T_6 (Soil + FYM + Vermicompost + vermiculite 1:2:2:1) with (4.95) followed by treatment T_4 (Soil + FYM + Vermicompost + vermiculite 1:1:2:1) with (4.64) and the minimum leaf area (cm^2) was recorded in T_0 (control) with (3.15).
- The maximum leaf area index of kagzi lime was recorded in treatment T_6 (Soil + FYM + Vermicompost + vermiculite 1:2:2:1) with (0.82) followed by treatment T_4 (Soil + FYM + Vermicompost + vermiculite 1:1:2:1) with (0.77) and the minimum leaf area index was recorded in T_0 (control) with (0.52).
- The maximum chlorophyll content of kagzi lime was recorded in treatment T_6 (Soil + FYM + Vermicompost + vermiculite 1:2:2:1) with (51.03) followed by treatment T_4 (Soil + FYM + Vermicompost + vermiculite 1:1:2:1) with (50.69) and the minimum chlorophyll content was recorded in T_0 (control) with (44.20).
- The maximum root length (cm) of kagzi lime was recorded in treatment T_6 (Soil + FYM + Vermicompost + vermiculite 1:2:2:1) with (17.93) followed by treatment T_4 (Soil + FYM + Vermicompost + vermiculite 1:1:2:1) with (17.86) and the minimum root length (cm) was recorded in T_0 (control) with (15.05).
- The maximum no. of secondary roots of kagzi lime was recorded in treatment T_6 (Soil + FYM + Vermicompost + vermiculite 1:2:2:1) with (39.12) followed by treatment T_4 (Soil + FYM + Vermicompost + vermiculite 1:1:2:1) with (38.69) and the minimum no. of secondary roots was recorded in T_0 (control) with (34.92).
- The maximum benefit Cost Ratio of kagzi lime was recorded in treatment T6 (Soil + FYM + Vermicompost + vermiculite 1:2:2:1) with (2.61) followed by treatment T4 (Soil + FYM + Vermicompost + vermiculite 1:1:2:1) with (2.25) and the minimum Benefit Cost Ratio was recorded in T0 (control) with (1.18).

These results were in close agreement with the findings of **Prajapati*et al.*(2017)**, **Kumar *et al.* (2020)**, **Ladaniya *et al.* (2020), Das *et al.* (2021)**, **Ladaniya *et al.* (2021),Marak *et al.* (2021), Rajale *et al.* (2021) in kagzi lime and Jareda *et al.*(2024).**

Table 1: Effect of Different Growing Media on plant height, no. of leaves, stem girth, leaf area on Establishment of Kagzi lime (C*itrus aurantifolia*Swingle).

Treatments	Treatment Combinations	Plant height (cm)	Number of leaves	Stem girth (mm)	Leaf area (cm^2)
T0	Control	20.38	17.13	5.01	3.15
T1	Soil + FYM + Vermicompost + vermiculite (1:1:1:1)	25.73	18.09	5.82	3.9
T2	Soil + FYM + Vermicompost + vermiculite (2:1:1:1)	23.53	17.48	5.41	3.73
T3	Soil + FYM + Vermicompost + vermiculite (1:2:1:1)	26.24	19.07	6.48	4.07
T4	Soil + FYM + Vermicompost + vermiculite (1:1:2:1)	27.37	19.19	7.05	4.64
T5	Soil + FYM + Vermicompost + vermiculite (1:1:1:2)	25.86	18.47	6.3	3.97
T6	Soil + FYM + Vermicompost + vermiculite (1:2:2:1)	27.72	19.6	7.25	4.95
	F - test	**S**	**S**	**S**	**S**
	C.D.	**0.644**	**1.253**	**0.699**	**0.396**
	SE(d)	**0.293**	**0.569**	**0.317**	**0.18**
	C.V.	**1.418**	**3.779**	**6.273**	**5.422**

Table 2:Effect of Different Growing Media on leaf area index, chlorophyll content, root length, number of secondary roots on Establishment of Kagzi lime (C*itrus aurantifolia*Swingle).

Treatments	Treatment Combinations	Leaf	Chlorophyll	Root	Number of

		area index	content (SPAD) value	length (cm)	secondary roots
T0	Control	0.52	44.2	15.05	34.92
T1	Soil + FYM + Vermicompost + vermiculite (1:1:1:1)	0.65	45.92	16.14	36.67
T2	Soil + FYM + Vermicompost + vermiculite (2:1:1:1)	0.62	45.42	15.35	36.12
T3	Soil + FYM + Vermicompost + vermiculite (1:2:1:1)	0.67	50.15	16.69	38.53
T4	Soil + FYM + Vermicompost + vermiculite (1:1:2:1)	0.77	50.69	17.86	38.69
T5	Soil + FYM + Vermicompost + vermiculite (1:1:1:2)	0.66	49.9	16.34	37.1
T6	Soil + FYM + Vermicompost + vermiculite (1:2:2:1)	0.82	51.03	17.93	39.12
	F - test	**S**	**S**	**S**	**S**
	C.D.	**0.006**	**0.577**	**1.013**	**0.974**
	SE(d)	**0.03**	**0.262**	**0.46**	**0.442**
	C.V.	**5.419**	**0.665**	**3.416**	**1.451**

Table 3: Economics of various treatments.

Treatment No.	Fixed Cost (Rs.)	Variable Cost (Rs.)	Total cost of cultivation (Rs.)	No. of kagzi lime seedlings /10000m	Selling price/plant	Gross return (Rs.)	Net Return (Rs.)	B:C Ratio
T0	61009.66	0	61009.66	1111	120	133320	72310.34	1.18
T1	61009.66	410	61419.66	1111	130	144430	83010.34	1.35
T2	61009.66	410	61419.66	1111	125	138875	77455.34	1.26
T3	61009.66	420	61429.66	1111	150	166650	105220.3	1.71
T4	61009.66	460	61469.66	1111	180	199980	138510.3	2.25
T5	61009.66	760	61769.66	1111	140	155540	93770.34	1.51
T6	61009.66	460	61469.66	1111	200	222200	160730.3	2.61

CONCLUSION

On the basis of the experimental findings it can be concluded that maximum plant height (27.72) cm, no. of leaves (19.19), stem girth (7.25 mm), leaf area (4.95 cm^2), leaf area index (0.82), chlorophyll content (51.03), root length (17.93), no. of secondary roots (39.12) and benefit Cost Ratio was found in the treatment T_6 (Soil + FYM + Vermicompost + vermiculite 1:2:2:1) with (2.61) followed by (2.25) and (1.18).

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REFERENCES

1. **AnupriyaAsati, TR Sharma, Vijay Kumar Singh and Hirdesh Kumar (2020).** The effect of nutrients on physico - chemical composition yield and economics of acid lime.Journal of Pharmacognosy and Phytochemistry 9(4): 3279-3282.
2. **Babu, R. (2001).** Lime and lemons. Handbook of horticulture, ICAR. New Delhi. 212 pp.
3. **Cheema, G.S., Bhat, S.S., and Naik, K.C. (1954).** Commercial fruits of India. Macmillan and Co. Ltd., Calcutta, Bombay, Madras, London, PP. 142-146, 258-260, 278.
4. **DG Prajapati, BN Satodiya, AB Desai and Pawan K Nagar (2017).** Influence of storage period and growing media on seed germination and growth of acid lime seedlings (Citrus aurantifoliaSwingle) Cv. Kagzi. Journal of Pharmacognosy and Phytochemistry 6(4): 1641-1645.
5. **Jature, S.D. and Chakrawar, V.R. (1981).**Varibility studies on kagzi lime strains. Punjab Hort. J., 2 : 157-160.
6. **Jature, S.D. and Chakrawar, V.R. (1981).** Studies on certain strains of Kagzi lime (Citrus aurantifoliaSwingle) fruits for their yield and physic-chemical characters. J. Maharashtra agric. Univ., 6 : 91-93.
7. **JitendraJareda, Dr. Samir E Topno and Dr. Annjoe V Joseph (2024).** Studies on growth, development and establishment of different varieties of ber (*Ziziphusmauritiana*) under Prayagraj agro climatic condition. International Journal of Advanced Biochemistry Research 8(5): 573-575.
8. **Kunal D. Rajale, MukeshKumar Maurya, D. B. Dhangar, R. S. Dhivare (2021).**Kagzi Lime Orchard's production costing in DhuleDistrict,Maharashtra. Quest Journals Journal of Research in Agriculture and Animal Science Volume 8 ~ Issue 9 pp: 01-08 ISSN(Online) : 2321-9459.
9. **M. S. Ladaniya, R.A. Marathe, A.A. Murkute, A. D. Huchche, A. K. Das, AnjithaGeorge and JayashreeKolwadkar (2021).** Response of Nagpur mandarin (Citrus reticulata Blanco) to high density planting systems. Doi.10.1038/s41598-021-89221-4.
10. **M.S. Ladaniya, R.A. Marathe, A.K. Das, C.N. Rao, A.D. Huchche, P.S. Shirgur e, A.A. Murkute (2020).**High density planting studies in acid lime (*Citrus aurantifolia* Swingle). ScientiaHorticulturaeVolume 261, 108935.
11. **Payel Das, V.M. Prasad, Vijay Bahadur and Samir E. Topno (2021).** Effect of Foliar Application of bio-regulators (GA3 and NAA) on Vegetative Growth characters and Establishment of Lemon Citrus limon (L.) cv. Eureka under Subtropical Prayagraj Agro Climatic Condition. Biological Forum – An International Journal 13(3): 159-162.
12. **Rikmatchi Ch. Marak, Saket Mishra, Vijay Bahadur, Samir E. Topno and Anupriya Paul (2021).** Establishment and Effect of Foliar Application of

Brassinosteriods and Salicylic Acid on Vegetative Growth of Nagpur Orange (Citrus reticulata Blanco). Biological Forum – An International Journal 13(3): 000-000.
13. **Singh AK, Singh R.** Influence of growth regulating substances on rooting of cuttings of poinsettia cv. Flaming Sphere. Prog. Hort. 2005: 37 (1): 85-88
14. **Souci SW, Fachmann W, Kraut H.** Food composition and nutrition tables. 6thedn. Medpharm Scientific Publishers, Stuttgart. 2000.

15. Kumar , Dinesh, Gurdeep Singh, Navdeep Singh, and Mahak Rani. 2024. “Effect of Foliar Spray of Zinc and Manganese on Vegetative Growth, Yield and Fruit Quality of Kinnow Mandarin (Citrus Reticulate)”. Asian Journal of Advances in Agricultural Research 24 (7):61-69. https://doi.org/10.9734/ajaar/2024/v24i7523.
16. Akter, M. M., M. T. Islam, N. Akter, M. F. Amin, M. A. Bari, and M. S. Uddin. 2020. “Pre-Harvest Fruit Bagging Enhanced Quality and Shelf-Life of Mango (MangiferaIndica L.) Cv. Amrapali”. Asian Journal of Agricultural and Horticultural Research 5 (3):45-54. https://doi.org/10.9734/ajahr/2020/v5i330055.
17. Roussos PA, Denaxa N, Damvakaris T. Strawberry fruit quality attributes after application of plant growth stimulating compounds. ScientiaHorticulturae. 2009 Jan 6;119(2):138-46.
18. Guardiola JL, García-Luis A. Increasing fruit size in Citrus. Thinning and stimulation of fruit growth. Plant growth regulation. 2000 May;31:121-32.