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Economics of growing kokum (*Garcinia indica* Choisy) seedling on different potting media

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Abstract
Kokum (*Garcinia indica* Choisy) is commonly known as Kokum butter tree and underexploited tree spices mostly found in Konkan region of Maharashtra, Goa, Karnataka, Kerala and Surat district of Gujarat on the West Coast of India (Haldankar *et al.*, 2012 and Braganza *et al*., 2012) [6, 2]. The seeds (Kernels) are rich source of oil known as kokum butter, which is in solid form at room temperature Availability of strong and vigorous seedling as a rootstock plays vital role in the success of nursery programme. With a view to hasten the growth of seedling in order to get strong and vigorous seedling as rootstock at early stage of growth an experiment was undertaken at College of Horticulture, Dapoli, Dist. Ratnagiri 415 712 (M.S.) during the year 2018 to find out most effective potting media for seedling growth of Kokum.
The experiment was conducted in Randomized Block Design with six treatments and four replications. The treatment comprises T_1: Soil + FYM (3:1) with 1" Cocopeat at top, T_2: Soil + Vermicompost (3:1) with 1" Cocopeat at top, T_3: Soil + FYM + Vermicompost (2:1:1) with 1" Cocopeat at top, T_4: Soil + FYM + Rice husk (1:1:1) with 1"Cocopeat at top, T_5: Soil + FYM + Vermicompost + Cocopeat (1:1:1:1) and T_6: Soil + FYM (1:1). Results revealed that treatment T_6 i. e. Soil + FYM at 1:1 proportion recorded maximum seedling height (48.60 cm), more number of leaves (39.83), highest leaf length (20.11 cm), leaf width (1.93 cm), leaf area (40.61 cm^2) and the highest AGR (0.094 cm/day) and RGR (0.0024 cm/cm/day) at 360 days. Similarly, media containing Soil + FYM at 1:1 proportion recorded highest seedling survival percentage (97.50%) and highest percentage of graftable seedlings (83.25%) at 360 DAB and resulted in generating higher gross income (Rs. 3900), maximum net returns (Rs. 467.61) with highest B: C ratio (1.13) and seedling grown on this media were light in weight and easy to transport.

Keywords: Media, growth, survival and graftable seedlings

Introduction
Kokum (*Garcinia indica* choisy) is underexploited dioecious tree condiment belongs to family Guttiferae. It is commonly known as Kokum butter tree in English and vernacular names are kokum, ratamba, birand, amsol (Braganza *et al*., 2012) [2]. Kokum is commonly known as Kokum butter tree in English and other vernacular names are kokum, ratamba, birand, amsol (Konkani and Marathi) brindon (Portuguese in Goa), murugalu (Kannada) and punarpuli (Malayalam) (Braganza *et al*., 2012) [2].
Kokum has got multifarious uses and therefore, finds an inevitable place in the lifestyle of local population. The fruit juice is used for preparation of syrup, squash, RTS, *agal* (salted juice) etc. The dried rind is used as a souring agent in Goan cuisine. The seeds are rich source of oil known as kokum butter, which is in solid form at room temperature. It is nutritive and used for smoothening, softening etc. It is also used for cosmetic, confectionary and culinary purposes.
As the growth of kokum seedling at nursery establishment is very slow which needs to hasten to get vigorous rootstock for grafting at early stage of growth. Soil + FYM (3:1) is a basic media used for nursery production. However, its requirement in nursery programme is very huge and becoming scare with time. Different growing media other than soil like Cocopeat, Rice husk, FYM, Vermicompost etc. are light in weight and also have good porous structure which can be used as component along with soil. Very little work on economic importance of different media on growth of underexploited fruit trees has been done with this view; present investigation to find out most economic potting media for seedling growth of Kokum was carried out.

Material & Methods

The experiment was conducted at College of Horticulture, under Dr. Balasheb Sawant Konkon Krishi Vidyapeeth, Dapoli, Dist. Ratnagiri 415 712 (MS.) during the year 2018 as a part of M. Sc (Hort.) degree programme. The experiment was laid out in Randomized Block Design with six treatments namely T_1: Soil + FYM (3:1) with 1" Cocopeat at top, T_2: Soil + Vermicompost (3:1) with 1" Cocopeat at top, T_3: Soil + FYM + Vermicompost (2:1:1) with 1" Cocopeat at top, T_4: Soil + FYM + Rice husk (1:1:1) with 1" Cocopeat at top, T_5: Soil + FYM + Vermicompost + Cocopeat (1:1:1:1) and T_6: Soil + FYM (1:1) and treatments were replicated four times. Randomly selected six-month-old kokum seedlings uniform in growth grown in polybags of size 6″ x 8″ were transferred in polythene bags of 9″ x 11″ size and used for the experimental purpose. A group of 100 seedlings was formed a unit. Average leaf length (cm), average leaf width (cm) and leaf area (cm^2) were measured with the help of Portable leaf area meter (Licor, company. USA.). Absolute growth rate (cm/day) AGR for increase in plant height was calculated by using formula given by Radford (1967) [13] and expressed as height in cm/day.

$$AGR = \frac{(H_2 - H_1)}{(t_2 - t_1)}$$

Where, H_2 and H_1 represent height per plant and t_2 and t_1 time intervals between two observations, respectively.

Relative growth rate (cm/cm/day) is the rate of increase in height (cm) per time and expressed as cm/cm/day. RGR was calculated by the using formula given by Briggs *et al.* (1920) [3]

$$RGR = \frac{(\log_e H_2 - \log_e H_1)}{(t_2 - t_1)}$$

Where, H_2 and H_1 represent the plant height per plant at t_2 and t_1 times, respectively. Statistical analysis of the data was carried out by following the standard method of analysis of variance as given by Panse and Sukhatme (1985) [10]. Graphs and plates have been used to project the important results.

Result & Discussion

Data pertaining to height of seedling, number of leaves, number of shoots and leaf characters are presented in Table 1 and depicted with Figure 1.

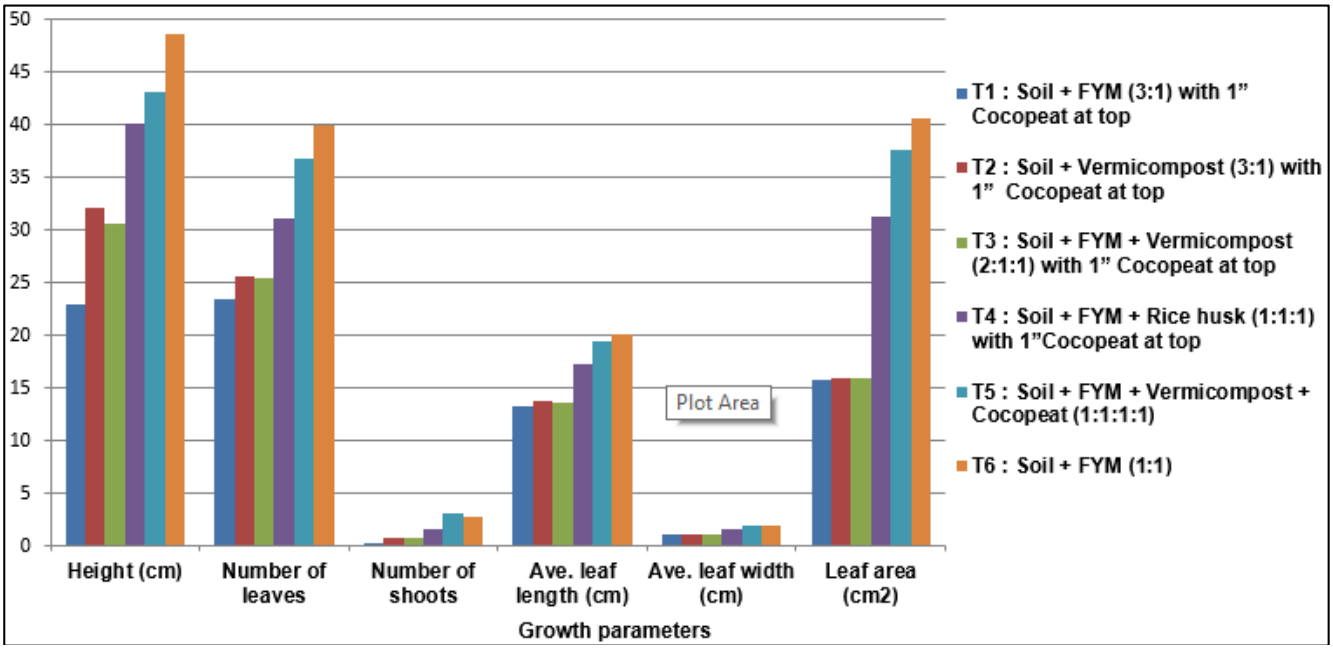

Fig 1: Performance of kokum seedlings on different potting media

Plate 1: Performance of kokum seedlings grown on different growing media at 360 days after bagging in 9″ x 11″ size polybag

Table1: Effect of different growing media on growth of kokum seedlings at 360 days after bagging (DAB)

Treatments	Height (cm)	Number of leaves	Number of shoots	Ave. leaf length (cm)	Ave. leaf width (cm)	Leaf area (cm^2)
T_1: Soil + FYM (3:1) with 1" Cocopeat at top	22.95	23.40	0.18	13.22	1.09	15.73
T_2: Soil + Vermicompost (3:1) with 1" Cocopeat at top	31.98	25.58	0.70	13.65	1.11	15.83
T_3: Soil + FYM + Vermicompost (2:1:1) with 1" Cocopeat at top	30.56	25.38	0.65	13.53	1.13	15.81
T_4: Soil + FYM + Rice husk (1:1:1) with 1"Cocopeat at top	40.03	31.03	1.60	17.25	1.61	31.27
T_5: Soil + FYM + Vermicompost + Cocopeat (1:1:1:1)	43.13	36.73	2.98	19.38	1.81	37.56
T_6: Soil + FYM (1:1)	48.60	39.83	2.65	20.11	1.93	40.61
SEm ±	1.24	1.36	0.25	0.81	0.08	2.55
CD @ 5%	3.73	4.10	0.77	2.44	0.23	7.69

Effect of growing media on seedling height

Data presented in Table 1 revealed that at 360 DAB maximum height (48.60 cm) was recorded in T_6 (Soil + FYM 1:1) and was superior over the rest of the treatments. Treatment T_4 (40.03) was at par with T_5 (43.13) (Soil + FYM + Vermicompost + Cocopeat 1:1:1:1). The minimum height (22.95 cm) was observed in T_1 (Soil + FYM (3:1) with 1″ Cocopeat at top). It was observed that treatment T_6 (Soil + FYM 1:1) was found to be superior for height of kokum seedling. This may be due to the role of FYM in increasing aeration and water holding capacity of soil, availability of essential nutrients for plant growth and also improve soil physical, chemical and biological properties (Ramteke *et al*., 2016) [14]. Similar findings were reported by Parasana *et al.*, (2013) for mango in growing media containing Soil + Sand + FYM (2: 1: 1), Panchal *et al*., (2014) [8] for khirni seedling in Soil + Cocopeat + FYM (1:1:1).

Effect of growing media on number of leaves

At 360 DAB the maximum number of leaves (39.83) was recorded in treatment T_6 (Soil + FYM 1:1) which was at par with T_5 (36.73). The minimum number of leaves (23.40) were recorded in treatment T_1 (Soil + FYM (3:1) with 1″ Cocopeat at top) which was at par with T_3 (25.38) and T_2 (25.58). The results revealed that treatment T_6 (Soil + FYM 1:1) found to be superior for increasing number of leaves of kokum seedling. The possible reason was nutritional contribution of the growing media. Soil mixtures with organic substrates such as farm yard manure enhanced the production of leaves. Similar results were reported by Parasana *et al.*, (2013) in mango for growing media containing Soil + Sand + FYM (2: 1: 1), Gholap and Polara (2015 a) [5] for mango rootstock in Soil + FYM + Leaf mould (1:1:1) media, Panchal *et al*., (2014) [8] for khirni seedling in Soil + Cocopeat + FYM (1:1:1) and Khot (2017) [7] for Bullock's heart in Soil + FYM (2:1) media.

Effect of growing media on number of shoots

At 360 DAB the highest number of shoots (2.98) was recorded in treatment T_5 (Soil + FYM + Vermicompost + Cocopeat 1:1:1:1) followed by T_6 (2.65) and both were at par with each other. The minimum number of shoots (0.18) was observed in treatment T_1 (Soil + FYM (3:1) with 1″ Cocopeat at top) which was at par with T_3 (0.65) and T_2 (0.70).

The results showed that the treatment T_5 (Soil + FYM + Vermicompost + Cocopeat 1:1:1:1) found superior for increasing number of branches of kokum seedling. Improved aeration of media, water holding capacity, cation exchange capacity and increased nutrient status of media which might have increased the growth of plant by producing more number of shoots. The results are in accordance with the findings obtained by Panchal *et al.*, (2014) [8] for khirni seedlings in Soil + Cocopeat + FYM (1:1:1) media, Qayom (2011) for mango seedlings in Soil + Sand + Compost + Coir pith (2:1:1:1) media.

Effect of growing media on leaf length

At 360 DAB the treatment T_6 recorded the highest leaf length (20.11 cm) in media Soil + FYM 1:1) and was at par with T_5 (19.38 cm). The lowest leaf length (13.22 cm) was recorded in treatment T_1 (Soil + FYM (3:1) with 1″ Cocopeat at top) however it was at par with T_3 (13.53 cm) and T_2 (13.65cm). Thus, the present investigation showed that the leaf length was influenced by media. It was maximum in treatment T_6 (Soil + FYM 1:1). The results are in accordance with the findings of Gawankar (2019) [4] in jackfruit.

Effect of growing media on leaf width

At 360 DAB the highest average leaf width (1.93 cm) was recorded in treatment T_6 (Soil + FYM 1:1) which was at par with T_5 (1.81 cm). The lowest average leaf width (1.09 cm) was observed in treatment T_1 (Soil + FYM (3:1) with 1″ Cocopeat at top) which was at par with T_2 (1.11 cm) and T_3 (1.61 cm). Thus, the study revealed that treatment T_6 (Soil + FYM 1:1) found to be superior for average leaf width of kokum seedling.

Effect of growing media on leaf area

At 360 DAB the highest leaf area (40.61 cm^2) was recorded in treatment T_6 (Soil + FYM 1:1) which was at par with T_5 (37.56 cm^2). While the lowest leaf area (15.73 cm^2) was observed in treatment T_1 (Soil + FYM (3:1) with 1″ Cocopeat at top) which was at par with T_3 (15.81 cm^2) and T_2 (15.83 cm^2).

The study revealed that the leaf area of kokum was influenced by media and was maximum in treatment T_6 (Soil + FYM 1:1). The availability of nutrients in growing substrate greatly affects the size of leaves. The dimension of leaf namely leaf length, leaf width and leaf area are deciding the opportunity to capture solar radiation which is the main determinant of photosynthesis and overall growth of seedling.

In current investigation maximum leaf length, leaf width and leaf area were noticed under Soil + FYM 1:1 proportion. This could be due to properties of media namely pH value, EC value and NPK content and water holding capacity favorable for emergence and expansion of leaves. Peter-Onoh *et al*., (2014) [11] have also reported that the standard nursery soil is appropriate growth media for stimulation of emergence and expansion of leaves in African nutmeg. Similar findings were reported by Bhardwaj (2014) [1] in papaya.

Effect of growing media on absolute growth rate (AGR)

Data pertaining to the effect of different growing media on absolute growth rate (cm/day) are presented in Table 2. At 0-180 DAB the highest AGR (0.094 cm/day) recorded in treatment T_6 and the lowest AGR (0.045 cm/day) was

observed in T_1 (Soil + FYM (3:1) with 1″ Cocopeat at top). At 180-360 DAB the highest AGR (0.140 cm/day) was observed in treatment T_6 (Soil + FYM 1:1) and lowest AGR (0.052 cm/day) was in T_1 (Soil + FYM (3:1) with 1″ Cocopeat at top).

Table 2: Effect of different growing media on absolute growth rate (cm/cm/day) and relative growth rate (cm/cm/day) of kokum seedling

Treatments	Absolute growth rate (cm/day)		Relative growth rate (cm/cm/day)
	0-180 DAB	180-360 DAB	0-360 DAB
T_1 - Soil + FYM (3:1) with 1″ Cocopeat at top	0.045	0.052	0.0018
T_2 - Soil + Vermicompost (3:1) with 1″ Cocopeat at top	0.057	0.089	0.0021
T_3 - Soil + FYM + Vermicompost (2:1:1) with 1″ Cocopeat at top	0.056	0.080	0.0020
T_4 - Soil + FYM + Rice husk (1:1:1) with 1″ Cocopeat at top	0.078	0.111	0.0023
T_5 - Soil + FYM + Vermicompost + Cocopeat (1:1:1:1)	0.084	0.120	0.0023
T_6 - Soil + FYM (1:1)	0.093	0.140	0.0024
Mean	0.069	0.099	0.0021

In current investigation, Soil + FYM 1:1 has maximum AGR magnitude at different growth stages indicating media with high proportion of soil is necessary for better absolute growth rate of seedling. Ramteke *et al*., (2016) [14] who observed maximum AGR of papaya seedling in media having Soil + Sand + Cocopeat and vermicompost in 1:1:1:1 proportion.

Effect of growing media on relative growth rate (AGR)

RGR is an index of efficiency of the plant to grow in contest of the photosynthesis of the crop per unit area. It measures the efficiency of the plant to grow per unit area per unit time. It is the growth rate relative to previous size. It is also called as exponential growth rate which is a quantification of speed of plant growth.

Data regarding effect of different growing media on relative growth rate (cm/cm/day) are presented in the table (Table 2).

At 360 DAB the highest RGR (0.0024 cm/cm/day) was observed in treatment T_6 (Soil + FYM 1:1) and the lowest RGR (0.0018 cm/cm/day) was observed in T_1 (Soil + FYM (3:1) with 1″ Cocopeat at top).

Study revealed that the treatment T_6 (Soil + FYM 1:1) recorded the maximum RGR of kokum seedling. This may be due to the fact that FYM would have increased aeration and water holding capacity in soil, availability of essential nutrients for plant growth and conversions of unavailable nutrients to available forms through microbial activity. Similar results were reported by Ramteke *et al*., (2016) [14] for papaya seedling in soil + FYM (1:1) media and Panchal *et al*., (2014) [8] in khirni.

Effect of growing media on seedling survival percentage

Data presented in Table 3 indicated that the highest survival of seedlings (97.50%) was also recorded in treatment T_6 (Soil + FYM 1:1) which was at par with T_4 (97.00%) and T_5 (95.00%). Significantly the lowest survival of seedling (91.50%) was recorded in treatment T_1 (Soil + FYM (3:1) with 1″ Cocopeat at top) and was at par with treatment T_2 (93.25%) and T_3 (93.50%). In present investigation treatment T_6 i.e. media having Soil + FYM at 1:1 reported maximum survival percentage of kokum seedling indicating effectiveness of FYM in the media which was also been reported by Qyom (2011) and Gholap and Polara (2015) [5] in mango.

Table 3: Survival percentage (%), percentage of graftable size seedlings and economics of growing kokum seedlings in different potting media (100 seedlings)

Treatments	Survival percentage (%)	Percentage of graftable seedlings	Gross income Rs.	Total cost Rs.	Net returns Rs.	Net B:C ratio	Weight of bag (kg)
T_1: Soil + FYM (3:1) with 1" Cocopeat at top	91.50 (73.41)	56.75 (49.06)	3660	3765.31	(-) 105.32	0.97	2.500
T_2: Soil + Vermicompost (3:1) with 1" Cocopeat at top	93.25 (75.08)	75.00 (60.11)	3730	4565.77	(-) 835.78	0.81	2.700
T_3: Soil + FYM + Vermicompost (2:1:1) with 1" Cocopeat at top	93.50 (75.34)	81.00 (64.31)	3740	4457.44	(-) 711.45	0.84	2.800
T_4: Soil + FYM + Rice husk (1:1:1) with 1" Cocopeat at top	97.00 (80.35)	89.00 (70.83)	3880	3639.57	240.41	1.06	1.900
T_5: Soil + FYM + Vermicompost + Cocopeat (1:1:1:1)	95.00 (77.19)	87.75 (69.96)	3800	4076.90	(-) 276.91	0.93	2.000
T_6: Soil + FYM (1:1)	97.50 (82.45)	90.00 (76.61)	3900	3432.37	467.61	1.13	1.700
SEm ±	1.24	3.71					
CD @ 5%	3.72	11.20					
Figures in parenthesis are arcsine transformed values							

Effect of different growing media on graftable size seedlings

Obtaining healthy and vigorous seedling which is further utilized for grafting purpose is the important aspect for any nursery programme. The data pertaining to percentage of graftable size seedlings as influenced by different media presented in Table 3 revealed that significantly the highest percentage of graftable seedlings was obtained in the treatment T_6 (83.25%) i.e. in media Soil + FYM at 1:1 proportion and was at par with T_4 (81.75%), T_2 and T_3 (71.75%) and T_5 (71.00%). Significantly lowest percentage of graftable seedlings was obtained in T_1 (45.75%) where Soil + FYM at 3:1proportion with 1″ Cocopeat at top was the potting media. Study revealed that kokum seedlings rose in Soil + FYM at 1:1 proportion produced 83.25 percent graftable seedlings at earliest of 360 days after bagging. Thus, media having Soil + FYM at 1:1 proportion found effective in enhancing growth of seedling for obtaining graftable size seedlings. This may be due to the media containing Soil + FYM might have accredited nutritional status in the media which enhanced photosynthetic activity resulted in more plant stored material, thereby exhibited favourable effect on seedling growth (Gholap and Polara 2015) [5].

Cost of production of Kokum seedlings on different potting media

The data on gross income, total cost, net returns, benefit to cost ratio (B: C) and weight of seedling at a time of sale as influenced by different growing media are presented in Table 3.

Cost of producing 100 seedlings on different media indicated that total cost on production of seedling was the highest in treatment T_2 (Rs. 4565.77) which is due to more proportion and expenditure on soil. Gross income generated was the highest in treatment T_6 (Rs. 3900) and minimum in treatment T_1 (Rs.3660). Net returns (Rs. 467.61) and B: C ratio (1.13) was the highest in treatment T_6. This may be due to highest survival of seedling found in this treatment.

Thus, treatment T_6 (Soil + FYM (1:1)) was found superior and resulted in generating higher gross income (Rs. 3900), maximum net returns (Rs. 467.61) with highest B: C ratio (1.13). The weight of bag was also less in this treatment (1.700 kg/bag).

Conclusion

In present study growing media having Soil + FYM at 1:1 proportion was found better for increasing seedling height, number of leaves, leaf area, survival percentage of seedling after transferring in bigger size polybag and getting more percentage of graftable seedlings at early stage of growth. Thus, it is concluded that use of Soil + FYM of 1:1 proportion is the best medium for raising seedlings.

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