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Manju Attri
Research Scholar, Forestry Department of Silviculture and Agroforestry, College of Horticulture & Forestry, Jhalrapatan, Jhalawar, Rajasthan, India

SBS Pandey
Head, Department of Silviculture and Agroforestry, College of Horticulture & Forestry, Jhalrapatan, Jhalawar, Rajasthan, India

Raju Jatav
Research Scholar, Forestry Department of Silviculture and Agroforestry, College of Horticulture & Forestry, Jhalrapatan, Jhalawar, Rajasthan, India

Corresponding Author:
SBS Pandey
Head, Department of Silviculture and Agroforestry, College of Horticulture & Forestry, Jhalrapatan, Jhalawar, Rajasthan, India

Economics of producing quality seedlings of important agroforestry species with different growing media under shade-net conditions in semi-arid region of Rajasthan

Manju Attri, SBS Pandey and Raju Jatav

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Abstract
A field experiment was conducted during June, 2019 to March, 2020 at the Instructional farm Fruit Science at the College of Horticulture and Forestry, Jhalawar, Agriculture University Kota (Rajasthan). The experiment was comprised of eighteen treatments of four growing medium viz.; soil, sand, FYM and Vermicompost in different ratio. The study aimed to find out best growing medium for following three species viz. Ardu (*Ailanthus excelsa*), Bael (*Aegle marmelos*) and Neem (*Azadirachta indica*). Seedlings were raised in the polybags of size 6" x 10" under green shed net (50% light intensity) nursery conditions. Highest Benefit cost ratio of 2.23, 2.97 and 2.23 was observed in T_0 with lowest cost of cultivation as used only soil as growing medium for Ardu, Bael and Neem respectively whereas revenue remained constant for Bael Rs.20 per seedling and for Ardu and Neem Rs. 15 only in all the treatments. The results obtained from this study can be used to produce quality planting material of Ardu, Bael and Neem in shortest possible time and lowest quality input.

Keywords: Seedling, ardu, bael, neem, benefit cost ratio and revenue

Introduction
Nursery may be defined as an area where plants are raised for eventual planting out. Nurseries play a very important part in afforestation, reforestation and artificial regeneration programmes. Nurseries are used to raise seedlings of uniform age and in required numbers to meet the demands of industrial wood, farm as well as social forestry and to provide seedling for avenue, railway and road side planting. The roles of nursery further increases in those species whose seeds do not produced or germinate profusely in nature and require a certain treatment for germination which is provided by care takers. Nursery raised Seedlings can also be used in agroforestry systems which can provide farmer the combined benefits of agriculture and forestry on the same piece of land. Bene *et al.* (1977) [2] has defined agroforestry as a sustainable management system for land that increase overall production, combines agriculture crops, tree crops and forest plants and /or animals simultaneously or sequentially and applies management practices that are compatible with the culture patterns of a local population. Output from the agroforestry system can be further increased if we take good quality planting stock and this can be made sure if we conduct some research on factors like number of plants required for actual planting, germination percentage of seeds, viability of seedlings, post planting mortality and selection of superior seedlings.

Ailanthus word was derived from ailantho an Ambones probably meaning 'tree of the Gods' or 'tree of heaven' is a genus of trees belonging to the family Simaroubaceae. This tree was first described by William Roxburgh in 1795 for the Circars in the eastern parts of India. The tree is indigenous to Southern and Central India and suitable for planting in dry areas of Rajasthan with annual rainfall of about 400mm (Bhimaya *et al*, 1963) [3]. It avoids moist area with high rainfall. It can grow even on shallow, dry, eroded ravenous land and skeletal soils and in tarai and babhar zones. It is fast growing extensively cultivated in many parts of India towards the vicinity of villages. It is often planted along the roads. It is exotically found in Sudan. It is suitable for making match boxes, the splints lose their white colour to grey on exposure besides somewhat weak, even then it is in demand for match industry in south India. The leaves are rated as highly palatable and nutritious fodder for sheep and goats. In Rajasthan, tree is growing in house compounds and people sell leaves for fodder on lease basis that add to their income.

It is a large deciduous tree, 18-25 m tall; trunk straight, 60 to 80 cm in diameter; bark light gray-brown and rough on large trees, aromatic slightly bitter. Leaves alternate, Pinnately compound, large, 30 - 60 cm or more in length; leaflets 8 - 14 or more pairs, long stalked, ovate or broadly lanced shaped. (Lavhale and Mishra, 2007) [5, 7]. The fresh seed is sown in June – July in well prepared raised beds to allow good drainage. The elevated nursery beds are made by mixing sand, soil and FYM in the ratio 3:1:1. The seeds can be sown in lines 20 cm apart. Sowing should be done up to depth of 5mm only. The seeds should be covered lightly with pulverized soil, after sowing. Germination commences after 10 – 15 days. Watering should be done regularly, as the seedlings are liable to damping off.

Bael tree *(Aegle marmelos* L.) belongs to the family Rutaceae and its various parts are used in Ayurveda and Siddha medicines to treat a variety of ailments. The plant has its origin from Eastern Ghats and central India. It is indigenous to Indian subcontinent and is mainly found in tropical and sub-tropical regions. The tree is also found as a wild in nature, in lower ranges of Himalayas up to an elevation of 500 meters. It is a widely distributed plant and found in India, Ceylon, China, Nepal, Sri Lanka, Myanmar, Pakistan, Bangladesh, Nepal, Vietnam, Laos, Cambodia, Thailand, Indonesia, Malaysia, Tibet, Sri Lanka, Java, Philippines and Fiji. The roots are useful for treating diarrhoea, dysentery and dyspepsia. Besides having antifungal and antibacterial properties, Bael has also been reported to contain varied classes of compounds of alkaloids, fatty acids, amino acids etc. (Neeraj *et al.* 2017) [8], which when subjected to decomposition, can provide essential nutrients to soil for plant uptake assisting in productivity. The juice of the leaves is a relief to the Diabetics, and the pulp of the fruit cures diarrhoea. The fruit called bel is considered a favourite of Lord Shiva.

It is a slow-growing medium sized tree and is 12-15 m tall with short trunk; thick, soft, flaking bark and spreading, sometimes spiny branches, the lower ones drooping. Bael has enormous traditional uses against various diseases and many bioactive compounds have been isolated from this plant also (Maity *et al.,* 2009) [6]. The natural regeneration is very short since soil insects and nematodes destroy the seeds. Seeds, root suckers, grafting and layering can be used to propagate Bael. Seeds do not have a dormancy and loose viability soon. Seeds can be sown in polybags or in beds of standard size (12m X 1.2m X 0.3m) in June - July. Seeds start germinating within 12 – 15 days after sowing and germination is completed within 45 – 50 days. Young seedlings are protected from weed infestation and frost. Irrigation is also given. We use only 15 – 20 cm tall seedlings for establishment in fields which take one to one and a half years.

The Neem tree *(Azadirachta indica)* belongs to family Meliaceae, is a tropical evergreen tree related to mahogany. Native to east India and Burma, Neem (*Azadirachta indica*) is a versatile, hardy Indian tree of great religious, medicinal and ornamental importance. The species has been used to afforest drier tracts, ravines and refractory soils in the states of Gujarat, Rajasthan, Punjab, Haryana, Utter Pradesh, Bihar, Orissa, Tamil nadu. It grows in much of Southeast Asia and West Africa; a few trees have recently been planted in the Caribbean and several Central American countries, including México. The people of India have long revered the neem tree for centuries, millions have cleaned their teeth with neem twigs, smeared skin disorders with neem-leaf juice, taken neem tea as a tonic, and placed neem leaves in their beds, books, grain bins, cupboards, and closets to keep away troublesome bugs.

Trees will reach up to 30 m tall with limbs reaching half as wide. The shiny dark green pinnately compound leaves are up to 30 cm long. Each leaf has 10–12 serrated leaflets that are 7 cm long by 2.5 cm wide. It will grow where rainfall is as little, and thrives in areas that experience extreme heat of up to 48°C. Even some of the most cautious researchers are saying that neem deserves to be called a “wonder plant”. In the application of Neem, Neem used as Fertilizer, Manure, and urea coating agent, fumigant, pesticide, Soil Conditioner and Neem pest control is very beneficial for proper crop and pest management. (Roshan *et al*.,2015) [10]. Sowing in raised nursery beds is done in June-July in drills 15cm apart; the seed being 2.5cm apart in the lines (Luna, 1996). The seeds are sown in raised seedbeds of size 12m x 1.2m. Seedbeds should contain sand, soil and FYM in the ratio 1:1:1. The seeds are broadcasted and watered daily.

Rabo and Mazadu (2018) [9] conducted a study on economic feasibility of 24 species - 14 ornamental species, 8 tree crops species and 4 forest species. The result of the economic analysis from this study showed that the rate of returns (RORT) was high with the highest returns on Golden Palm (350), Ficus (193.33), Yellow bush (50) and Gmelina (33.33).

Shinoj *et al.* (2010) [11] found that Rajasthan farmers incurred a cost of around Rs 31,295/ha, during the first year whereas the estimates for Chhattisgarh and Uttarakhand were Rs 8,319/ha and Rs 12,050/ha, respectively. This can be attributed to the inter-state variations in subsidies on Seedlings and other inputs, variations in labour charges, differential usage of inputs, etc. The farmers in the Sikar district of Rajasthan had to pay Rs 6-10 per seedling as they did not get any subsidy from the state government. The cost of seedling alone came around 35 per cent of their total cost. In contrast, Chhattisgarh farmers were getting seedlings at a highly subsidized rate of Rs 0.50 per seedling and the Uttarakhand farmers were provided hundred per cent subsidy on seedlings.

Kulkarni *et al.* (2017) [4] found highest benefit cost ratio (B:C ratio) (3.17 and 3.37 in two years) in treatment with Cocopeat 40%, Red soil 30%, F.Y.M. 20% and Sand 10% combination while lowest (1.80 and 1.94) in the treatment with red soil 80% + sand 20% combination. The treatment T_8 realized maximum net returns of Rs7, 01,236 and Rs 7, 11,124 in 560 m^2 areas for two years.

Bhardwaj (2014) [1] found that application of vermicompost: pond soil: sand (1:1:1) with 2 cm cocopeat media for preparation of papaya seedling proved most profitable and showed maximum net return (Rs 3493.30/1000 seedlings and Rs 3448.00/1000 seedlings) and benefit: cost ratio (1.85 and 1.84) for the first and second year of experimentation, respectively due to higher germination percent and survival percent obtained.

Material and Methods

A field experiment was conducted during June, 2019 to March, 2020 at the Instructional farm Fruit Science at the College of Horticulture and Forestry,Jhalarapatan city, Jhalawar (Agriculture University Kota (Rajasthan)). Geographically Jhalawar district is located at 23°4’ to 24°52’ N-Latitude and 75°29’ to 76°56’ E Longitude in South-Eastern Rajasthan. The experimental site of Instructional farm of the Department of Fruit Science falls under Zone V and is known as Humid South Eastern Plain. Madhya Pradesh is the neighbouring state of the district and is located at just the

edge of malwa plateau. Jhalawar is rich in water resources. District topography is made up of plain though some parts consist of hilly terrain. The Aravallis which are the most ancient mountain system of India roughly divide the plains of Hadoti from the Malwa Plateau.

The climate of Jhalawar is different from the rest of the state because of abundant rainfall received by the region which is against the common perception of Rajasthan. Climate is typically sub-humid with extremes of temperature both in summer and winter. Climate of the region can be studied with respect to season- (i) Summer season: The summer season starts in March and ends in the month of June. Temperatures range from 27 - 42^{0}C. May is the hottest part of the year. Temperatures remains high during this season and the heat can be very oppressive sometimes. The summers are hot and extremely uncomfortable.

(ii) Monsoon season: The monsoon season is from June to September. The conditions become milder making life easier for natives. The rains provide much required relief from the heat. Temperatures is around the 30^{0}C during this periods. South western monsoon brings abundant rainfall to the region.

(iii) Winter season: Winters are cool and comfortable making it the best time of the year. Season begins from October and last till February. It is the best time to visit Jhalawar. Temperature stays between 10 to 25^{0}C though sometime temperature may go down as low as 1^{O}C. Jhalawar is a district with a significant rainfall. The district receives an average rainfall of around 943 mm. District is known for the highest rainfall in the state of Rajasthan. An average of 35 inches of rainfall keeps the region cool, and gentle breezes relieve the people from stifling humidity. The region is governed by the monsoonal rhythm like the rest of India. This year monsoon was stronger causing greater precipitation in the region. The driest month is February which receives little or nil rainfall. Most of the precipitation here falls in August amounting to 336 mm on average.

The experiment was comprised of eighteen treatments of four growing medium viz.; soil, sand, FYM and Vermicompost in different ratio. The study aimed to find out best growing medium for following three species viz. Ardu *(Ailanthus excelsa)*, Bael *(Aegle marmelos)* and Neem (*Azadirachta indica*). Seedlings were raised in the polybags of size 6" x 10" under green shed net (50% light intensity) nursery conditions. The gross realization in terms of rupees per plant was worked out on the basis of cost of cultivation of each treatment per plant. The benefit-cost ratio was calculated as per the following formula:

$$Benefit\ cost\ ratio = \frac{Gross\ Return\ per\ plant}{Cost\ of\ cultivation\ per\ plant}$$

Result and Discussion

It is evident from the data in Table 1 and Figure 1 & 2 that max benefit cost ratio (2.23) of Ardu(*Ailanthus excelsa*) and Neem (*Azadirachta indica*) was observed in T_0 (soil, control) followed by T_2 (1.62) and then by T_6 (1.55) and T_{13} (1.55) whereas lowest benefit cost ratio was observed in T_{16} (1.19) followed by T_{12} (1.21). Cost of cultivation per seedling was found to be lowest in T_0 (Rs 6.73) and was highest in T_{16} (Rs 12.61). Survival of seedlings was not taken into account since whatever seedlings had died after 240 DAS or earlier, they were replaced with new transplanted seedlings. (Mishra *et al.*, 2017) [7] reported that the maximum net return was obtained in treatment Sand: Garden soil: FYM (1:1:2). Economic analysis is in accordance with research done by Kulkarni *et al*. (2017) [4] in potted gerbera and by Bhardwaj (2014) [1] in papaya cv. Red Lady.

The data on the cost of raising seedling, revenue and benefit-cost ratio (B: C) of Bael (*Aegle marmelos*) has been depicted in Table 2 and graphically in Figure 3 and 4. Highest Benefit cost ratio was observed in T_0 (soil, control) (2.97) which was followed by T_2 (2.15) and then by T_6 (2.07) and T_{13} (2.07). Lowest benefit cost ratio was observed in T_{16} [Soil: Sand: Vermicompost] (1.59) followed by T_{12} (1.61). T_0 (Rs 6.73) and T_{16} (Rs 12.61) remained minimum and maximum cost of cultivation per seedling. In empty polybags, new seedlings were transplanted after 240 DAS. Mishra *et al*., (2017) [7] reported that the maximum net return was obtained in treatment Sand: Garden soil: FYM; 1:1:2. Economic analysis is in the conformity with research done by Bhardwaj (2014) [1] in papaya cv. Red Lady and by Kulkarni *et al*. (2017) [4] in potted gerbera.

Table 1: An Economic analysis of raising Ardu and Neem seedlings

Treatment	Number of seedling	Production							Revenue per seedling (Rs)	B/C ratio
		Labour (Rs)	Insecticides/ Fungicides (Rs)	Poly bags (Rs)	Cost of growing media per seedling (Rs)	Total cost of growing medium per treatment (Rs)	Cost of cultivation (Rs)	Cost of cultivation per seedling (Rs)		
T_0 Soil	45	150	45	67.50	0.90	40.50	303.00	6.73	15	2.23
T_1 Soil:Sand (1:1)	45	150	45	67.50	4.20	189.00	451.50	10.03	15	1.50
T_2 Soil:FYM (1:1)	45	150	45	67.50	3.45	155.25	417.75	9.28	15	1.62
T_3 Soil: Vermicompost (1:1)	45	150	45	67.50	4.95	222.75	485.25	10.78	15	1.39
T_4Soil:Sand:FYM (1:1:1)	45	150	45	67.50	4.80	216.00	478.50	10.63	15	1.41
T_5 Soil:Sand:FYM (1:1:2)	45	150	45	67.50	5.10	229.50	492.00	10.93	15	1.37
T_6Soil:Sand:FYM (2:1:1)	45	150	45	67.50	3.83	172.35	434.85	9.66	15	1.55
T_7 Soil:Sand:FYM (1:2:1)	45	150	45	67.50	5.48	246.60	509.10	11.31	15	1.33
T_8Soil:Sand:FYM (2:1:2)	45	150	45	67.50	4.26	191.70	454.20	10.09	15	1.49
T_9 Soil:Sand:FYM (1:2:2)	45	150	45	67.50	5.58	251.10	513.60	11.41	15	1.31
T_{10} Soil:Sand:FYM (2:2:1)	45	150	45	67.50	4.56	205.20	467.70	10.39	15	1.44
T_{11} Soil:Sand:Vermicompost (1:1:1)	45	150	45	67.50	5.80	261.00	523.50	11.63	15	1.29
T_{12}Soil:Sand:Vermicompost (1:1:2)	45	150	45	67.50	6.60	297.00	559.50	12.43	15	1.21
T_{13}Soil:Sand:Vermicompost (2:1:1)	45	150	45	67.50	3.83	172.35	434.85	9.66	15	1.55
T_{14} Soil:Sand:Vermicompost (1:2:1)	45	150	45	67.50	6.23	280.35	542.85	12.06	15	1.24
T_{15} Soil:Sand:Vermicompost (2:1:2)	45	150	45	67.50	5.46	245.70	508.20	11.29	15	1.33
T_{16}Soil:Sand:Vermicompost (1:2:2)	45	150	45	67.50	6.78	305.10	567.60	12.61	15	1.19
T_{17} Soil:Sand:Vermicompost (2:2:1)	45	150	45	67.50	5.16	232.20	494.70	10.99	15	1.36

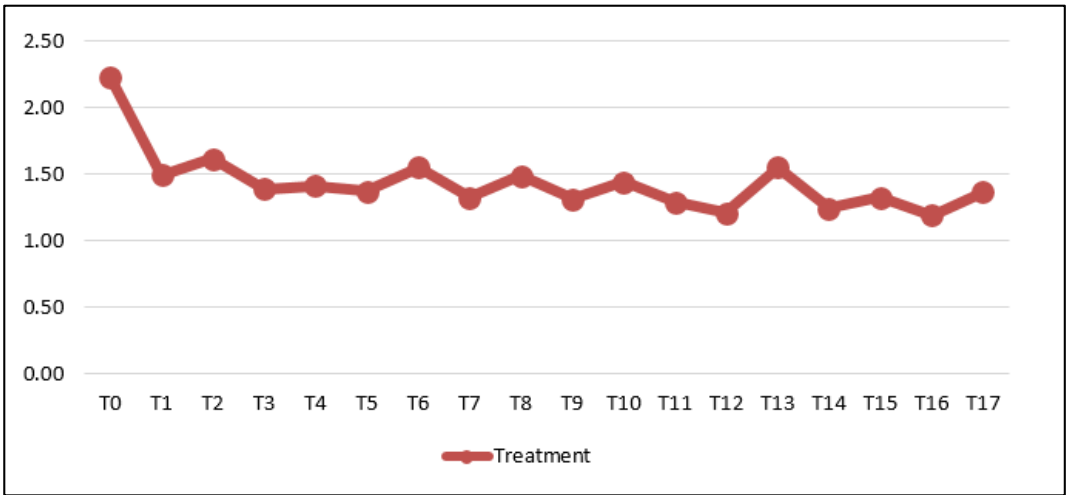

Fig 1: Benefit cost ratio of raising Ardu and Neem seedlings treatment wise

Table 2: Economic analysis of raising Bael seedlings

Treatment	Number of seedling	Production							Revenue per seedling (Rs)	B/C ratio
		Labour (Rs)	Insecticides/ Fungicides (Rs)	Poly bags (Rs)	Cost of growing media per seedling (Rs)	Total cost of growing medium per treatment (Rs)	Cost of cultivation (Rs)	Cost of cultivation per seedling (Rs)		
T_0 Soil	45	150	45	67.50	0.90	40.50	303.00	6.73	20	2.97
T_1 Soil:Sand (1:1)	45	150	45	67.50	4.20	189.00	451.50	10.03	20	1.99
T_2 Soil:FYM (1:1)	45	150	45	67.50	3.45	155.25	417.75	9.28	20	2.15
T_3 Soil: Vermicompost (1:1)	45	150	45	67.50	4.95	222.75	485.25	10.78	20	1.85
T_4Soil:Sand:FYM (1:1:1)	45	150	45	67.50	4.80	216.00	478.50	10.63	20	1.88
T_5 Soil:Sand:FYM (1:1:2)	45	150	45	67.50	5.10	229.50	492.00	10.93	20	1.83
T_6Soil:Sand:FYM (2:1:1)	45	150	45	67.50	3.83	172.35	434.85	9.66	20	2.07
T_7 Soil:Sand:FYM (1:2:1)	45	150	45	67.50	5.48	246.60	509.10	11.31	20	1.77
T_8Soil:Sand:FYM (2:1:2)	45	150	45	67.50	4.26	191.70	454.20	10.09	20	1.98
T_9 Soil:Sand:FYM (1:2:2)	45	150	45	67.50	5.58	251.10	513.60	11.41	20	1.75
T_{10} Soil:Sand:FYM (2:2:1)	45	150	45	67.50	4.56	205.20	467.70	10.39	20	1.92
T_{11} Soil:Sand:Vermicompost (1:1:1)	45	150	45	67.50	5.80	261.00	523.50	11.63	20	1.72
T_{12}Soil:Sand:Vermicompost (1:1:2)	45	150	45	67.50	6.60	297.00	559.50	12.43	20	1.61
T_{13}Soil:Sand:Vermicompost (2:1:1)	45	150	45	67.50	3.83	172.35	434.85	9.66	20	2.07
T_{14} Soil:Sand:Vermicompost (1:2:1)	45	150	45	67.50	6.23	280.35	542.85	12.06	20	1.66
T_{15} Soil:Sand:Vermicompost (2:1:2)	45	150	45	67.50	5.46	245.70	508.20	11.29	20	1.77
T_{16}Soil:Sand:Vermicompost (1:2:2)	45	150	45	67.50	6.78	305.10	567.60	12.61	20	1.59
T_{17} Soil:Sand:Vermicompost (2:2:1)	45	150	45	67.50	5.16	232.20	494.70	10.99	20	1.82

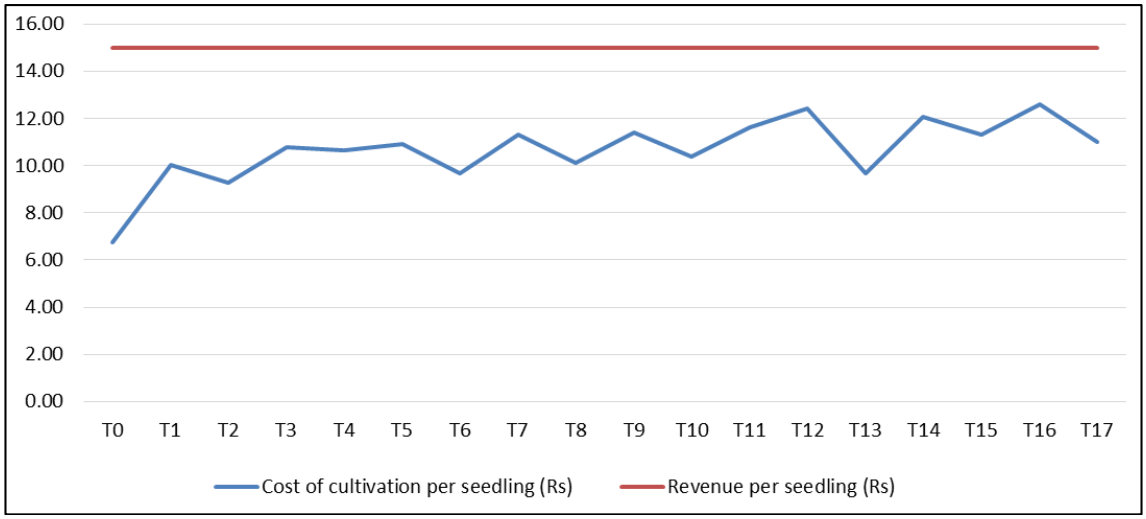

Fig 2: Cost of cultivation and revenue of Ardu and Neem seedling treatment wise

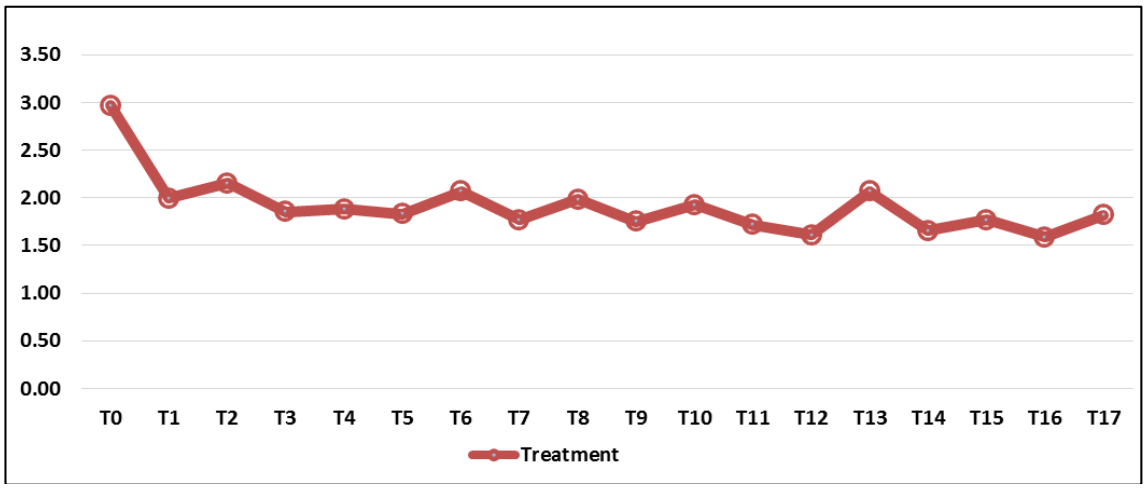

Fig 3: Benefit cost ratio of raising Bael seedlings treatment wise

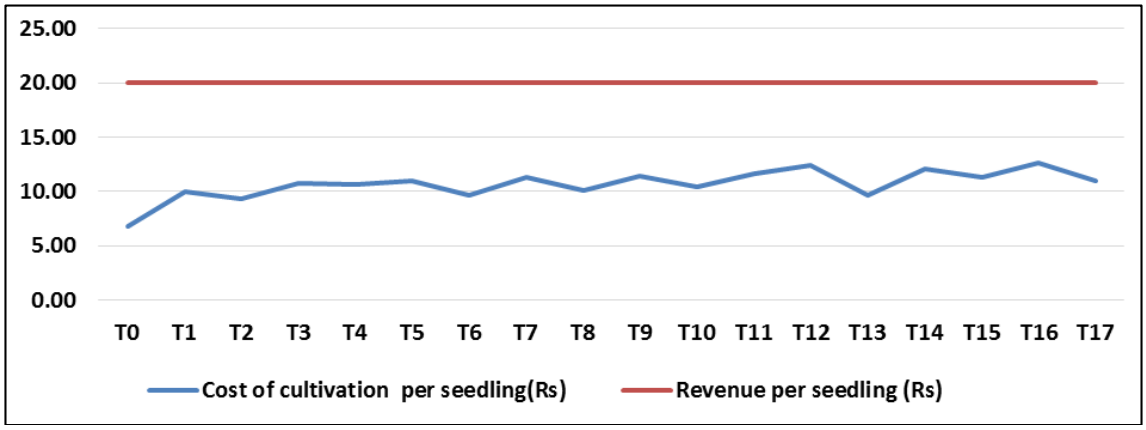

Fig 4: Cost of cultivation and revenue of Bael seedlings treatment wise

Note

1. Cost of Soil = Rs 0.60 per Kg
2. Cost of Sand = Rs 5 per Kg
3. Cost of Fym = Rs 4 per Kg
4. Cost of Vermicompost = Rs 6 per Kg
5. Labour Charges = Rs 150 per treatment (Mixture preparation, Irrigation, Spraying of Insecticide/Fungicide)
6. Insecticide Cost = Rs 1.00 per seedling
7. Cost of Polybag = Rs 1.5 per polybag
8. Seedling Selling Price = Rs 20 per plant for Bael
9. Seedling Selling Price = Rs 15 per plant for Ardu and Neem

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