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Assessment of growth parameters of micro forest Miyawaki garden in Kariavattom Campus, Thiruvananthapuram

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Abstract

Miyawaki afforestation is a forest restoration method using plants native to the area and replicating natural forest regeneration processes. The technique was invented and introduced in Japan by Professor Akira Miyawaki in the 1980s. The method aims to creating forest cover quickly by growing many tree in a limited space in a brief period of time. Today, Miyawaki method has implemented worldwide especially across the communities where there is too much pressure on land. A study was conducted to find the growth performance of plants under Miyawaki method of planting in the Department of Botany, University of Kerala, Kariavattom Campus. About thirty-eight plant species were selected for the study, including tree, shrub, and herb. The performance of these tree was assessed with biometrical traits growth parameters such as the height of the plant, girth of the plant, number of leaves, and numbers of primary branches continuously every week for up to five weeks. Among the species studied, *Annona reticuta* exhibited highest growth, thus suiting better for Miyawaki afforestation. *Thespesia populnea*, *Azadirachta indica*, *Tamarindus indica*, *Lawsonia inermis*, and *Coleus* sp. also performed well in terms of biometric. Thus the use of these indigenous species can be successfully employed for Miyawaki afforestation technique to create thick, multilayered forests.

Keywords: Afforestation, Miyawaki, growth performance, native species.

Introduction

Rapid industrialization, urbanization, and over - exploitation have resulted in the decline and permanent loss of forest cover at an alarming rate (Kumari *et al*., 2019). Climate change, desertification, soil depletion, fewer crops, floods, increased greenhouse gas levels in the atmosphere, wildlife extinction and habitat loss will all result from the loss of tree and other vegetation. At the ecological level, restoration is also well - defined as ''an intentional activity that initiates or accelerates recovery of an ecosystem with respect to its health, integrity, and sustainability'' (Schirone *et al*., 2011). Reforestation is an essential method for mitigating climate change and decreasing or reversing biodiversity loss. However, there are many potential compromises between the structural (biodiversity) and functional (carbon sequestration and water yield) effects of reforestation, which can be affected by decisions on spatial design and establishment

of plantings (Cunningham *et al*., 2015)there are many potential compromises between the structural (biodiversity. Reforestation projects usually progress through two main stages: an initial 'establishment' phase and a long - term 'building' phase (Kanowski and Catterall, 2007). Therefore, reforestation success can be viewed as a continuum from the successful establishment of the initial planting to the maturation and realization of the forest's full environmental and socio - economic benefits. Reforestation objectives are fundamentally valued and have traditionally been focused on Wood production, erosion prevention, and water flow management (Le *et al*., 2012). In recent decades, the objectives have shifted towards socio - economic benefits, ecosystem goods and services, recreation, and wildlife conservation (Vallauri, *et al*., 2002).

Miyawaki is a worldwide micro - afforestation project being carried out by a group of nature lovers to reclaim the lost biodiversity through human nature's uncontrolled exploitation. This Japanese afforestation project, named after Professor Akira Miyawaki, a world - renowned Japanese botanist and environmentalist who developed the concept, aims to grow many tree in a limited space briefly and grow a forest similar to a natural forest. He found that the forest formed in this way could withstand the frequent natural disasters in Japan (Miyawaki, 1998). The Miyawaki process, also known as the Potted Seedling Method creates thick, multilayered forests using native species. The approach involves planting dozens of native species in the same area, and it becomes maintenance - free after the first three years. The use of indigenous species for plantations is a key tenet in developing these forests (Miyawaki and Fujiwara, 1988). The forest's overall density is advantageous in lowering the temperature, rendering soil healthy, supporting local biodiversity and carbon sequestration (Goveanthan *et al*., 2019). Undertaking assessments at an early stage of a reforestation project can only indicate future success (Reay and Norton, 1999). The present investigation was undertaken to find the growth performance of selected plant species grown as per the Miyawaki method of planting in Department of Botany, University of Kerala, Kariavattom.

Materials and Methods

Study Site

The work was carried out in Department of Botany, University of Kerala,India during the period 2019 to 2021. The study site includes the micro forest Miyawaki garden; Department of Botany, University of Kerala, Kariavattom (Latitude: 8°33´59.59´´N, Longitude: 76°53´11.11´´E, Altitude: 22 m). It covers an area of 14.60 m × 14.50 m, and the field was prepared by proper leveling, and seedlings were planted at proper distances. About 800 plants were grown as per the Miyawaki method. All other agricultural practices such as irrigation and fertilization were uniformly applied to the forest.

Data collection

The method included planting tree with only native species in the same area, and the saplings become

self - sustainable. The plants grown in the selected area were identified and authenticated with the help of flora and taxonomic experts. The categorization of plants was done based on their habits like shrub, herb, tree, and canopy for further documentation. Different growth parameters like plant height and girth, number of leaves, and number of branches were studied through regular field visits up to five weeks at an interval of one week and it was compared with control plants.

Data analysis

Different aspects of quantitative growth parameters were analyzed statistically. The statistical data analyses were performed using IBM SPSS Statistics 22 to elucidate growth parameters between the plant species. To assess the significance of uantitative morphological characters, one - way ANOVA was done, and the results were expressed as mean ± standard error.

Results and Discussion

About thirty - eight plant species were selected for the study as listed in Table 1; it included tree, shrub, and herb (Fig.1) The plants were categorized as above mentioned and growth parameters such as the height of the plant, girth of the plant, number of leaves, and numbers of primary branches were observed continuously every week. The data were recorded for up to five weeks.

Fig 1. Study site

Table 1
Categorization of plants based on their habit and growth pattern

Sl. No.	**Botanical Name**	**Common Name**	**Advantage** Medicinal/ Timber/ Fruit/ Flower	**Type** Evergreen /deciduous /perennial	**Layer** Tree/ canopy/ Sub Tree/ Shrub/Herb
1.	*Saraca asoca* (Roxb.) Willd.	Ashokam	Medicinal	Evergreen	Tree
2.	*Alstonia scholaris* (L.) R.Br.	Devil Tree	Medicinal	Evergreen	Tree
3.	*Tamarindus indica* L.	Tamarind, Puli	Fruit	Evergreen	Tree
4.	*Artocarpus heterophyllus* Lam.	Jack fruit Tree, Plavu	Fruit	Evergreen	Tree
5.	*Dalbergia latifolia* Roxb.	Indian Rose Wood	Timber	Deciduous	Tree
6.	*Thespesia populnea* (L.) Soland. *ex* Correa	Indian tulip Tree Poovarasu,	Medicinal	Evergreen	Sub Tree
7.	*Cinnamomum malabatrum (*Burm. f.*)* Presl	Vayana	Medicinal	Evergreen	Tree
8.	*Psidium guajava* L.	Guava	Fruit	Evergreen	Tree
9.	*Pongamia pinnata* (L.) Pierre	Indian Peech, Pongam	Medicinal	Evergreen	Canopy
10.	*Averrhoa bilimbi* L.	Bilimbi, Irumban puli	Fruit	Evergreen	Sub Tree
11.	*Polyalthia longifolia* (Sonn.) Thwaites	Cemetery Tree	Timber	Evergreen	Tree
12.	*Syzygium* cumini L.	Njaval	Fruit	Evergreen	Tree
13.	*Azadirachta indica* A. Juss.	Neem, Ariyaveppu	Medicinal	Evergreen	Tree
14.	*Annona reticulata* Sieber ex A.DC.	Soursop, Mulluatha	Fruit	Evergreen	Tree

15.	*Calophyllum inophyllum* L.	Oil nut Tree, Punna	Fruit	Evergreen	Tree
16.	*Plumeria alba* L.	Frangipani	Flower	Deciduous	Tree
17.	*Madhuca indica* J.F.Gmel.		Medicinal	Evergreen	Tree
18.	*Syzygium cumini* (L.) Skeels	Njaval	Fruit	Evergreen	Tree
19.	*Butea monosperma* (Lam.) Taub.	Flame of Forest, Chamatha	Medicinal	Deciduous	Tree
20.	*Averrhoa carambola* L.	Star Apple	Fruit	Evergreen	Sub Tree
21.	*Garcinia indica* (Thouars) Choisy	Malabar Tamarind, Kudampuli	Fruit	Evergreen	Tree
22.	*Aegle marmelos* (L.) Correa	Wood Apple, Koovalam	Medicinal	Deciduous	Tree
23.	*Cassia fistula* L.	Indian Laburnum, Kanikkonna	Flower	Deciduous	Tree
24.	*Dillenia indica* L.	Elephant Apple	Fruit	Evergreen	Tree
25.	*Phyllanthus emblica* L.	Indian Gooseberry	Fruit	Deciduous	Tree
26.	*Limonia acidissima* Houtt.	Wood Apple	Fruit	Deciduous	Tree
27.	*Melia azedarach* L.	Pride of India	Medicinal	Evergreen	Sub Tree
28.	*Putranjiva roxburghii* Wall.	Lucky bean Tree	Medicinal	Evergreen	Tree
29.	*Annona muricate* L.	Prickly custard	Fruit	Evergreen	Tree
30.	*Morus alba* L.	Mulberry	Fruit	Deciduous	Tree
31.	*Eugenia uniflora* L.	Brazil cherry	Fruit	Evergreen	Shrub
32.	*Justicia adhatoda* L.	Adalodakam	Medicinal	Evergreen	Shrub
33.	*Hibiscus rosa – sinensis* L.	China Rose	Flower	Evergreen	Shrub
34.	*Nerium oleander* L.	Oleander, Arali	Medicinal	Evergreen	Shrub
35.	*Lawsonia inermis* L.	Henna, Milanji	Medicinal	Evergreen	Shrub
36.	*Ixora coccinea* Curtis	Chethi	Medicinal	Evergreen	Shrub
37.	*Coleus amboinicus* Lour.	Panikkurkka	Medicinal	Perennial	Herb
38.	*Pogostemon heyneanus* Benth.	Indian Patchouli	Medicinal	Evergreen	Herb

The results showed that, *Annona reticulata* (1.412 - 1.418 m) was the highest growing plant when compared to other tree species followed by *Thespesia populnea* (1.213 - 1.402 m) and *Azadirachta indica* (1.105 - 1.389 m) and the minimum height was recorded in *Annona muricata* (0.191 - 0.225 m) (Fig. 2). Among shrub, *Lawsonia inermis* (0.902 - 1.159 m) showed the highest growth, where as, *Coleus amboinicus* (0.262 - 0.481 m) recorded the highest growth rate (Fig. 3 & 4) among herbs. The highest girth among tree species was observed in *Plumeria* sp. (0.079 - 0.092 cm) followed by *Madhuca* sp (0.062 - 0.071 cm) and *Dalbergia latifolia* (0.039 - 0.073 cm) (Fig. 5). However the lowest girth among tree was observed in *Phyllanthus emblica* (0.009 - 0.011 cm) . In case of shrub, the largest girth was recorded in *Nerium oleander* (0.024 - 0.057 cm) and among herb, *Pogostemon heyneanus* (0.0381 - 0.0551 cm) showed largest girth compared to *Coleus* sp. (0.025 - 0.0412 cm) (Figs. 6 & 7).

Tamarindus indica (16.05 - 36.10) and *Averrhoa bilimbi* (11.02 - 27.11);both are tree species that have recorded the highest number of primary branches among tree (Fig. 8). In case of shrubs, the number of primary branches was higher in *Lawsonia inermis* (28.20 - 52.11), while *Coleus* sp.

(7.20 - 26.31) showed higher number of primary branches compared to *Pogostemon heyneanus* (5.12 - 22.01) among herb (Figs. 9 & 10). The largest number of leaves among trees was recorded in *Tamarindus indicus* (93.41 - 162.11) followed by *Putranjiva roxburghii* (90.22 - 125.12) and lowest in *Butea monosperma* (5.10 - 10.02) (Fig. 11). It is observed that *Lawsonia inermis* (140.21 - 180.17) had higher number leaves in case of shrubs and among herbs, *Coleus* sp. (24.11 - 76.09) recorded the highest number of leaves (Figs. 12 & 13). Urban forest assessments are essential in supporting urban forest management and planning to improve cities' environmental quality and human health (Kim, 2016). Planting dense forests with indigenous plants, which is a core tenet of the Miyawaki approach, is better adapted to building permanent long - standing forests that set up a kind of equilibrium, and these habitats are the best at sequestering carbon for a climate challenge (Singh and Saini, 2016).

The growth rate of naturally growing tree species *Artocarpus heterophyllus*, *Syzygium cumini*, *Phyllanthus* sp., *Morus alba, Ixora* sp. were recorded after one year and were tabulated (Table .2). The growth rate of the plants in the Miyawaki forest was compared to that of naturally growing plant species, and the results showed that the plants in the Miyawaki forest grew faster. When grown under optimum conditions, plant species from fertile, productive habitats have higher relative growth rates than species from less favorable environments (Lambers, 2008). Plant morphology determines the access to soil resources, a feature crucial for early growth in annual species (Alvarez - Flores *et al*., 2014)a feature crucial for early growth in annual species. Plant growth and root traits in little-known species of Andean chenopods were compared with the hypothesis that plants from low-resource habitats show traits that enhance resource capture. Three cultivated Chenopodium populations (two populations of the tetraploid Chenopodium quinoa Willd., one population of the diploid Chenopodium pallidicaule Aellen. Mixed plantations with many species planted densely lead to good growth because of the differences in crown spaces (Miyawaki, 1988). The forest improvement could effectively improve the soil quality, and the effect of the Miyawaki method is the best afforestation method compared to traditional afforestation methods (Guo, 2018). The Miyawaki technique in around 550 areas in Japan and Malaysia, Southeast Asia, Brazil, Chile, and a few zones of China was fruitful, permitting brisk natural rebuilding efforts of firmly corrupted zones (Goveanthan *et al*., 2019).

The Miyawaki method could offer a quicker and more effective reforestation approach, especially in urban areas. These native micro forests also offer many ecological and social service functions, such as disaster prevention and mitigation. Finally, these results could offer a chance to introduce a new method to reduce the time for a complete environmental restoration in a short period. Moreover, it provides conservation of native plant species with their natural habitat and micro forests in urban areas to mitigate climate change.

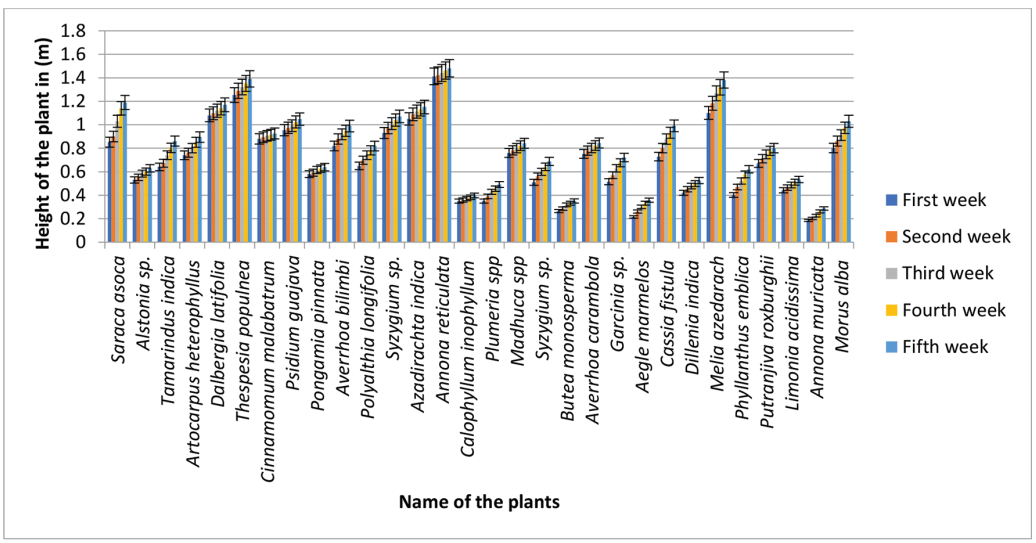

Fig 2. Height of Trees

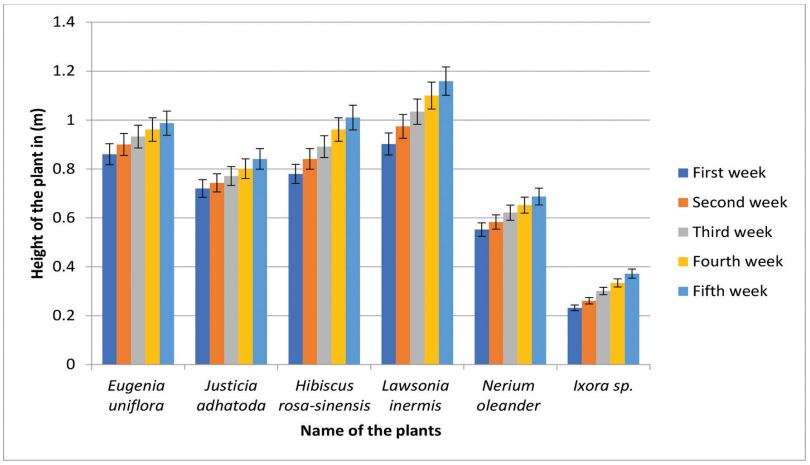

Fig 3. Height of Shrubs

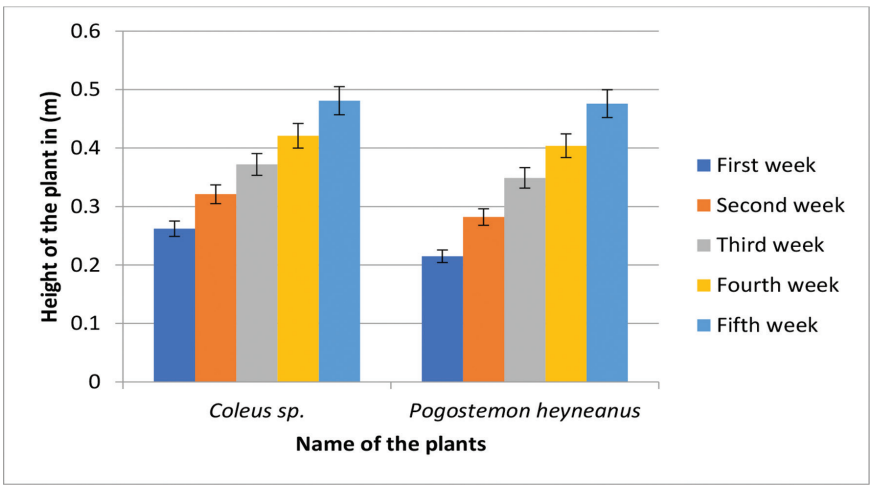

Fig 4. Height of Herbs

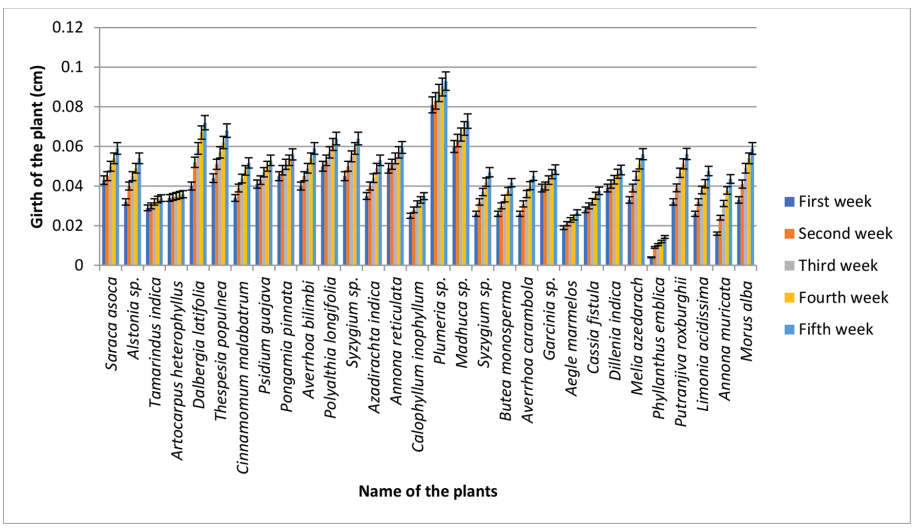

Fig 5. Girth of Trees

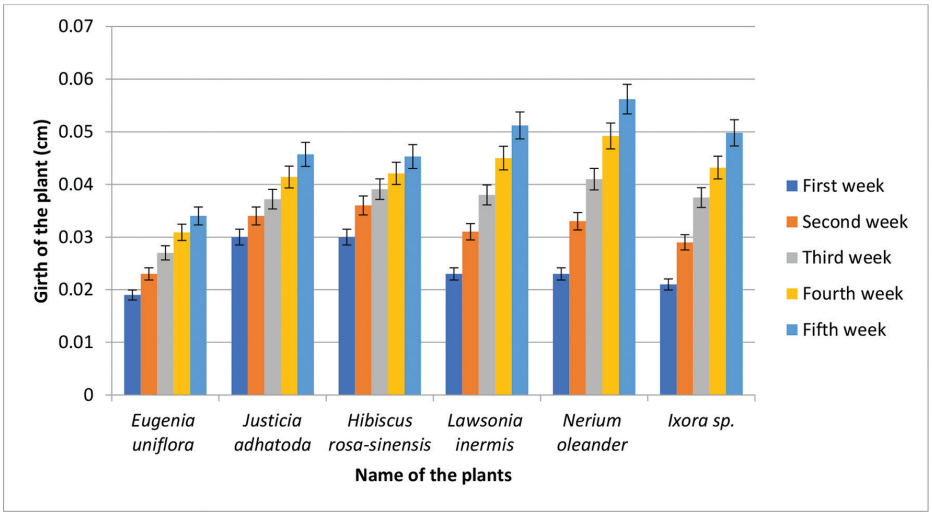

Fig 6. Girth of the Shrubs

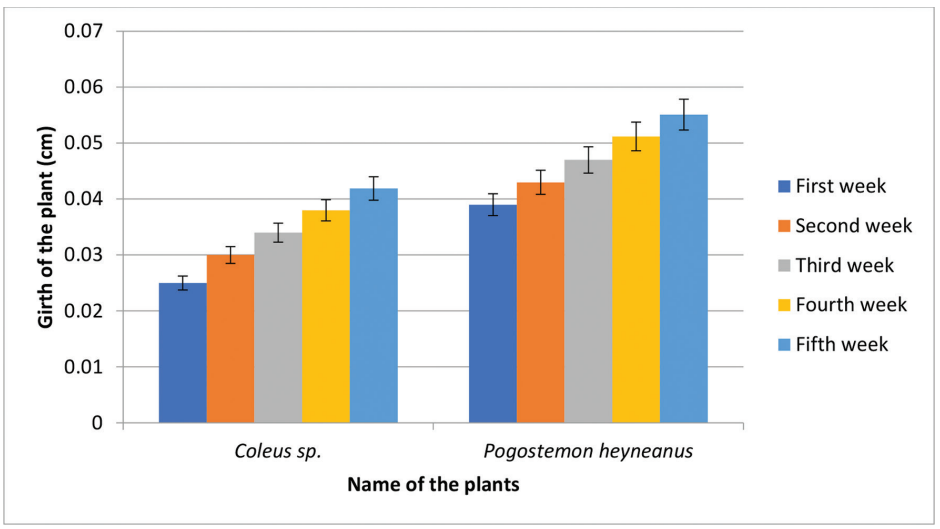

Fig 7. Girth of the herb

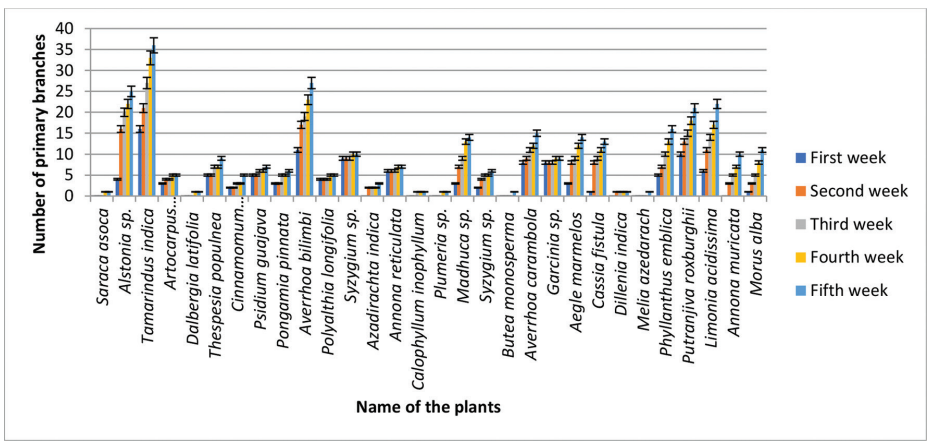

Fig 8. Number of Primary branches in Tree

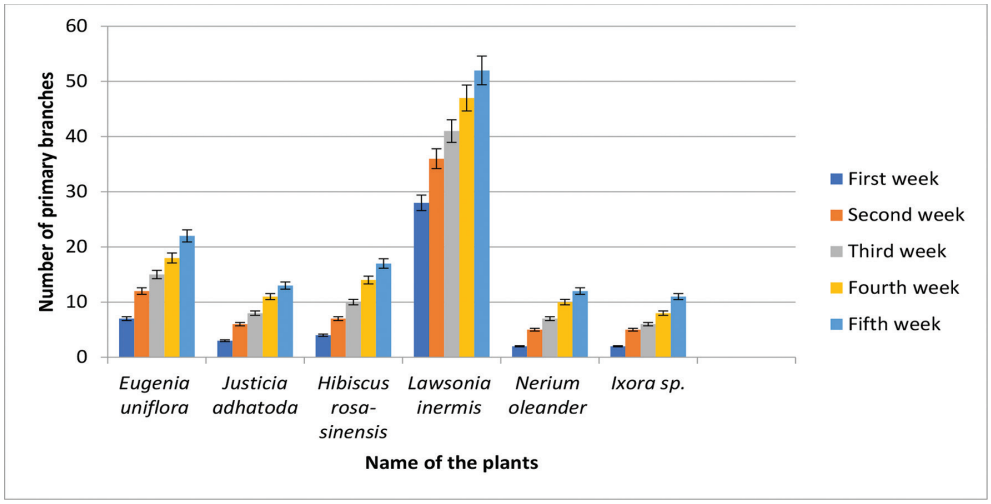

Fig 9. Number of Primary branches in Shrub

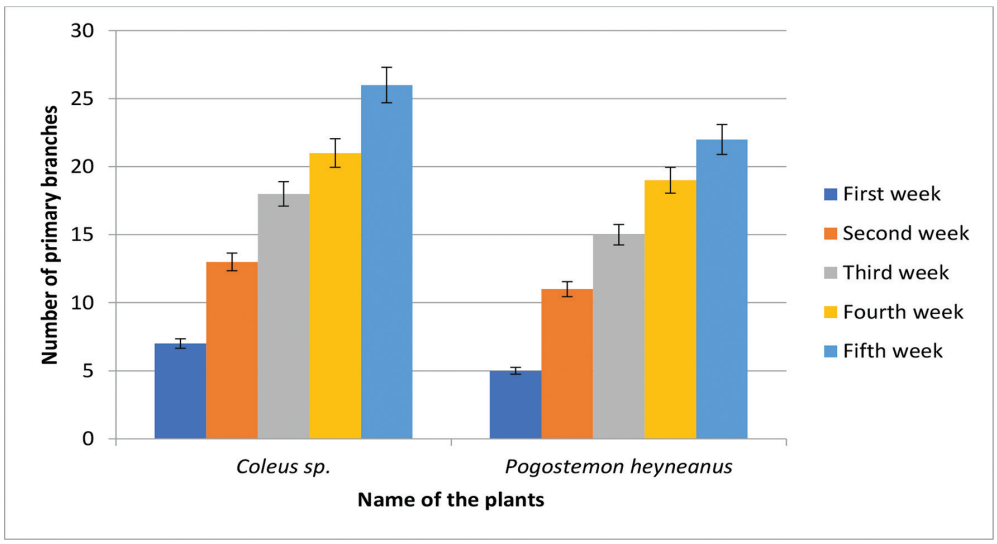

Fig 10. Number of Primary branches in Herb

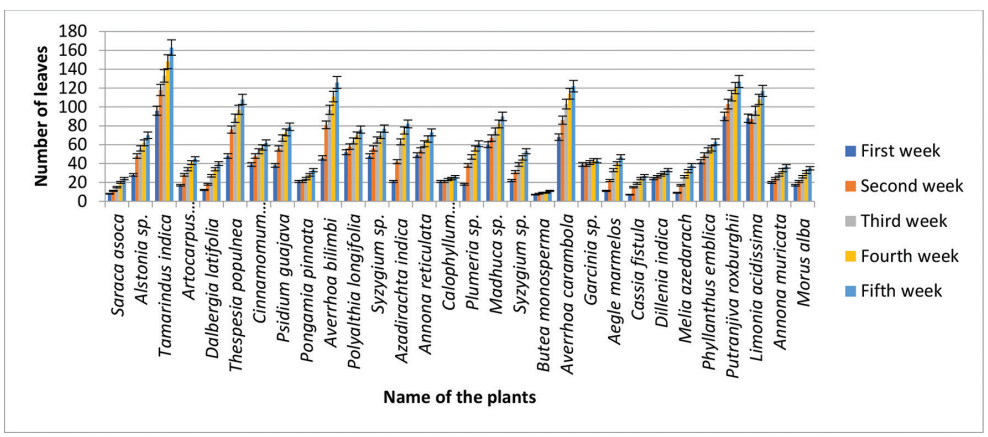

Fig 11. Number of leaves in Tree

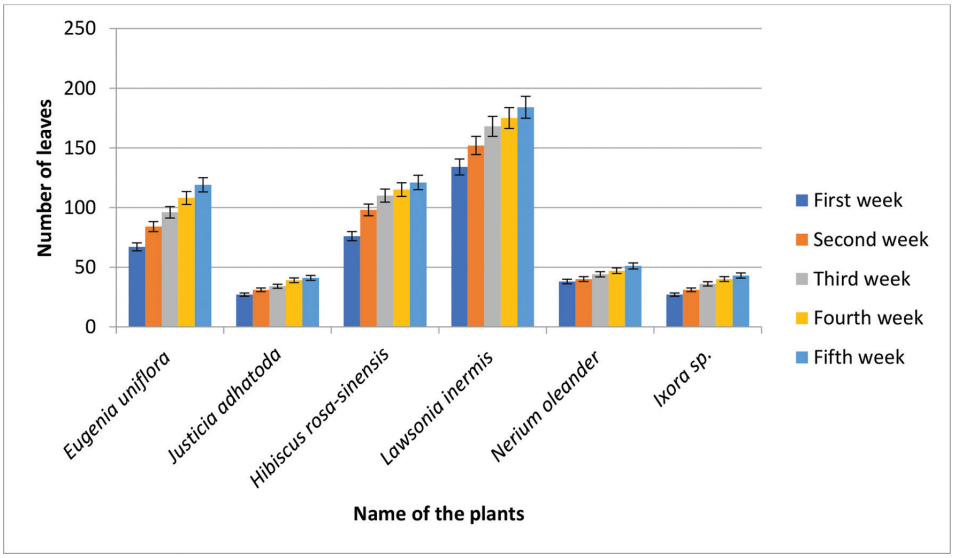

Fig 12. Number of leaves in shrub

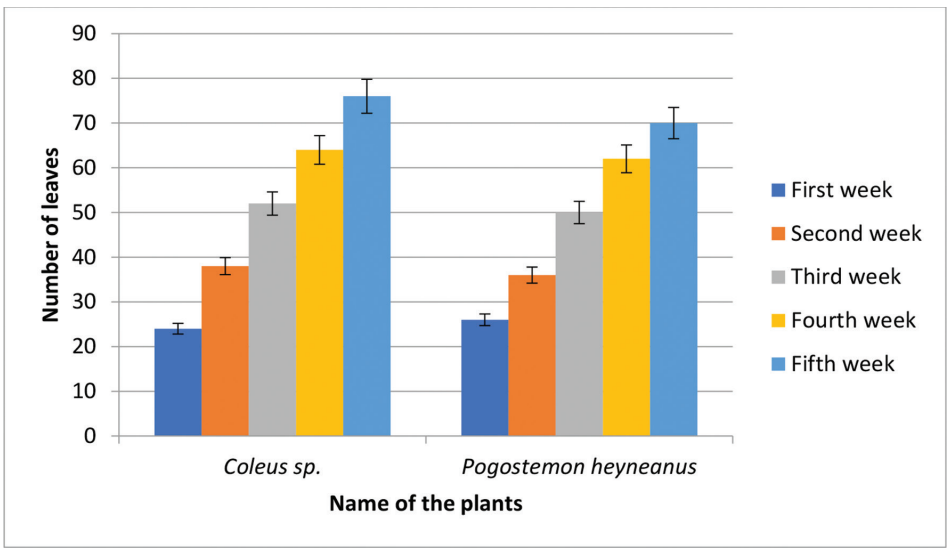

Fig 13. Number of leaves in herb

Table 2
Growth parameters of the control plants after one year

Name of the plant	Height in (m) (mean± SD)	Girth in (m) (mean± SD)	Number of leaves (mean± SD)	Number of primary branches (mean± SD)
Artocarpus heterophyllus	1.9533±.07024	0.12467±0.004509	437.00±10.536	14.67±1.528
Syzygium cumini	1.2100±.07550	0.16333±0.004041	292.33±10.017	17.67±0.577
Phyllanthus sp.	2.2400±.06000	0.15000±0.004000	587.67±9.609	14.67±0.577
Morus alba	3.6400±.02000	0.16600±0.004000	287.33±7.506	13.33±0.577
Ixora coccinea	0.7400±.02000	0.26333±0.015275	343.33±5.508	11.67±0.577

Conclusion

The current study documents plant vegetative maturity in Miyawaki garden at Department of Botany, University of Kerala, Kariavattom. The observed data were analyzed, and the results concluded that the plants *Annona reticulata*, *Thespesia populnea*, *Azadirchta indica*, *Tamarindus indica*, *Lawsonia inermis*, and *Coleus* sp. exhibited their suitability for Miyawaki afforestation even though they exhibited mixed biometric traits. This micro afforestation method offers to address all the issues of soil erosion. Urban areas and tourist areas with high environmental issues induce climate change and air pollution. Micro forest in urban areas is an effective and novel method to mitigate climate change. The study could offer a chance to introduce the advantages of a new afforestation method, which helps reduce the time for a complete environmental restoration in a short period. Moreover, it also offers a model for conserving native plant species within their natural habitat, even in urban areas.

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