Original Research Paper BOTANY

Role of Sacred Groves in Ameliorating Soil Physical Properties and Microclimate: A Case Study of Sree Sankulangara Sacred Grove and Adjacent Disturbed Land at S.N Puram, Thrissur, Kerala

Jincy.T.S Research Scholar in PG Dept of Botany and Research, S.N.College, Nattika, Thrissur, University of Calicut,Kerala, India.

Subin.M.P Assistant Professor in PG Dept of Botany and Research, S.N.College, Nattika, Thrissur, University of Calicut, Kerala, India.

ABSTRACT

The major factor affecting the soil quality and microclimate of an area is based on the vegetation cover in that area. The present investigation deals with a comparative study on vegetation and phytosociology, physical properties of soil and microclimatic parameters between the selected Sankulangara sacred grove and the adjacent disturbed non sacred grove land at S.N Puram in the Coastal Belt of Thrissur District, Kerala. Vegetation and phytosociological analysis of both the selected lands was studied using quadrat method for trees, shrubs, herbs, lianas and climbers and has been compared. The study reveals that with respect to all the plant groups, with the exception of herbs, most of the parameters like floral density (FD), relative density (RD) and relative frequency (RF) and total basal area (TBA) of tree species were considerably higher at Sree Sankulangara sacred grove compared to adjacent disturbed non-sacred grove land. Analysis of various physical properties of soil samples collected during the pre monsoon and post monsoon season reveals a better physical property for the soils of sacred grove region. Values of moisture content, water holding capacity, porosity and electrical conductivity were recorded high in sacred grove region while values of bulk density and pH were recorded low when compared to adjacent disturbed non-sacred grove region. Analysis of temperature and humidity related to soil and atmosphere in the study sites reveals that low temperature and humidity is maintained within the grove region compared to non-sacred grove region. The investigation clearly revealed the role of sacred grove in rejuvenating and maintaining a better soil physical properties and microclimate of the region compared to a disturbed region.

KEYWORDS Sree Sankulangara sacred grove, adjacent disturbed non-sacred grove region, vegetation, soil physical properties, microclimate

Introduction

Sacred groves are forest fragments of varying sizes traditionally been protected on the grounds of spiritual and religious faith and they are a treasure house of rare and endangered species of plants. Sacred groves are also having rich diversity of many plant species which are relevant to the maintenance of ecosystem balance. As an ecosystem, sacred groves help in soil and water conservation, besides preserving the biological wealth. Sacred groves enrich the soil through its rich litter and the nutrients generated by litter decomposition are not only recycled within the sacred grove ecosystem but also find their way into the adjoining agro ecosystems (Ramachandran et al., 1991). The thick litter cover and channels created by soil macro fauna together enhances water retention, root system development, gaseous exchange, and heat conductance. Therefore, being a unique unit in the rural landscape, the sacred grove performs several ecological functions, which can directly or indirectly help in the maintenance of ecosystem health of all interacting landscape units. According to Rajendraprasad (1995), sacred groves with their complex array of interaction, influence the flora and fauna of the region as well as the microclimate of that locality. Gadgil and Vartak (1975) observed that in many parts of India, sacred groves represent surviving examples of climax vegetation but these groves are gradually disappearing under the influence of modernization and this may be mainly due to lack of awareness regarding the importance of sacred groves in maintenance of ecosystem balance, biodiversity conservation and maintenance of microclimatic conditions. There are many general reports on the importance of sacred groves on ecosystem balance and biodiversity conservation however the scientific data based research results on their role in maintaining the physico-chemical and microclimatic aspects of an ecosystem is very less and therefore one of the challenging tasks before the ecologist is to make understand and to make aware the public, concerned organizations and government bodies regarding the important relationship between plant wealth & diversity and the functioning & conservation of ecosystems (Davis and Richardson, 1995). The present work is being proposed in the above contest. The authors believe that a detailed study of relationship between the vegetation, soil properties and microclimate at Sree Sankulangara sacred grove and comparing situation with the adjacent disturbed non-sacred grove region and passing the scientific information gathered from the study will influence the concerned regarding the importance to conserving the existing sacred groves for future ecosystem balance.

Materials and Methods

Study area and season

The study area is Sree Sankulangara sacred grove and adjacent disturbed non-sacred grove land at S.N Puram which belongs to the Coastal Belt of Thrissur District, Kerala. The study area lies at 10.52^{0}N 76.21^{0}E and has an average altitude of 2.83m. The sacred grove covering an area of about 157 cents (0.636 ha) and the same extent of adjacent disturbed non-sacred grove land was selected for comparison. The study was conducted during the pre monsoon (April-May) and post monsoon (August-September) period.

Vegetation and Phytosociological Analysis

Different plant groups such as trees, shrubs, herbs, lianas and climbers of both Sree Sankulangara sacred grove and adjacent disturbed non-sacred grove land were selected and analyzed for various phytosociological studies like floral distribution, floral density (FD), total floral density (TFD) and relative density(RD), after dividing the study area into approximately 4 equal quadrats of 39.25 cents (0.159ha) each while frequency (F) and relative frequency (RF) of different plant groups was analyzed after dividing each study area in to eight equal quadrats of approximately 19.63 cents (0.08ha) each. Total basal area (TBA) and relative basal area (RBA) of tree species and importance value index (IVI) of Tree species and family were analyzed and calculated following the methods of Curtls and Mclntosh (1950), Misra and Purl (1954), Misra (1969), Muller and Ellenberg (1974) and Werger (1974).

Analysis of Soil Physical Properties

Separate soil samples in triplicates from core and transition region of Sree Sankulangara sacred grove and soil samples from disturbed but grove influenced and highly disturbed region of adjacent non-sacred land were collected at a depth of 30cm from the surface, using the core type soil auger to get comparatively less disturbed pedon of soil. The soil samples were then carefully transferred into air tight polythene covers and analyzed for various physical properties like soil moisture, water holding capacity, bulk density, porosity, pH and electrical conductivity. Soil moisture was estimated using the gravimetric method. Three important physical constants of the soil namely water holding capacity, bulk density and porosity were determined by Keen Racksowski box method. pH and electrical conductivity of soil samples were determined by electrometric method using Digital pH Meter and Conductivity Meter respectively.

Analysis of Microclimate

Microclimatic parameters like temperature, humidity etc in the soil and atmosphere of both Sree Sankulangara sacred grove and adjacent disturbed non-sacred grove land were analyzed and compared. Both the parameters were measured by using Thermo-Hygrometer (TA318) during the mid day period.

Results and Discussion

Trees, shrubs, herbs, lianas and climbers of Sree Sankulangara sacred grove and adjacent disturbed non-sacred grove land were the different plant groups considered for the present investigation. The data on floral distribution, density, relative density and total floral density obtained from the vegetation analysis is depicted in table 1 and 2. The highest distribution of plant group in terms of number was recorded with climbers followed by trees, shrubs, herbs and lianas in sacred grove while the highest distribution was recorded with herbs followed by shrubs, trees, climbers and no lianas were recorded in adjacent disturbed land. The data reveals the average total floral density per quadrat at Sree Sankulangara sacred grove is 530 in which the climbers recorded the highest relative density of 45.57% which was followed by trees (20.28%), Shrubs (18.40%), herbs (8.58%) and lianas (7.17%). On comparing this situation with adjacent disturbed land, the average total floral density was 55462 per quadrat which is very high compared to Sree Sankulangara sacred grove; however it can be seen that the highest relative density of plant group is recorded with herbs which constitute around 99.88% of the total floral density and the remaining plant groups together constitute only 0.12%. This clearly reveals significant reduction in the floral density of shrubs, trees, climbers and lianas in the disturbed land compared to Sree Sankulangara sacred grove which were 59.23%, 86.51%, 94.93% and 100% reduction respectively.

Relative frequency (RF) of different plant groups such as trees, shrubs, herbs, lianas and climbers in Sree Sankulangara sacred grove and adjacent disturbed non-sacred grove land was analyzed and the results are depicted in table 3. The results reveal that highest relative frequency was recorded by trees with respect to Sree Sankulangara sacred grove (30.99%) while it was by herbs with respect to disturbed non-sacred grove land (60.94%). The lowest RF value was recorded for lianas (5.63%) in Sree Sankulangara sacred grove and for climbers (5.39%) in disturbed land. Lianas were totally absent in the disturbed land. Even though the values of floral density and relative density of shrubs in disturbed land recorded significantly lower values than that in sacred grove, the relative frequency of shrub was recorded 7.11% higher and it indicates more uniform distribution of shrubs in the disturbed land compared to sacred grove.

Total basal area (TBA) and relative basal area (RBA) of tree species in Sree Sankulangara sacred grove and adjacent disturbed non-sacred grove land was analyzed and compared. The data obtained from the analysis is depicted in table 4 and 5. Highest TBA of 645 m^2 was recorded in Sree Sankulangara sacred grove which is about 97.73% higher than the TBA of 14.61m^2 recorded in disturbed non-sacred grove land. The table 4 shows that there are about 35 different tree species identified and their basal area was recorded in sacred grove. The highest RBA was recorded with *Hopea ponga* (578 m^2**)** which belongs to the family Dipterocarpaceae and constitute around 89.61% of total basal area of trees. However in disturbed land only 18 tree species were identified and the highest RBA was recorded with *Cocos nucifera* (9.05m^2**)** which belongs to the family Arecaceae and constitute around 62% of total basal area of trees.

Importance value index (IVI) of different tree species and family of tree species at both the study sites was analyzed and the data is shown in table 6 and 7. In Sree Sankulangara sacred grove, the tree species representing the highest IVI score was recorded by Hopea ponga (118.3**)** and the highest IVI score for the family was recorded in Dipterocarpaceae with an overall total IVI score of 132.24 and this family comprises of two tree species namely Hopea ponga and Veteria indica. In the case of adjacent disturbed land, the highest IVI score for the tree species was recorded by Cocos nucifera (106.8) and the highest IVI score for the family were recorded in Arecaceae with an overall total IVI score of 164 which comprises of two tree species namely Cocos nucifera and Areca catechu.

The results of the vegetation analysis in the present study showed that with the exception of herbs, the floral density and relative density of different plant groups and tree species diversity and total basal area of tree species are very high in sacred grove compared to adjacent disturbed land. The dominance of herbaceous plants is also an indication of degraded forests. Besides these the analysis of importance value index (IVI) of family of different tree species in Sree Sankulangara sacred grove showed *Hopea ponga and Veteria indica* of Dipterocarpaceae together constitute highest IVI value while in adjacent non-sacred grove land *Cocos nucifera* and *Areca catechu* of Arecaceae constitute highest IVI value. This clearly reveals that the Sree Sankulangara sacred grove is a repository of the original forest vegetation preserved on religious ground whereas adjacent land is an area of high human interference representing highly disturbed and degraded forest vegetation.

Analysis of Soil Physical Properties

Soil samples collected from different regions of Sree Sankulangara sacred grove and adjacent disturbed non-sacred grove land were analyzed for various physical properties and the results obtained are depicted in table 8 and table 9. Soil porosity is the amount of air space or void space present between soil particles of particular soil type which are important for infiltration, groundwater movement and storage space. The data shows the soil porosity is higher in sacred grove regions when compared with the disturbed non- sacred grove regions. The highest porosity value was obtained in soil sample collected from the core region of sacred grove followed by transition region of sacred grove, disturbed inner region of non-sacred grove, and the lowest value was obtained in soil sample collected from disturbed outer region of non-sacred grove. The increase in soil porosity at core region of sacred grove compared to disturbed outer region was about 6.85% and 4.06% respectively during the post monsoon season and pre monsoon season. The study reveals that when comparing the porosity values of different soil samples obtained during different seasons, the porosity values were found to improve in the post monsoon season compared to pre monsoon season and this was 4.45%, 4.55%, 1.25% and 1.66% respectively for core region, transition region, disturbed grove influenced inner region, and disturbed outer region. Higher soil porosity in the sacred grove region may be due to the existence of fine-textured soil which might be the result of higher organic matter content together with reduced soil disturbances and minimum soil compaction and erosion compared to disturbed land (Kêsik et al., 2010).

Bulk density is an indicator of soil compaction and soil health. It affects infiltration, available water capacity, soil porosity, plant nutrient availability, and soil microorganism activity which influence key soil processes and productivity. The values of bulk density of soil samples collected from sacred grove regions are lower when compared to non- sacred grove regions. The data reveals more or less similar trend in the bulk density levels in different soil samples collected during both the pre monsoon and post monsoon season (table 8 and table 9). The highest bulk density value was obtained in soil samples collected from disturbed outer region followed by disturbed inner region, transition region and core region. On comparing the bulk density values obtained in different seasons, comparatively lower values were recorded in the post monsoon season and this may be due to the improvement in organic matter content of the soil which results from increased decomposition rate of dead organic matter especially litter fall due to increased microbial activity.

The average bulk density of soil at core region of sacred grove was 1.38g/cm^3 during the pre monsoon and 1.31g/cm^3 during the post monsoon season while it was 1.48g/cm^3 and 1.43g/cm^3 respectively during above seasons with respect to disturbed outer region of non-sacred grove and this was about 6.76% and 8.39% increase respectively over the core region of sacred grove. Strong relationship between organic matter content and bulk density of soil is reported by many researchers and Curtis and Post (1964) stated a reverse correlation between organic matter and bulk density. The lower bulk density and higher porosity of soil in Sree Sankulangara sacred grove compared to the adjacent disturbed land observed in the present investigation may be attributed to the higher relative density and frequency of trees. This is because as the tree density and frequency in a land increases, it may led to the vigorous growth of the root system in the soil and this has a positive effect on reducing the soil strength and there by improvement in soil aeration. However in disturbed non-sacred grove land, low tree density and frequency leads to adverse effect on root growth resulting in increased soil strength and decreased soil aeration causing increase in bulk density and decrease in soil porosity. This observation in the present study is in par with the observations of Nambiar and Sands (1992) on the effect of tree root development on the compaction of soil. Another important factor that may contribute to the lower bulk density and higher porosity of soil in Sree Sankulangara sacred grove is the frequent addition of leaf litter as organic matter. The decomposition of leaf litter by microbial organisms acts as an agent for improving the stability and quality of the soil by forming soil aggregates and promotes better pore distribution. This is because decomposed organic matter components are less dense than the mineral components and cause improvement in soil porosity and lowering of bulk density (Portella et al., 2012; Enrique et al., 2015). Pravin et al. in 2013 reported that the bulk density of a soil is found to decrease as the total micronutrient and macronutrient content in the soil increases. The lower bulk density value observed with the soils of sacred grove regions compared to non-sacred grove region in the present study may also be attributed to the difference in macro and micro nutrient content of the soil types.

The analysis of soil moisture content shows that the samples collected from Sree Sankulangara sacred grove generally maintained higher soil moisture level compared to that collected from adjacent non-sacred grove land. The highest soil moisture content was recorded in the sample collected from the core region of sacred grove while the lowest moist level was recorded in the sample collected from the disturbed outer region of non-sacred grove during both the pre monsoon as well as the post monsoon season. During the pre monsoon season, the average soil moisture content at core region of sacred grove was 8.80% while it was 3.78% at disturbed outer region of non-sacred grove and this was about 57.05% less moisture content than the core region whereas during the post monsoon season, the average soil moisture content increased to 13.84% at core region while it increased to 6.52% at disturbed outer region and is about 52.89% lower moisture content than the core region. The data presented in the table 8 and table 9 shows a progressive decrease in soil moisture content level in the direction of core region – transition region – disturbed inner region – disturbed outer region and therefore the present investigation clearly reveals that the soil of Sree Sankulangara sacred grove has higher moisture retention capacity compared to disturbed non-sacred grove land. The higher moisture retention capacity of soil in sacred grove may be due to increased organic matter and humus content of the soil which improves water holding capacity as a result of lower bulk density (Johan, 1998). The reduced surface evaporation due to very high litter fall and their deposition over the surface soil together with specific microclimatic conditions of sacred grove due to higher density of different plant groups especially trees may also have contributed towards improved moisture retention capacity.

Water holding capacity (WHC) of the soil is the amount of water held by the capillary spaces of the soil after the percolation of gravitational water into the deeper layers. The data presented in the table 8 and table 9 reveals higher water holding capacity for soil samples collected from sacred grove regions when compared to disturbed non-sacred grove regions, during the pre monsoon as well as the post monsoon season. The highest WHC value was recorded in soil sample collected from core region and then the value gradually decreased in the direction of transition region, disturbed inner region of non-sacred grove and disturbed outer region. The WHC value recorded in the core region of sacred grove during the pre monsoon and post monsoon season was about 17.6% and 18.9% higher respectively over the values recorded in the disturbed outer region of non-sacred grove. The study generally observed that the WHC of all the soil samples collected during the post monsoon season recorded values higher than the values recorded by corresponding soil samples during the pre monsoon season. Higher water holding capacity of soils in the sacred grove regions compared to disturbed non-sacred grove regions may be because of greater floristic composition and distribution. The high rate of litter fall and their decomposition oriented increased organic matter content in the soil can improve the binding of soil particles and aggregation which results in increased pore space and improvement in specific surface area (Vengadaramana and Jashothan, 2012; Volk and Ullery, 1993). The increased pore space and large surface area of soil in sacred grove contributed by the smaller particles like clay and silt together with affinity of organic matter for water allow the soil of sacred grove to hold a larger volume of water and thereby increase water holding capacity. An important observation in this respect made was while analyzing the WHC within the non-sacred grove region, the disturbed but grove influenced inner region of non-sacred grove recorded an improved WHC compared to disturbed outer region and which was 0.95% and 3.28% increase respectively during the pre monsoon and post monsoon season. This may be attributed to the leaching of decomposed organic matter content from the grove region to the immediate adjacent disturbed land.

pH is a good measure of acidity or alkalinity of a soil water suspension and provides good indication of the soil chemical properties (Trivedy and Goel, 1986). The soil pH in sacred grove and adjacent disturbed non-sacred grove land was within the range of medium to strongly acidic however; comparatively lower pH values were recorded in the soil of sacred grove compared to adjacent disturbed land. Comparing the pH values obtained during different seasons, soil samples collected during the post monsoon season recorded pH values comparatively higher than the values recorded during the pre monsoon season. The lowest pH value was recorded in the soil at core region during both the season and the pH value of other soil samples exhibited a gradual increasing trend in the direction of transition region, disturbed but grove influenced inner region and disturbed outer region. The difference in soil pH between Sree Sankulangara sacred grove and adjacent disturbed land may be related to difference in the dynamics of the soil organic matter (Bell and Raczkowski, 2008). Lower pH values of soils in the sacred grove region compared to disturbed region may be due to increased organic matter content of the soils contributed by high leaf litter fall from rich vegetation especially tree group. Organic matter is usually considered to lower soil pH by releasing hydrogen ions that are associated with organic anions or by nitrification in an open system (Porter et al., 1980).

Soil electrical conductivity (EC) is the ability of soil water to carry an electrical current and the EC value of a soil can give a good indication of the amount of nutrients available for the plants to absorb. The results of the electrical conductivity obtained from the analysis shows the soil samples collected from sacred grove recorded higher EC value compared to non-sacred grove regions during both the seasons. The higher EC value of soils in the Sree Sankulangara sacred grove compared to non-sacred grove region may be attributed to the higher release of soluble inorganic ions from the rich soil organic matter, favoured by increased soil porosity and higher moisture content (Granged, 2011). The present study observed a negative correlation between EC value and bulk density in the analysed soil samples while there is a positive correlation between EC value, inorganic matter, porosity and moisture content of analysed soil samples.

Analysis of Microclimate

Soil and atmospheric temperature within the Sree Sankulangara sacred grove and adjacent disturbed non-sacred grove land were analyzed during the pre monsoon as well as post monsoon season and the results are shown in table 10 and table 11. The data reveals that both soils as well as atmospheric temperature recorded in the non-sacred grove regions are higher when compared to the sacred grove regions during both seasons. The increase was more prominent when comparing the temperature recorded in the outer zone of disturbed non-sacred grove region with the core region of sacred grove and this was maximum during the pre monsoon season with an increase of 18.06% with respect to soil and 15.80% with respect to atmospheric temperatures while it was only 15.5% and 13.5% respectively during post monsoon season. The comparison between the temperatures recorded during the pre monsoon and post monsoon season within the grove as well as outside the grove reveals, the increase of temperature from post monsoon season to pre monsoon season was more prominent with respect to disturbed outer region of non-sacred grove which was 10.47% and 11.17% increase respectively for soil temperature and atmospheric temperature while with respect to core region of sacred grove, the increase was only 7.67% and 8.74% respectively for soil temperature and atmospheric temperature. Morecroft et al. (1998) compared the air and soil microclimates of deciduous forest land with an open site at Wytham Woods, Oxford, UK and reported that the effect of forest cover on soil and air temperatures were much considerable and could be lowered under the canopy of forest land than at the open site during the summer. Similarly Johnson et al. (1985) observed that whole-tree harvesting in an oak forest in Virginia resulted in an increase in the temperature of 6-8°C in the July and August, compared to the adjacent uncut land. The present study results are also in same lines with the above observations. The study reveals that the sacred groves are playing important role in regulating the temperature in the area and this may be attributed to the dense canopy of sacred grove especially the tree canopy which act as a protective cover and provide cool climate to the area resulting from the release of large quantity of water vapor through transpiration. Further the ground vegetation cover together with thick layer of litter fall act as insulation to the ground playing the role of regulating the soil temperature.

The results of the analysis of soil and atmospheric humidity are shown in table 10 and table 11. The data indicates the higher values of humidity was recorded in the non-sacred grove regions compared to sacred grove regions during both the season and the maximum difference was obtained between the outer disturbed zone of non-sacred grove and core zone of sacred grove. The increase was about 17.81% and 16.67% respectively for soil and atmospheric humidity during the pre monsoon season while it was 10.94% and 12.12% respectively during the post monsoon season. Similar to the case with temperature parameter, while comparing the humidity values recorded during the pre monsoon and the post monsoon season, within the grove as well as outside the grove reveals, the increase of humidity from post monsoon season to pre monsoon season was more prominent with respect to outer zone of disturbed non-sacred grove region and was 15.79% and 15.38% increase respectively for soil humidity and atmospheric humidity while with respect to core region of sacred grove, the increase was only 9.52% and10.77% respectively. Loss of moisture through evaporation from the surface soil of an open field may be higher as loss of moisture from forest soil of similar character under protection of forest cover (Abdul Sahim, 2003). The blocking of light radiation by canopy cover, lower soil temperature together with the thick cover of leaf litter on the ground and the resultant reduction in evaporation of moisture from the soil surface of sacred grove may be the reason for reduced soil and atmospheric humidity in the grove region compared to adjacent disturbed land.

Conclusion

The present study clearly reveals that the sacred groves are playing a very important role in ameliorating soil physical properties and microclimatic conditions which are very necessary for the biodiversity conservation and ecosystem balance. The overall better soil physical properties and climatic factors in Sree Sankulangara sacred grove compared to the adjacent disturbed land may be due to the rich vegetation, diversity and vigorous root system of trees and other plants in the grove area. Besides these, continuous addition of organic matter content through litter fall and comparatively less external disturbances to plant and soil in the grove land are contributing to the productive capacity of the soil favoring the maintenance of natural regeneration of vegetation, healthy climate factors and ecological patterns. Though ancient people of India established sound socio-cultural practices epitomizing in-situ conservation of biological and genetic diversity of sacred groves considering their importance in ecosystem maintenance, in recent times this has been ignored. People are gradually destroying these natural patches of forests knowingly or unknowingly for various purposes such as agriculture, construction, developmental activities etc. Therefore the situation demands an urgent need for recognizing such traditionally valued natural systems and to gear up strong actions for a combined and holistic approach for conserve such grove tradition.

Table 1: Floral distribution, floral density, relative density (RD) and total floral density of different plant groups in Sree Sankulangara sacred grove

Sl. No	Name of the Plant group	Distribution of plant	Relative density (%)	Floral density per Quadrat	Total floral density per quadrat	
					Including Herbs	Excluding Herbs
1	Trees	430	20.28	107.5	530	485
2	Shrubs	390	18.40	97.5		
3	Herbs	182	8.58	45.5		
4	Lianas	152	7.17	38.0		
5	Climber	966	45.57	241.5		

Table 2: Floral distribution, floral density, relative density (RD) and total floral density of plant groups in disturbed non-sacred grove land adjacent to Sree Sankulangara sacred grove

Sl. No	Name of the Plant group	Floral distribution of plant	Relative density (%)	Floral density per Quadrat	Total floral density per quadrat	
					Including herbs	Excluding herbs

1	Trees	57	0.026	14.5	55462	66
2	Shrubs	159	0.072	39.75		
3	Herbs	221583	99.88	55395.75		
4	Lianas	0	0.0	0.0		
5	Climber	49	0.022	12.25		

Table 3: Relative frequency (RF) of plant groups at Sree Sankulangara sacred grove and disturbed non-sacred grove land adjacent to Sree Sankulangara sacred grove

Sl. No	Name of the Plant group	Total no of quadrats of occurrence of plant groups		Relative frequency plant groups (%)	
		Sacred grove	Non-sacred grove	Sacred grove	Non-sacred grove
1	Trees	154	36	30.99	12.12
2	Shrubs	100	64	20.12	21.55
3	Herbs	70	181	14.08	60.94
4	Lianas	28	0	5.63	0
5	Climber	145	16	29.18	5.39

Table 4: Total basal area (BA) and relative basal area (RBA) of tree species at Sree Sankulangara sacred grove

Sl. No	Name of the Tree species	Family	**Total basal area of the species-m^2/157 cent (0.636 ha)**	Relative basal area of the species (%)
1	*Adenanthera pavonina* L.	Fabaceae	0.4	0.06
2	*Aphanamixis polystachya* (Wall.) R.N.Parker.	Meliaceae	0.69	0.11
3	*Aporosa cardiosperma* (Gaertn.) Merr.	Euphorbiaceae	0.66	0.1
4	*Areca catechu* L.	Arecaceae	0.15	0.02
5	*Artocarpus hirsutus* Lam.	Moraceae	17.2	2.67
6	Carallia branchiata (Lour.)Merr.	Rhizophoraceae	0.79	0.12
7	*Caryota urens* L.	Arecaceae	3.87	0.6
8	*Chrysophyllum cainito* L.	Sapotaceae	0.35	0.05
9	*Cinnamomum malabathrum* (Burm. f.) Blume.	Lauraceae	0.61	0.09
10	*Ficus amplissima* Smith.	Moraceae	6.8	1.05
11	*Ficus bengalensis* L.	Moraceae	0.83	0.13
12	*Ficus drupaceae* Thunb.	Moraceae	0.01	0.002
13	*Ficus religiosa* L.	Moraceae	0.13	0.02
14	*Garcinia gummi-gutta* L.Roxb.	Clusiaceae	0.58	0.09
15	*Holigarna arnottiana* Hook.f	Anacardiaceae	4.5	0.7
16	*Hopea ponga* (Dennst.)Mabberley.	Dipterocarpaceae	578	89.6
17	*Hydnocarpus pentandra* (Buch.Ham.)Oken.	Flacourtiaceae	1.88	0.29
18	*Litsea zeylanica* Nees&T.Nees.	Lauraceae	0.01	0.002
19	*Mimusops elengi* L.	Sapotaceae	0.99	0.15
20	Olea diocia Roxb.	Oleaceae	1.05	0.16
21	*Persea macrantha* (Nees) Kosterm.	Lauraceae	0.02	0.004
22	*Pinanga dicksonii* (Roxb.)Blume.	Arecaceae	0.38	0.06
23	*Pouteria campechiana* (Kunth.) Baehni.	Sapotaceae	0.04	0.01
24	*Quassia indica* (Gaertn.)Noot.	Simaroubaceae	1.64	0.25
25	*Saraca asoca* (Roxb.) de Wilde.	Fabaceae	0.01	0.001
26	*Sterculia guttata* Roxb.	Sterculiaceae	0.96	0.15
27	*Strychnos nux vomica* L.	Loganiaceae	0.67	0.1
28	*Syzygium lanceolatum* (Lam.)Wight&Arn.	Myrtaceae	0.64	0.1
29	*Syzygium hemisphericum* (Wt.) Alston.	Myrtaceae	4.01	0.62
30	*Tabernaemontana alternifolia* L.	Apocynaceae	0.19	0.03
31	*Terminalia bellirica* (Gaertn.)Roxb.	Combretaceae	0.69	0.11
32	*Terminalia catappa* L.	Combretaceae	0.01	0.002
33	*Veteria indica* L.	Dipterocarpaceae	14.0	2.18
34	*Vitex altissima* L.	Verbenaceae	1.99	0.31
35	*Vitex pinnata* L.	Verbenaceae	0.04	0.01
	Grand total		645	100

Table 5: Total basal area (BA) and relative basal area (RBA) of tree species at disturbed non-sacred grove land adjacent to Sree Sankulangara sacred grove

Sl. No	Name of the Tree species	Family	Total basal area of the species-m^2/157 cent (0.636 ha)	Relative basal area of the species (%)
1	*Ailanthus triphysa* (Dennst.)Alston.	Simaroubaceae	0.526	3.6
2	*Anacardium occidentale* L.	Anacardiaceae	0.56	3.84
3	*Annona reticulata* L.	Annonaceae	0.01	0.07
4	*Areca catechu* L.	Arecaceae	2.591	17.7
5	*Artocarpus heterophyllus* Lam.	Moraceae	0.647	4.43
6	*Artocarpus hirsutus* Lam.	Moraceae	0.806	5.52
7	*Briedelia retusa* (L.) A. Juss.	Euphorbiaceae	0.006	0.04
8	*Carallia branchiata* (Lour.) Merr.	Rhizophoraceae	0.02	0.14
9	*Cinnamomum zeylanicum* Blume.	Lauraceae	0.004	0.03
10	*Cocos nucifera* L.	Arecaceae	9.05	62
11	*Garcinia gummi-gutta* L.Roxb.	Guttiferae	0.104	0.71
12	*Hydnocarpus pentandra* (Buch.-Ham.)Oken.	Flacourtiaceae	0.024	0.16
13	*Mangifera indica* L.	Anacardiaceae	0.18	1.23
14	*Swietenia macrophylla* King in Hook.	Meliaceae	0.022	0.15
15	*Tabernaemontana alternifolia* L.	Apocynaceae	0.02	0.14
16	*Tectona grandis* L.f.	Verbenaceae	0.013	0.09
17	*Terminalia catappa* L.	Combretaceae	0.013	0.09
18	*Vitex altissima* L.	Verbenaceae	0.01	0.07
	GRAND TOTAL		14.61	100

 ISSN - 2250-1991 | IF : 5.215 | IC Value : 77.65

Table 6: Importance Value Index (IVI) of tree species and family at Sree Sankulangara sacred grove

Sl.No	Family	Name of Tree species	RF	RD	RBA	IVI of species	IVI of Family
1	Dipterocarpaceae	Hopea ponga	5.19	23.5	89.6	118.3	132.24
		Veteria indica	4.55	7.21	2.18	13.94	
2	Moraceae	Artocarpus hirsutus	5.19	6.98	2.67	14.84	27.14
		Ficus amplissima	3.9	2.56	1.05	7.51	
		Ficus drupaceae	1.95	0.93	0.002	2.88	
		Ficus bengalensis	0.65	0.23	0.13	1.01	
		Ficus religiosa	0.65	0.23	0.02	0.9	
3	Arecaceae	Caryota urens	5.19	7.44	0.6	13.23	22.83
		Pinanga dicksonii	3.9	2.09	0.06	6.05	
		Areca catechu	2.6	0.93	0.02	3.55	
4	Lauraceae	*Cinnamomum malabathrum*	3.9	3.26	0.09	7.25	15.66
		Litsea zeylanica	2.6	1.16	0.002	3.76	
		Persea macrantha	3.25	1.4	0.004	4.65	
5	Simaroubaceae	Quassia indica	5.19	6.28	0.25	11.72	11.72
6	Flacourtiaceae	Hydnocarpus pentandra	5.19	5.58	0.29	11.06	11.06
7	Oleaceae	Olea diocia	4.55	4.42	0.16	9.13	9.13
8	Sapotaceae	*Mimusops elengi*	3.9	2.79	0.15	6.84	9.12
		Chrysophyllum cainito	1.3	0.93	0.05	2.28	
9	Anacardiaceae	Holigarna arnottiana	4.55	3.26	0.7	8.51	8.51
10	Euphorbiaceae	Aporosa cardiosperma	4.55	3.72	0.1	8.37	8.37
11	Meliaceae	Aphanamixis polystachya	4.55	2.79	0.11	7.45	7.45
12	Apocynaceae	*Tabernaemontana alternifolia*	3.9	2.79	0.03	6.72	6.72
13	Verbenaceae	*Vitex altissima*	1.95	1.86	0.31	4.12	5.9
		Vitex pinnata	1.3	0.47	0.01	1.78	
14	Clusiaceae	*Garcinia gummi-gutta*	3.25	2.09	0.09	5.43	5.43
15	Myrtaceae	Syzygium hemisphericum	1.95	0.93	0.62	3.5	5.37
		Syzygium lanceolatum	1.3	0.47	0.1	1.87	
16	Fabaceae	Adenanthera pavonina	1.3	0.7	0.06	2.06	3.83
		Saraca asoca	1.3	0.47	0.001	1.77	
17	Sterculiaceae	*Sterculia guttata*	1.95	0.93	0.15	3.03	3.03
18	Rhizophoraceae	Carallia branchiate	1.95	0.7	0.12	2.77	2.77
19	Combretaceae	Terminalia bellirica	0.65	0.23	0.11	0.99	1.87
		Terminalia catappa	0.65	0.23	0.002	0.88	
20	Loganiaceae	*Strychnos nux vomica*	0.65	0.23	0.1	0.98	0.98
21	Sapotaceae	Pouteria campechiana	0.65	0.23	0.01	0.89	0.89

Table 7: Importance Value Index (IVI) of tree species and family at disturbed non-sacred grove region adjacent to Sree Sankulangara sacred grove

Sl No	Family	Name of Tree species	RF	RD	RBA	IVI	IVI of Family
1	Arecaceae	Cocos nucifera	16.7	28.1	62	106.8	164
		Areca catechu	16.7	22.8	17.7	57.2	
2	Moraceae	Artocarpus heterophyllus	5.56	3.51	4.43	13.5	25.31
		Artocarpus hirsutus	2.78	3.51	5.52	11.81	
3	Anacardiaceae	Anacardium occidentale	5.56	3.51	3.84	12.91	18.67
		Mangifera indica	2.78	1.75	1.23	5.76	
4	Apocynaceae	Tabernaemontana alternifolia	8.33	8.77	0.14	17.24	17.24
5	Simaroubaceae	Ailanthus triphysa	5.56	3.51	3.6	12.67	12.67
6	Flacourtiaceae	Hydnocarpus pentandra	5.56	5.26	0.16	10.98	10.98
7	Clusiaceae	Garcinia gummi-gutta	5.56	3.51	0.71	9.78	9.78
8	Verbenaceae	Tectona grandis	2.78	1.75	0.09	4.62	9.22
		Vitex altissima	2.78	1.75	0.07	4.6	
9	Lauraceae	Cinnamomum zeylanicum	5.56	3.51	0.03	9.1	9.1
10	Meliaceae	Swietenia macrophylla	2.78	1.75	0.15	4.68	4.68
11	Rhizophoraceae	Carallia branchiate	2.78	1.75	0.14	4.67	4.67
12	Combretaceae	Terminalia catappa	2.78	1.75	0.09	4.62	4.62
13	Annonaceae	Annona reticulate	2.78	1.75	0.07	4.6	4.6
14	Euphorbiaceae	Briedelia retusa	2.78	1.75	0.04	4.57	4.57

Table 9: Physical properties of soil samples collected from Sree Sankulangara sacred grove and adjacent disturbed non-sacred grove during the Pre monsoon season

Parameter	Sree Sankulangara sacred grove		Adjacent non-sacred grove	
	Core area	Transition area	Disturbed inner grove influenced	Disturbed
Moisture content (%)	8.8±0.17	7.29±0.11	6.1±0.15	3.78±0.10
Water Holding Capacity (%)	32.9±1.32	31.57±1.14	27.37±0.61	27.11±0.73
Bulk density (g/cm^3)	1.38±0.02	1.4±0.02	1.47±0.02	1.48±0.02
Porosity (%)	45.29±0.69	43.28±0.64	41.59±0.86	41.23±0.65
Electrical Conductivity (dS/m)	0.04±0	0.04±0	0.03±0.01	0.02±0.01
pH	4.6±0.08	4.8±0	5.2±0.08	5.7±0.16

Table 8: Physical properties of soil samples collected from Sree Sankulangara sacred grove and adjacent disturbed non-sacred grove during the Post Monsoon Season

Parameter	Sree Sankulangara sacred grove		Adjacent non-sacred grove	
	Core area	Transition area	Disturbed but grove influenced	Disturbed
Moisture content (%)	13.84±0.1	11.86±0.08	8.47±0.16	6.52±0.15
Water Holding Capacity (%)	38.89±0.94	37.97±0.83	32.61±1.27	31.54±0.78
Bulk density (g/cm^3)	1.31±0.03	1.35±0.03	1.42±0.02	1.43±0.02
Porosity (%)	49.74±0.90	47.83±0.82	42.84±0.53	42.89±0.57
Electrical Conductivity (dS/m)	0.03±0	0.03±0	0.02±0.01	0.02±0
pH	4.7±0	4.9±0.08	5.5±0.08	5.8±0

Table 10: Climatic factors of soil and atmosphere in Sree Sankulangara sacred grove and adjacent disturbed non-sacred grove during the Post monsoon season

Parameter	Sree Sankulangara sacred grove		Adjacent non-sacred grove	
	Core area	Transition area	Disturbed but grove influenced	Disturbed
Soil temperature (°C)	28.9±0.16	29.5±0.24	32.8±0.33	34.2±0.33
Atmospheric temperature(°C)	28.2±0.08	29.1±0.08	31.2±0.16	32.6±0.24
Soil humidity (%)	57±0.08	58±0.16	58.8±0.65	64±0.98
Atmospheric humidity(%)	58±0.16	60±0.24	60.8±0.82	66±1.22

Table 11: Climatic factors of soil and atmosphere in Sree Sankulangara sacred grove and adjacent disturbed non-sacred grove during the Pre monsoon season

Parameter	Sree Sankulangara sacred grove		Adjacent non-sacred grove	
	Core area	Transition area	Disturbed but grove influenced	Disturbed
Soil temperature (°C)	31.3±0.41	32.1±0.57	34.8±0.90	38.2±1.14
Atmospheric temperature(°C)	30.9±0.33	31.7±0.16	33.2±0.33	36.7±0.73
Soil humidity (%)	63±0.16	66±0.49	68±0.82	76±1.31
Atmospheric humidity (%)	65±0.16	66±0.24	69.8±0.90	78±1.55

References

[1] Abdul Sahim Ansari. (2003), "Influence of Forests on Environment." Proceedings of the XII World Forestry Congress, Quebec City, Canada.

[2] Bell, M.C., and Raczkowski, C.W. (2008), "Soil property indices for assessing short-term changes in soil quality." Renewable Agriculture and Food Systems, 23, 70–79.

[3] Curtis, R.O., and Pos, B. W. (1964), "Estimating Bulk Density from Organic Matter Content in Some Vermont Forest soils." Soil Sci. Soc. Am. Proc., 28, 285-286.

[4] Davis, G., and Richardson, D. (1995), "Mediterranean Type Ecosystems: The Function of Biodiversity, Springer, Berlin.

[5] Enrique Arévalo-Gardini, Manuel Canto, Julio Alegre, Oscar Loli, Alberto Julca, and Virupax Baligar. (2015), "Changes in Soil Physical and Chemical Properties in Long Term Improved Natural and Traditional Agroforestry Management Systems of Cacao Genotypes in Peruvian Amazon." PLoS One, 10(7), e0132147.

[6] Gadgil, M., Vartak, V.D. (1975), "Sacred groves of India: a plea for continued conservation." Journal of Bombay Natural History Society, 72, 314-320.

[7] Granged, A.J.P., Zavala, L.M., Jordán, A., and Moreno, G. (2011), "Post-fire evolution of soil properties and vegetation cover in a Mediterranean heath land after experimental burning: A 3-year study." Geoderma, 164, 85–94.

[8] Johan Arvidsson. (1998), "Influence of Soil Texture and Organic Matter Content on Bulk Density, Air Content, Compression Index and Crop Yield in Field and Laboratory Compression Experiments." Soil and Tillage Research, 47, 159-170.

[9] Johnson, J.E., Smith, D.W., and Burger, J.A. (1985), "Effects on the forest floor of whole-tree harvesting in an Appalachian oak forest." Am. Midl. Nat., 114, 51–61.

[10] Kêsik, T., Baewicz-WoŸniak, M., and Wach, D. (2010), "Influence of conservation tillage in onion production on the soil organic matter content and soil aggregate formation." Int. Agrophys., 24, 267-273.

[11] Morecroft, M.D., Taylor, M.E., and Oliver, H.R. (1998), "Air and soil microclimates of deciduous forest land compared to an open site." Agricultural and Forest Meteorology, 90, 41–156.

[12] Nambiar, E.K.S., and Sands, R. (1992), "Effects of compaction and simulated root channels in the subsoil on root development, water uptake and growth of radiata pine." Tree Physiology, 10, 297–306.

[13] Portella, C.M.R., Guimarães, M.F., Feller, C., Fonseca, I.C.B., and Filho, J.T. (2012), "Soil 'aggregation under different management systems." Rev. Bras. Ciência Solo., 36, 1868–1877.

[14] Porter, W. M., Cox, W.1., and Wilson, I. (1980), "Soil acidity- it is a problem in Western Australia." West Aust. J. Agric., 21, 126-33.

[15] Pravin R. Chaudhari, Dodha V. Ahire, Vidya D. Ahire, Manab Chkravarty, and Saroj Maity. (2013), "Soil Bulk Density as related to Soil Texture, Organic Matter Content and available total Nutrients of Coimbatore Soil." International Journal of Scientific and Research publications, 3(2), 1-8.

[16] Saira Chandy, M.D., Subash Chandran, I., Ramachandra, T.V. (2014), "Soil quality– comparative study between sacred and non sacred grove forests." LAKE 2014: Conference on Conservation and Sustainable Management of Wetland Ecosystems in Western Ghats, 13th-15th November 2014.

[17] Vengadaramana, A., and Jashothan, P.T.J. (2012), "Effect of organic fertilizers on the water holding capacity of soil in different terrains of Jaffna peninsula in Sri Lanka." J. Nat. Prod. Plant Resour., 2(4), 500-503.

[18] Volk, V.V., and Ullery, C.H. (1993), Dep. of Soil Sci., Oregon state Univ., Coruallis, 1-50.