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Effect of Leguminous and Non-leguminous Species on Amelioration of Sodic Soil

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Abstract

Effect of leguminous (LGM) and non-leguminous (NLGM) tree species was studied on soil amelioration process and vegetation characteristics. As the standing biomass increases with age, correspondingly the forest floor litter as well as soil properties enrich gradually. LGM species were found superior as compared to N-LGM species biomass and the litter (L, F, H) pool sizes. We have noticed several significant changes in soil properties (physical, chemical and microbial) in 0-30 and 30-60cm soil depth. Soil pH, electrical conductivity (EC), exchangeable sodium percent (ESP), bulk density and total $CaCO_3$ decreased significantly as a result of afforestation. On the other hand, water holding capacity (WHC), porosity and active $CaCO_3$ increased in the corresponding period. Soil organic carbon, total and available nitrogen, available phosphorus and potassium also increased significantly in the planted site in comparison to barren (C-Bsl) sodic land. Addition of large amount of litter and nutritional input on soil surface facilitates to develop and colonize more microbial biomass (MB-C,-N and-P) in the soil. Soil improvement was relatively high under 25-yr- old LGM and even in 15-yr-old LGM species than 25-yr-old N-LGM species. Amongst the tree species, *Prosopis juliflora* (LGM) and *Casuarina equisitifolia* (N-LGM, N-fixer) were found more suitable in soil amelioration.

Keywords: Leguminous tree species, non-leguminous tree species, Soil properties, microbial biomass.

Introduction

In view of higher cost of chemicals used for reclamation of salt affected soils in India [27], few approaches have been done with afforestation on barren sodic lands in Indogangetic alluvial plains [6,7,18,28,37]. Where in different species, growth stages, plant population, basal area, litter fall and fine roots have influenced to modify the site conditions. Afforestation has proved an efficient ecological tool for reclamation of degraded sodic lands as it makes stable changes in soil properties over the years [31, 32, and 36]. However, most of the studies were mainly confined to assess the changes in physicochemical properties of soils and role of litter integrating biomass and basal area was not well studied in soil amelioration process. Microbial activities, which play a key role in nutrient cycling process, have not been examined so far to observe the specific role of rhizosphere developed under particular tree species and their litter quality. As the nature of tree species (symbiotic or non-symbiotic), age of the plantations, status of soil degradation and litter quality play a vital role in amelioration of soils, it would be quite useful to investigate how the different components of ecosystem of various nature tree species influence amelioration process of highly degraded soil on the particular site. Some of the preliminary investigations have revealed that the leguminous tree species are more suitable for afforestation on sodic soils [11, 12, 13and29], but how does the symbiotic association accelerate the reclamation efficiency is yet not clear.

Keeping these points in view, in this study we have examined the effects of age old tree species, (leguminous and non-leguminous) on soil physicochemical and microbial properties. We have tried to investigate the underlying process to some extent by measuring microbial biomass carbon. Since the roots of the tree extend deeply in the soil, changes in soil properties were examined upto 60 cm depth.

Material and Method

The present study was carried out at Banthra Research Station of CSIR-National Botanical Research Institute, Lucknow, where the mean annual rainfall is estimated as 872 mm and about 80% of total precipitation falls during the monsoon season (July- September). Plantations were established on a degraded sodic land. In order to make the sodic soil environment proper for initial root development of tree seedlings, 1 m^3 volume pits were dug out to break the middle order horizon of 30 to 40 cm thick hard pan Kanker layer (mixture of clay, precipitated $CaCO_3$ and Fe granules). The dugout soil material was crushed, mixed thoroughly and up to 70 cm depth the same soil was refilled in same pits. Rest 30 cm surface depth of pits was refilled with an amendment of farm yard manure (FYM), same soil material and sand in 1:1:1 proportion. The one year old seedlings of Leguminous tree species *(Acacia nilotica, Acacia auriculiformis, Prosopis juliflora,and non leguminous tree species Pithecellobium dulce, Albizia procera, Pongamia pinnata,* and *Prosopis juliflora (Casuariana equisetifolia, Eucalyptus tereticornis* and *Terminalia arjuna).* respective tree species were planted at 3m distance plant to plant and row to row during 1980,1985 and 1990 in $40x40^{m2}$ plots in three replications Post planting maintenance was carried out for three years and the gap filling was compensated in next year only. These plantations were monitored for their growth and soil amelioration after of 20 and 30 years in this study.

Litter was collected from $1m^2$ quadrat in three replicates on the ground surface under the plantation of each species. It was estimated in three different fractions as intact litter (L), partially decomposed fermented (F) and fully decomposed humus (H). The diameter of trees was recorded at breast height in the particular plot for computing basal area and biomass using regression equations already established from sample tree data [7]. Each fraction of litter (L, F and H) samples was analyzed for nutrients like N P, K, Ca, Mg and Na separately by standard methods described by Jackson [16]. Nitrogen was distilled from the digested extract of litter fractions following Kjeldahl method. Phosphorus was estimated through tri-acid (perchloric, nitric and sulfuric) digested extract of the litter samples. The same extract was used for the determinations of K, Ca^{+2} and Na by Flame photometer. The Mg was detected from the digested extract through Atomic Absorption Spectrophotomer.

Soil samples were collected from two depths (0-30 and 30-60cm) between the plant rows in three replications from each plot of the specific tree species and control plot (unplanted bare sodic land) which was properly fenced from biotic intervention. A stainless steel core sampler of known volume was used to collect soil samples which were thoroughly mixed to homogenize and kept at 4^0C in refrigerator for microbial biomass analysis.. Chloroform-fumigation and extraction method was followed for the estimation of microbial biomass-C, -N, -P [5, 33]. A second set was dried at 110^0C to constant weight for the determination of physico-chemical properties. Bulk density of the soil was obtained by dividing the weight of oven dry soil extracted from a known volume soil core. Porosity and water holding capacity were determined gravimetrically after completely saturating the soil with water using a circular brass metal box with perforated bottom .Particle size distribution (sand, silt and clay fraction %) was determined following the Bouyoucos Hydrometer method. Soil pH and EC (1: 2 soil and water ratio) were determined using digital pH and electrical conductivity meter. Organic carbon (%) was estimated by wet digestion procedure of Walkley and Black using potassium dichromate and sulfuric acid as oxidizing reagents. Total nitrogen was analyzed by the macro- Kjeldahl digestion of soil samples in sulphuric acid mixture using a Pelican N digestion & distillation system. Available N was extracted in $KMnO_4$ solution and titrated with N/10 H_2SO_4 using mixed indicator. Phosphorus was extracted in normal Na_2HCO_3 solution and after developing a blue color its optical density was measured on 'Shimadzu' double beam UV spectrophotometer. Exchangeable K was extracted in normal ammonium acetate solution and determined by Flame photometer comparing with known standards of potassium. Fractions of total and active (soluble) of $CaCO_3$ (%) were estimated [26]. The collected data were statistically analysed.

Results and Discussion

Basal area and biomass:

Basal area and standing biomass varied significantly amongst the species corresponding to age, nature of species and population density. Basal area ranged from 4.4 m^2 ha^{-1} (*Pithecellobium dulce*) to 36.12 m^2 ha^{-1} (*Acacia auriculiformis*) and standing biomass was lowest for 23.7 Mg ha^{-1} in *C. equisitifolia* and as high as of 301.33 Mg ha^{-1} for *A. auriculiformis* (Table 1).

Forest floor litter:

Residual litter on forest floor was classified in L, F, H layers according to decay stages. The fresh litter (L) was significantly higher under *P. juliflora* and *A. auriculiformis* plantations in comparison to other species at same age. It was nearly three times higher under *P. juliflora* from *Acacia* species at 20 years age; however such differences in F and H layers were narrow (Table 2). In most of the cases amount of F and H was higher than L layer, which indicates partial decomposition of annual litter fall. Thus the residual litter was significantly different across the species corresponding to their standing biomass as well as litter decomposition rates.

Nutrient concentration in litter fractions:

Nitrogen, phosphorus, calcium, magnesium and sodium concentrations were found in decreasing order from intact litter (L) to fermented (F) and humus (H) fractions of both leguminous (LGM) and non-leguminous (NLGM) tree species, whereas concentration of potassium increased considerably (Table 3). Most of the nutrient concentrations (N, K, Ca and Mg) in litter fractions were significantly higher in LGM species, especially in *P. juliflora*, *Albizia procera* and *P. dulce*, in comparison to that of NLGM trees. However, phosphorus concentration was higher in litter and humus fractions of NLGM tree species as compared to LGM trees.

Soil physicochemical and microbial properties:

Soil physical properties varied significantly across the tree species and soil depth (Table 4). The clay dominated sodic soils of this region when planted with various tree species, reduced the clay content in the soil, as consequence proportions of sand and silt increased under planted_soils (Table 4). This effect was more pronounced in the soils of LGM in comparison to NLGM tree species due to their relatively good growth and productivity. Many fold reductions in soil pH, electrical conductivity (EC), bulk density (BD) and exchangeable sodium percent (ESP) were noticed under planted species in comparison to barren (unplanted) sodic soil (Table 5). These values were significantly lower in surface soil (0-30 cm) in comparison to sub soil (30-60 cm). Soil porosity, water holding capacity (WHC) and active $CaCO_3$ increased significantly after afforestation on barren sodic land; however total $CaCO_3$ was not significantly different. The data LGM and N-LGM species were pooled in two separate groups to assess the impact of each group individually on soil amelioration. No doubt the reduction in soil sodicity (pH, EC, BD, and ESP) was high under LGM tree species against N-LGM species, but nitrogen fixer N-LGM species (*C. equistifolia*) cannot be undermined in soil reclamation (Table 5). The contribution of LGM and N-LGM is differentiated to about 30 and 26%, respectively to alleviate the soil sodicity problem. The improvement in porosity and WHC was greatest in LGM species followed by N-LGM over the control (C-Bsl); however porosity was almost similar in lower depth. The total and active $CaCO_3$ showed reciprocal trend to each other with respect to LGM, N-LGM and C-Bsl soils, as active $CaCO_3$ increases with site improvement and total $CaCO_3$ decreases correspondingly.

Tree species have exerted the significant effect on fertility parameters viz. soil organic C, total N, available N and P, C: N, and available K (Table 5). The highest (0.6%) organic carbon content was found in the soils of P. juliflora and A. auriculiformis (30-yr-old) and lowest (0.35%) under A. nilotica stand (20-yr-old). Likewise the total-N ranged from 327 to 756 mg kg-1 in surface (0-30cm) soils under different tree species. Available-N and P were also highest in soils planted with P. juliflora. Concentration of organic C, N, P, and K were significantly higher in the soils of LGM tree species than that of N-LGM . Organic C and total N showed about 5 to 6 times increase under LGM plantations, whereas, it was 4 to 5 times in N-LGM plantations from the control site. Thus both the group enhanced the carbon sequestration in the planted soil. C/N ratio was high under unplanted soils and reduced in planted soils, however, a very low C/N ratio does not favor the microbial activity and around 10-12 C/N ratio as found under LGM, most likely favored for efficient microbial activity.

Table 1 Basal area and biomass of different tree species planted on sodic land

Tree plantation	Age (years)	Basal area (m^2 ha^{-1})	Biomass (Mg ha^{-1})
Prosopis juliflora	30	22.85	215.67
Acacia auriculiformis	30	36.12	301.33
Pithecellobium dulce	30	4.40	40.73
Albizia procera	30	34.97	118.67
Pongamia pinnata	30	23.46	62.50
Eucalyptus tereticornis	30	16.37	48.90
Terminalia arjuna	30	20.01	95.00
Casuariana equisetifolia	25	8.72	23.70
Prosopis juliflora	20	9.16	29.90
Acacia nilotica	20	22.9	55.20
LSD 0.05			

Table 2 Litter (Mg ha^{-1}) on plantation floor in different state of decay

Tree species	Litter types (Mg ha^{-1})			Total
	Litter (L)	Fermented (F)	Humus (H)	
P. juliflora	34.00	83.39	74.13	191.52
A. auriculiformis	38.77	70.93	90.04	199.75
P. dulce	28.96	37.89	49.07	115.92
A. procera	29.55	46.65	46.80	123.00
P. pinnata	27.04	30.51	42.21	99.76
E. tereticornis	32.99	41.44	32.61	107.04
T. arjuna	29.15	34.99	40.61	104.75
C. equisetifolia	29.55	46.65	57.47	133.67
P. juliflora	30.29	40.56	73.07	143.92
A. nilotica	9.80	43.90	63.00	116.8

LSD 0.05 for species 1.17, LSD 0.05 for 2.45

Table 3 Nutrient concentration in different litter fractions of leguminous and non-leguminous tree species

Nutrients	Tree types	Litter types			
		Litter	Fermented	Humus	LSD
N	LGM	2.24 ± 0.006	2.02 ± 0.006	1.64 ± 0.007	0.0127
	NLGM	1.67 ± 0.012	1.50 ± 0.008	1.437 ± 0.010	0.018
P	LGM	0.102 ± 0.001	0.085 ± 0.001	0.076 ± 0.001	0.0136
	NLGM	0.107 ± 0.002	0.087 ± 0.002	0.093 ± 0.001	0.014
K	LGM	0.66 ± 0.011	0.71 ± 0.010	1.04 ± 0.009	0.018
	NLGM	0.32 ± 0.015	0.358 ± 0.006	0.77 ± 0.020	0.0346
Ca	LGM	1.26 ± 0.010	1.03 ± 0.016	0.93 ± 0.020	0.027
	NLGM	0.83 ± 0.011	0.99 ± 0.023	0.68 ± 0.014	0.032
Mg	LGM	0.524 ± 0.009	0.526 ± 0.008	0.426 ± 0.008	0.015
	NLGM	0.253 ± 0.012	0.34 ± 0.010	0.423 ± 0.012	0.021
Na	LGM	0.226 ± 0.006	0.191 ± 0.010	0.164 ± 0.007	0.014
	NLGM	0.293 ± 0.006	0.243 ± 0.006	0.24 ± 0.007	0.011

Table 4 Soil physicochemical properties under different tree species at two depths

Tree plantation	Sand	Silt	Clay	BD (g cm-3)	Porosity	WHC
P. juliflora	27.69	29.51	42.80	1.51	45.5	50.6
A. auriculiformis	23.85	32.45	43.70	1.49	42.3	49.7
P. dulce	21.10	26.75	51.15	1.60	42.2	43.4
A. procera	23.80	28.25	47.95	1.65	44.3	44.3
P. pinnata	23.65	29.62	46.72	1.59	42.0	44.2
E. tereticornis	23.55	29.62	46.72	1.60	43.0	43.2
T. arjuna	22.14	28.30	49.55	1.63	43.0	43.7
C. equisetifolia	26.55	30.25	43.20	1.58	44.3	45.5
P. juliflora	22.96	32.25	44.78	1.56	43.2	43.2
A. nilotica	21.75	26.95	51.30	1.60	40.0	43.1
Control (unplanted) Sodic land	15.87	27.85	56.28	1.67	38.5	33.5
LSD 01	0.503	0.550	0.515	0.01	0.48	0.86

T-CaCO3 = Total CaCO3; A-CaCO3 = Active CaCO3. EC = electrical conductivity, BD = bulk density, ESP = exchangeable sodium percent, WHC = water holding capacity.

Table 5 Nutr ient status and microbial biomass of soil under different tree species at two depths

Tree plantation	Depth (cm)	Soil nutrients and microbial biomass										
		pH	EC (µS cm^{-1})	OC (%)	TN (mg kg^{-1})	AN (mg kg^{-1})	AP (mg kg^{-1})	C:N (ratio)	AK (mg kg^{-1})	T-$CaCO_3$ (%)	A-$CaCO_3$ (%)	ESP
P. juliflora	0-30	7.4	202.5	0.60	756.0	64.9	31.4	12.8	326.7	5.40	0.60	9.85
	30-60	8.1	256.7	0.19	500.3	38.2	17.7	7.84	191.7	6.30	0.40	16.50
A. auriculiformis	0-30	7.6	162.5	0.61	634.7	58.9	26.4	10.2	200.0	5.40	0.50	10.20
	30-60	8.7	232.5	0.14	422.8	24.6	17.2	5.02	133.3	6.40	0.30	18.20
P. dulce	0-30	9.3	773.3	0.52	504.0	45.2	19.7	10.4	562.5	5.20	0.40	20.15
	30-60	10.1	1205.8	0.15	213.2	15.2	10.9	6.41	345.8	6.50	0.20	33.95
A. procera	0-30	9.3	694.2	0.45	352.0	36.4	19.8	12.2	500.0	6.00	0.40	18.00
	30-60	9.9	1117.5	0.11	173.8	13.9	12.6	5.89	408.3	7.00	0.20	32.15
P. pinnata	0-30	9.0	409.2	0.46	476.0	39.3	25.1	9.34	233.3	5.40	0.30	19.00
	30-60	10.7	845.0	0.11	234.3	19.2	18.5	4.72	175.0	6.60	0.20	34.50
E. tereticornis	0-30	9.1	485.0	0.41	475.0	41.1	16.2	9.15	250.0	5.80	0.30	17.30
	30-60	10.2	890.0	0.08	296.0	22.4	14.4	3.39	183.3	6.90	0.20	32.75
T. arjuna	0-30	9.0	468.3	0.38	428.0	41.2	19.1	8.56	270.8	5.70	0.40	20.20
	30-60	9.6	805.0	0.10	203.3	16.9	20.6	4.81	225.0	6.90	0.20	32.90
C. equisetifolia	0-30	8.7	303.3	0.48	534.7	49.7	22.4	10.07	208.3	6.00	0.40	15.70
	30-60	9.6	774.2	0.12	284.0	25.5	14.9	5.06	175.0	7.50	0.30	27.05
P. juliflora	0-30	9.0	426.7	0.48	506.0	37.4	18.0	10.52	200.0	5.50	0.50	17.90
	30-60	10.5	1003.3	0.13	281.0	19.7	11.5	5.01	150.0	6.60	0.30	32.90
A. nilotica	0-30	9.3	758.3	0.43	326.7	41.4	16.6	13.73	520.8	6.50	0.40	9.85
	30-60	10.2	1194.2	0.14	146.8	17.5	11.2	6.56	337.5	7.30	0.20	16.50
C-Bsl	0-30	9.95	770.0	0.15	67.50	21.0	11.12	17.6	157.5	6.70	0.14	50.35
	30-60	11.1	1235.0	0.04	23.00	7.50	6.32	15.7	80.0	7.95	0.11	71.30
LSD_{01} for depth		0.18	12.35	0.064	6.82	3.67	0.98	44.66	0.55	0.06	0.023	0.906
LSD_{01} for species		0.071	4.85	0.025	23.35	2.67	1.44	0.49	17.52	N.S.	0.05	0.50

Soil microbial biomass showed significant variations with respect to tree species. Microbial biomass carbon (MB-C) was highest in the soils of A. auriculiformis and lowest under exotic Eucalyptus tereticornis plantations . The highest values of MB-N and MB-P were under plantations of two different tree species viz. Pongamia pinnata and P. juliflora respectively. Alike to the increased availability of soil nutrients through plantations, soil microbial biomass was higher under LGM groups as compared from N-LGM species.

From the above findings it was observed change in soil properties after plantation may be directly collated with the biomass and litter pool size, where in P.

juliflora amended the soil to maximum degree; but the slow incorporation of humus into the soil resulted less effect at lower depth due to narrow population and diversity of microorganisms in sodic soils. Soil and vegetation interactions are known as complimentary and supplementary to each other and both positive and negative impacts are correlated in directly proportional relations between soil and plant biomass. A. auriculiformis, P. juliflora and Albizia procera in leguminous group and T. arjuna and Casuariana equisitifolia (N-fixer) among non-leguminous tree species grew fast over the other species as evidenced by their basal area and biomass pool size [18]. Besides, A. auriculiformis and P. juliflora had a relatively large amount of forest floor litter in the different state of decay process. It appears that litter decomposition was relatively slow under A. auriculiformis, accumulating maximum litter on forest floor particularly in F and H layers. This is probably due to the waxy phyllode leaf structure, which may not be much attractive to the microorganisms feeding, leading to a relatively slow decomposition process. Soil particles (sand, silt and clay) not only contribute in the formation of soil structure but also help to retain water and air among the particle spaces. This provides a habitat for soil microorganisms playing a great role in nutrient dynamics. Most of the changes such as oxidation and reduction, mobilization and immobilization of desired nutrients and absorption and adsorptions are directly governed with sand, silt and clay compositions in soil texture. Improvement in soil texture due to down ward movement of fine clay particles helps to develop the ground flora on planted soil, because of interspaces between the soil particles filled with fine humus particles support to grow the herbaceous species easily under plantations. Thus, plantation creates an amiable atmosphere for new growth of flora and fauna. Litter decomposition and large network of fine roots of trees generate mild organic acids during decay process which also helps to dissolve the semi weathered soil layers and insoluble calcite. The gravitational force pushes down the fine clay particles to down ward with percolating water (through capillaries) [14]. In next phases silt particles also follow the clay route because of widening of radius of down ward pores and capillaries. This is called as bioremediation of salt affected soils, where soil amelioration is directly proportional to vegetation development [1, 9, and 24]. Reduction in soil pH, EC, bulk density, and ESP to various degrees from the unplanted barren sodic soil indicates a good recovery in soil properties as a result of plantations. Similarly increase in porosity and water holding capacity made a good soil structure. Soil amelioration (pH, EC, BD and ESP) was relatively high at surface layer (0-30 cm) due to increased concentration of organic carbon and continuous humification of litter and fine roots mostly concentrated in surface horizons [19, 30].Decomposition of organic debris and respiration of fine roots generate CO_2 which reacts with water to form carbonic acid and other mild organic acids (humic, fulvic) during humification of litter, which induce changes in chemical properties favorably. Effect of species and age (3-9 years) in sodic soil amelioration was earlier studied [10, 21, 22 and 23] in which aggregate changes by different species were relatively less to that of our study as their plantations were quite young. Leguminous tree species contributed more effectively in soil amelioration process possibly due to N fixation in rhizosphere. The elevated levels of Ca^{++} and Mg^{++} through the decomposition of litter of leguminous tree species especially of *Albizia procera*, *Pithecellobium dulce* and *Prosopis juliflora* played a significant role in reducing sodium toxicity by replacing monovalent Na^{+} from soil clay surface and adsorption of Ca^{++} and Mg^{++} at the exchange site. Earlier studies have confirmed that leguminous tree species (*P. juliflora*) improved soil structure and nutrient availability more efficiently as compared to non-leguminous (*Eucalyptus tereticornis*) tree species within ten years[24].Improvement in porosity and water holding capacity may also be related to enhancement of naturally increasing clay surface area and formation of micro channels among the clay particles due to addition of spherically micro size humus particles and decaying fine roots in soil underneath plantation. Since Ca^{++} and Mg^{++} are more hygroscopic because of their divalent nature than Na^{+} therefore a high adsorption of Ca^{++} and Mg^{++} on clay surface of soil may be additional possible reason for increasing the WHC of soil under leguminous tree plantation. Continuous addition of humus, humic and fulvic acids in the capillaries have reduced soil dispersion and aggregation of clay particles and enhanced downward leaching of sodium salts . The mild organic acids released during decomposition processes also act to solubilize Ca^{2+} from the precipitated calcite (total $CaCO_3$) to increase the active $CaCO_3$ [35].

Manifold increase of organic matter and nutrients under the plantations has enriched the soil fertility of the once sodic soil depending on species biomass production at different ages [3, 10, 15, 22 and 35]. Leguminous trees have reclaimed the sodic soil more efficiently due to relatively high organic carbon and nutrient input through litter. Several studies have reported the enhanced concentration of available phosphorus and potassium in sodic soils managed under plantations with various leguminous tree species as compared to non-leguminous species [2, 22]. Both Ca: Na and Mg: Na ratios were found significantly higher in litter fractions (L F H) of leguminous tree especially in *P. juliflora* and *A. auriculiformis*. Our sodic soil is rich with precipitated calcite ($CaCO_3$ granules) which is solublized through development of leguminous tree species. Relatively large requirement of Ca^{++} and Mg^{++} cations in comparison to Na^{+} in plant metabolic activities constitutes a high proportion of Ca^{++} and Mg^{++} in plant parts as also in litter component. As a consequence, Ca: Na ratio was higher than Mg: Na ratio in litter fractions (L F H) of both leguminous and non-leguminous tree species, which indicates a large amount of Ca^{++} uptake and recycling by the trees. *Prosopis juliflora* was most effective leguminous tree to rehabilitate the sodic soil because of its several merits like shallow root system, good coppice ability, N fixer, abundant litter mulching and fast litter decomposition rate [4, 17, 21 and 23]. In non-leguminous tree species *C. equisitifolia* played a prominent role in soil amelioration because of its nitrogen fixing ability through frankial association in comparison to other non-leguminous tree species like *E. tereticornis* and *T. arjuna,*.

Plantations on degraded land had a strong impact on the recovery of soil biota measured as microbial biomass carbon and nitrogen component [8], Chauvat et al., 2007). An increased level of biologically available substrates (organic matter) has lead to simultaneous increase in microbial activity and microbial biomass in sodic soils through vegetation development. Microbial biomass responds more quickly to the changes induced by vegetation in soil ecosystem than the organic carbon content. With the growth and development of trees an increased inputs of organic materials in the soil reduced the soil sodicity and modifications in microreleaf have increased microbial biomass size in the once sodic soil**.** Microbial biomass increased rapidly during initial stages of tree growth on sodic soils and gradually stabilized with tree aging. Increase in soil microbial biomass due to afforestation on degraded lands showed that soil ecosystem becoming more stable with vegetation age [34]. Generally it is considered that microbial biomass remained high during initial stage of plantation establishment and gets a stable stage in later years [20]. Soil microbial biomass is considered a temporally integrated measure of labile carbon in the rhizosphere and amount of root derived carbon therefore it was higher under plantations [25]. Leguminous tree species showed a greater recovery in microbial biomass C, N and P when compared to non-leguminous tree species from the unplanted soils sites. Tree species exert different effects on microbial biomass levels possibly due to variation in the levels of root exudate, sloughed cells and other debris from fine roots and litters to soil or due to differences in organic matter composition. As such the almost inert soil of the unplanted site becomes biologically active and nutritionally rich through carbon sequestration and establishment of nutrient cycling on the planted site.

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