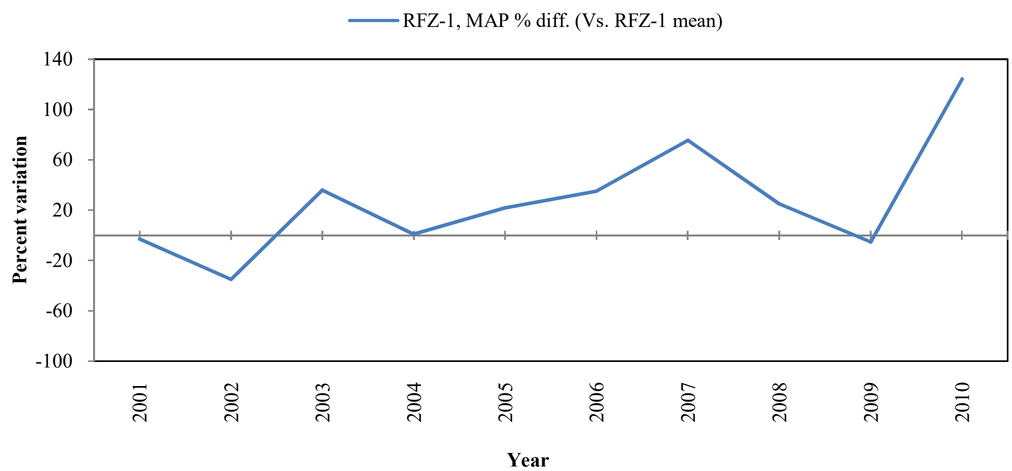
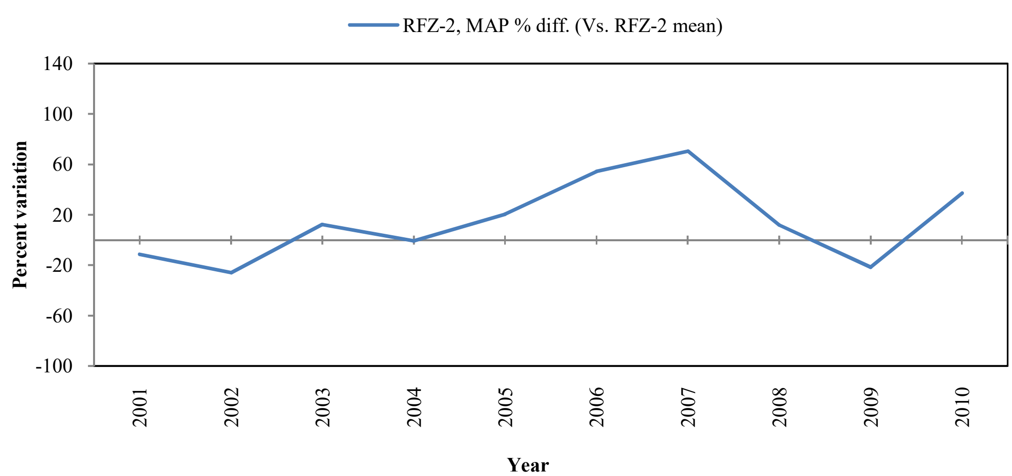
3.1. Variability in rainfall zones (RFZs)

Forests in Gujarat are unevenly distributed and its total area has experienced many alterations during the past few decades. In 1985, Forest department had estimated 9.86% of land cover as forest area, which depleted up to 9.63% in 1995. After constant management activities, forest area increased up to 9.73% in 2005. Currently the state bears 9.76% (in 2011) of land cover classified as forest area. These figures are collected from Gujarat Forest Statistics report, 2010-2011. Forest area, falling under each RFZ, was found to be significantly different. RFZ–1 showed minimum forest area, while RFZ–4 showed maximum forest area across the study area. According to Gujarat Forest Statistics (2010–2011 Report), forest area (proportionate to geographical area) of RFZ–1 and 2 is 7.5 and 7.9 %; RFZ–3 and 4 is 10.6 and 34.3 % respectively. Some of the districts falling under RFZs–1, and 2 showed very less forest cover. Districts like Ahmedabad, Anand, Bhavnagar, Jamnagar, Rajkot, and Surendranagar showed <3 % forest cover proportionate to their respective geographical area. Junaghad district from RFZ–2 showed 19.33 % forest cover. Few of the districts (Panchmahals, Sabarkantha, Surat, Navsari, Dahod) at RFZs–3, and 4 showed about 10–20% of forest cover proportionate to respective district's geographical area. Valsad, Narmada, and Dangs districts showed the highest (>30 %) forest area. RFZ–1, 2 are dominated by dried plains and barren scrub lands with lesser agricultural activities compared to RFZs–3, 4. RFZ–3, 4 were found to be having moist soil and healthy agricultural activities. It was observed that, nearly 40% of the studied plots were coming from areas managed by the state forest department. These activities include plantation, measures to prevent forest fire, allowing tribals to harvest forest produce judiciously. Plots are similarly influenced by human activities among all RFZs. RFZs–1, and 2 showed lesser coverage of water canals and dams and the natural vegetation here is highly dependent on rainfall compared to RFZs–3, 4. It was observed that RFZs 1–4 are significantly different ($P<0.05$) in receiving MAP (table 3). MAP at RFZ–1 was found to be 3 folds lesser than that of RFZ–4. During the past decade, RFZs have experienced great fluctuation in annual rainfall (Fig. 16) from its long term MAP (50 year mean). RFZ–1 showed maximum magnitude (-35 to 124 %) in MAP variation received each following year during past decade. RFZ–2 (-25 to 70 %), and RFZ–3 (-33 to 63 %) were moderate in MAP changes over years. RFZ–4 showed least magnitude of MAP change (-27 to 36 %).





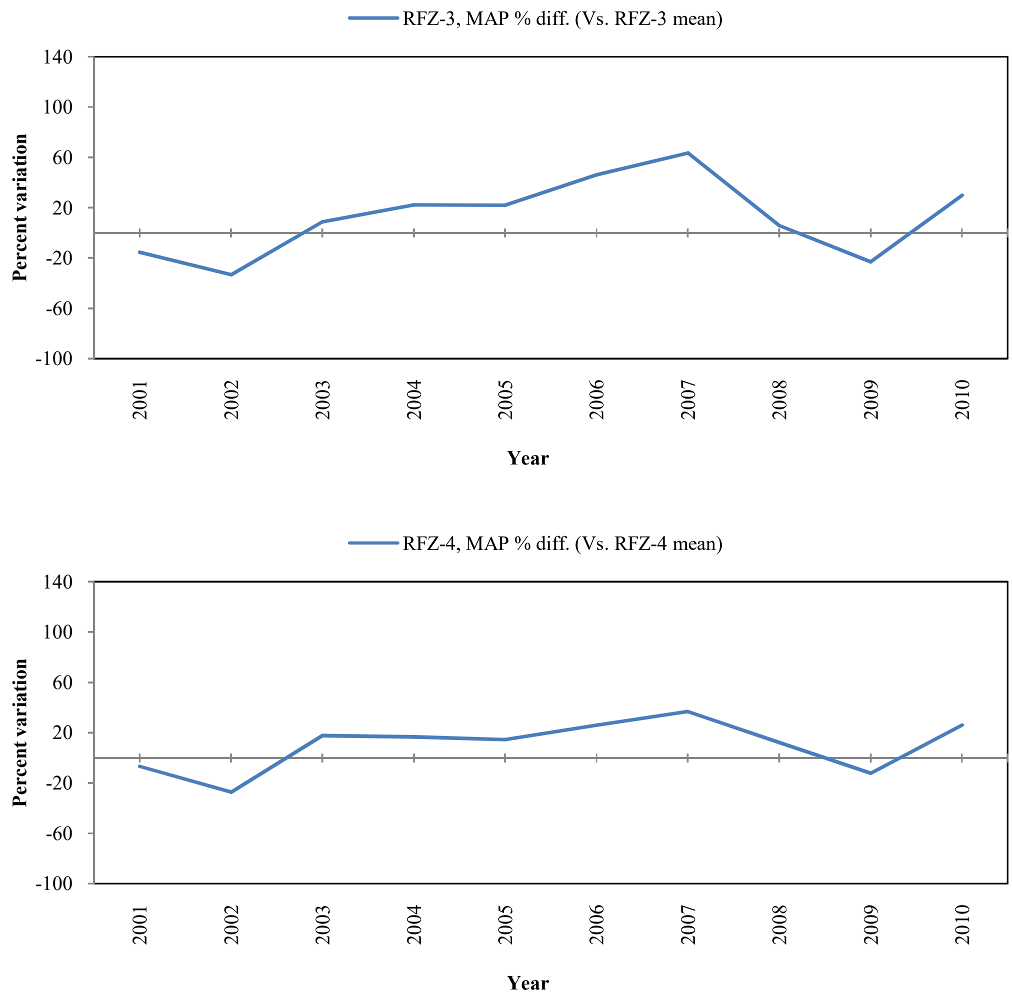


Figure 16: Percentage variation in annual rainfall received by each RFZ from MAP (50 year mean) during past decade across RFZs 1–4.

3.2. Forest plots

Field survey was done throughout the year except during heavy rainy days and harsh summer weeks. Perhaps, owing to phenological stage, shorter life cycle of plant species, and leaf fall season during the study period, some of the plots did not showed herbaceous vegetation, and some trees were leafless because of seasonal change. All the plots were visited once for data collection. Few of them were revisited to cross-check tree enumeration. Herb cover, observed on the ground was dependent on the timing of sampling as it completed lifecycle (<6 months) across the RFZs. At some plots, herb cover was seen as dried stems with dispersed fruits. Some of the species were identified on basis of their vernacular names. Scrublands across RFZ–1 were found to be devoid of herbaceous cover. Few sites have showed thin layer of herbs dominated by grasses like *Apluda mutica*, *Dectyloctemium aegypticum*. Common herbs across RFZ–2 were *Apluda mutica*, *Dectyloctemium aegypticum*, *Triumfetta* spp., *Cassia auriculiformis*, *Coculus* spp. RFZs 3 and 4 were found to be rich in herbaceous layer and showed good diversity. Common herbs found here were *Cassia tora*, *Commelina* spp., *Corchorus* spp., *Tephrocia purpuria*, *Hygrophilla* spp., *Heterophragma contoites*, *Triumfetta* spp. By keeping the dominance and economic values in aspect, *Prosopis juliflora* and bamboo were considered as tree cover across the study area.

In this study, 5,324 trees (>3 cm DBH) were sampled, belonging to 75 tree species of 34 families (Table A1). List of the observed tree species along with their family name has been given in table A3. A total of 662, 897, 1458, and 2307 trees (>3 cm DBH) were enumerated in RFZ – 1 to 4 respectively. All the trees falling at one of the four quadrats from each of the studied plots (n=95) have been marked with metal tags for future studies. Amongst the 75 tree species, 20 species were common to all plots. Maximum species richness was found at, RFZ–4 (48 species, 29 families), while minimum diversity was found in RFZ–1 (8 species, 5 families). RFZ–2 and 3 showed 36 and 38 species diversity respectively, belongs to 21 and 24 families respectively. Recorded density of trees was also maximum at RFZ–4 (270 trees ha^{-1}) followed by RFZ–3 (218 trees ha^{-1}), RFZ–2 (135 trees ha^{-1}) and minimum in RFZ–1 (122 trees ha^{-1}) (Table 4).

Table 4: Mean values of density (trees ha^{-1}), diversity (tree species ha^{-1}) of trees, and total number of trees enumerated across the four rainfall zones (RFZs).

RFZ	Species diversity	Family diversity	Tree density	Total trees enumerated
1	8	5	122	662
2	36	21	135	897
3	38	24	218	1458
4	48	29	270	2307

Plots across all the four RFZs were found to be having same range of NDVI values (0.05–0.65). However, it was observed that NDVI values did not truly represent vegetation status on the ground. It was observed that high greenness (higher NDVI) across all the RFZs were having differed vegetation composition, as well as different density and diversity. Same tree density observed at lower and higher NDVI value plots, where difference was the herbaceous cover. At RFZ 1 and 2, herbaceous cover played a major role in having higher NDVI values. *Prosopis* was the most common species followed by *Acacia spp* and *Diospyros* across RFZ–1 and 2. *Prosopis* was found to be very common in RFZ–1 with 60% plots showing its dominance, while only 30% of plots in RFZ–2 showed dominance of *Prosopis.* With increase in MAP, RFZ–3 and 4 showed more diverse vegetation with *Tectona* and *Butea* as dominating species followed by *Acacia spp*, *Wrightia, Diospyros, Holarrhaena, Terminalia, and Lagerstroemia*. From a functional perspective, RFZ–1 and 2 had trees that were generally short and thorny with small leaves (showing xeric features), while RFZ–3 and 4 had trees that were taller and bearing well spread canopy and larger leaves (showing mesophytic features).

DBH values ranged from 3.18 cm to 113.97 cm across the study area. RFZ–1 showed lowest mean DBH (6.36 cm) ranging between 3.63 and 16.31 cm. Mean DBH values were the highest (14.84 cm) in RFZ–4 ranging between 3.18 to 113.97 cm. 8% of the total recorded trees (across the four RFZs) fell in the DBH range of 3–4.2 cm (Table A2). Percentage of young trees (DBH, 3–4.2 cm) was in the range of 5–10% across RFZs 1–4. It was almost the same (~9%) for RFZ–1 and 4. Trees with higher DBH class (12.9–19.1 cm) are relatively higher in RFZ–3 and 4 (Table A2). Height of the trees was recorded in a range of 2.1 to 25.2 m across the study area. Average stand height of RFZ–4 is about two fold higher than RFZ–1 (fig. 17). Mean stand height across the plots at RFZs 1–4 was 4.1, 5.7, 6.7, and 8.6 m respectively (fig. 17).

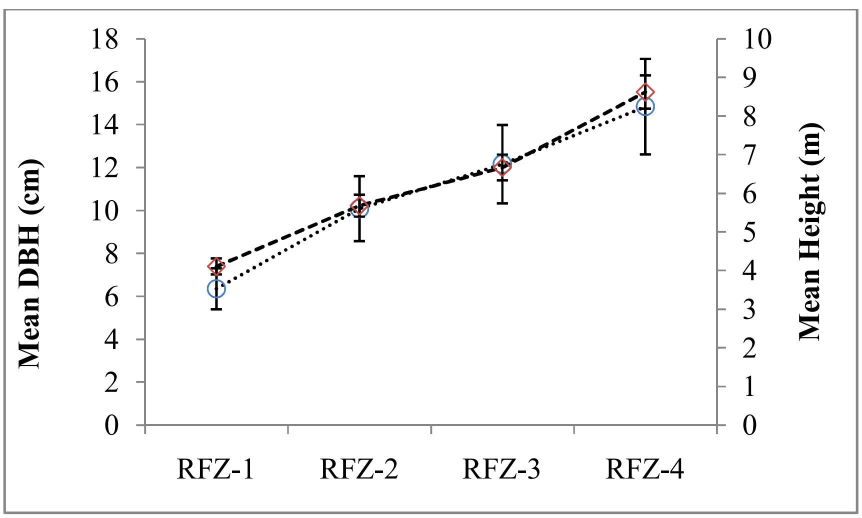


Figure 17: Mean diameter at breast height (DBH, cm) and mean stand height (m) of trees across RFZs 1–4.

3.3. Above-ground Biomass (AGB)

Mean dry weight of herbs across RFZs 1–4 was found to be in a range of 17.2 – 80.7 g in 1 m^2 quadrats. Average dry weight values for shrubs was ranged between 90.9 – 630.1 g in 5 m^2 quadrat. Herbs, shrubs and trees (saplings) of <3 cm DBH accounted for <5% of the total AGB calculated across the plots, and were hence excluded from AGB values. Results showed AGB values of quadrats across RFZs 1–4. AGB values were largely influenced by tree density, biophysical parameters, annual rainfall. For each quadrat, tree DBH, height, and species-specific volumetric equations were used to calculate the volume of individual trees. Foliage dry mass estimates were not included in these published volumetric equations. Thus, to bring consistency and accuracy in calculations, foliage dry mass was omitted in AGB calculation. The obtained volume further multiplied by region-specific and species-specific tree wood density (TWD, g cm^{-3}, provided by Indian Institute of Remote Sensing, IIRS, Dehradun, India) to obtain AGB of each individual tree. TWD values were found to be in a range of 0.18–1.28 g cm^{-3} across the study area. Mean TWD values across RFZ 1–4 were 0.77, 0.72, 0.70, 0.66 g cm^{-3} respectively. Results showed mean AGB values of quadrats laid were significantly different across four RFZs, and were increased with an increase in the MAP (Fig. 18).

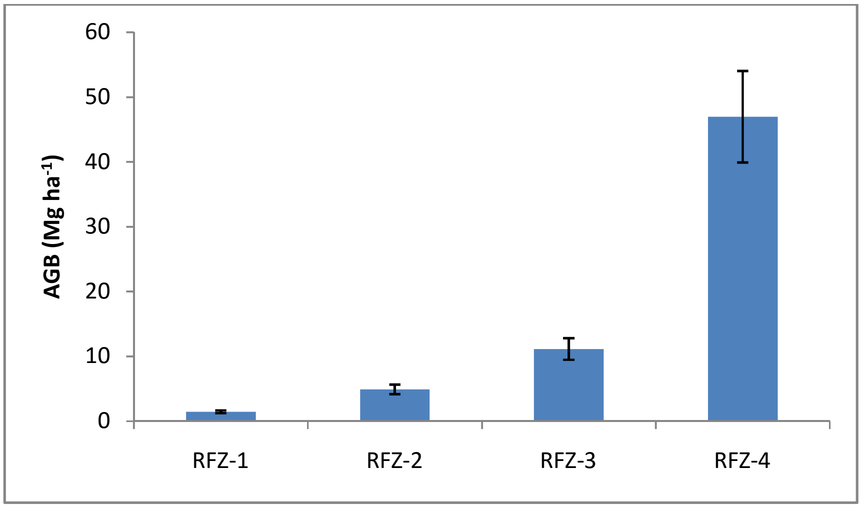


Figure 18: Mean above-ground biomass (AGB, Mg ha^{-1}) for all the rainfall zones (RFZ).

AGB values were ranged between 0.61–2.72, 0.09–14.41, 0.70–66.73, 4.18–168.28 Mg ha^{-1} for RFZs 1–4 respectively (Figure 18). Lower rainfall zone (RFZ–1) showed lowest AGB (1.57±0.8 Mg ha^{-1}) amongst all RFZs. Mean AGB values across RFZ–2 and 3 were 4.90±5.42 and 11.13±18.83 Mg ha^{-1} respectively. Forest plots coming from higher rainfall of RFZ–4 showed maximum AGB (47.63±39.77 Mg ha^{-1}) across all the RFZs of the study area. Apart from the influence of biophysical parameters and MAP on AGB, vegetation composition was significantly influencing the mean AGB values. Influence of higher diversity across RFZs–3 and 4 reflected on AGB values of these zones. Plots with 6 – 10 species showed mean AGB value of 20.5±4.3 Mg ha^{-1} and plots with 17–37 tree species diversity showed 36.9±4.6 Mg ha^{-1}. Plots of RFZ–1 were mostly dominated by *Prosopis*. Native species could not establish well in these plots. AGB of these plots largely came from *Prosopis*. AGB values of plots dominated by *Prosopis* were nearly 7 times lower than the plots not dominated by *Prosopis* (<10%), for similar density values in RFZ–2. In this zone, mean AGB value of *Prosopis* dominated plots was 0.72 Mg ha^{-1} while for plots with lesser density of *Prosopis* it was 5.46 Mg ha^{-1}. To check the significance of NDVI values on AGB estimates, AGB values of the plots with similar NDVI values pooled together across all the RFZs. Significant variability in AGB values have been seen for different NDVI values across four RFZs (table 5). It was found that higher NDVI values showed more AGB across all the RFZs except RFZ–3 plots (table 5). Same NDVI value plots showed higher AGB values as rainfall increases which is seen as increasing AGB values from RFZ–1 to 4. Mean AGB values for plot NDVI values of 0.1, 0.2, 0.3, 0.4, and 0.5 were found to be 19.72, 18.42, 17.16, 29.08, and 23.70 Mg ha^{-1} respectively.

Table 5: Mean AGB **(Mg ha^{-1})** values for the plots with different NDVI values across the four RFZs.

NDVI	**AGB (Mg ha^{-1})**			
	RFZ-1	**RFZ-2**	**RFZ-3**	**RFZ-4**
0.1	0.84	5.14	24.55	37.70
0.2	1.76	4.92	47.06	18.70
0.3	1.27	0.96	1.34	45.82
0.4	1.79	2.54	7.93	79.39
0.5	2.04	8.56	6.91	64.99

3.4. Soil Analysis

All the results obtained from the study are presented in Tables and Figures. The values presented in Tables and Figures are all mean values (n=3–16). ANOVA was performed for some of the experiments. The results are described under separate headings.

3.4.1. Physical Parameters

Mean soil pH values at depth up to 25 cm in soil for four RFZs were shown in Figure 19. Soils at the study area are slightly acidic to neutral with pH ranged from 5.51–7.44 across the RFZs. Soils of RFZs 2, 3, and 4 were slightly acidic while RFZ–1 was found to be almost neutral. Mean values of pH for RFZs 1–4 were 7.01, 6.55, 6.33, and 6.38 respectively (Figure 19). Soil particles composition (sand, silt, and clay) showed variability across RFZs 1–4 for the soil depth up to 25 cm (Figure 20). Inter zonal variability for clay proportion was not significant across RFZs. Soil texture was differing with wider dominance of sand fraction varying from 40.9–59.7 % across RFZs. Maximum sand percentage found at RFZ–2 and least at RFZ–4. Silt and clay percentage varied from 26.2–43.2 and 14.1–16.7 % respectively across RFZs. Mean fraction of silt and clay was maximum at RFZ–4. Water logging was observed at some of the plots at RFZ–4. Soil bulk density of RFZs was calculated by using sand, silt and clay fractions. Bulk density values ranged between 1.13–1.80 (mean 1.42) g cm^{-3} across RFZs 1–4.

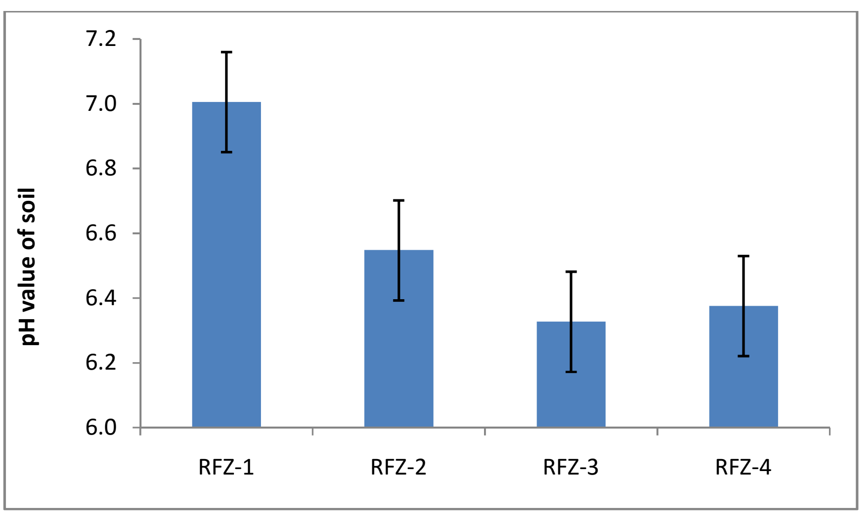


Figure 19: Mean pH values of soil for each rainfall zone (RFZ).

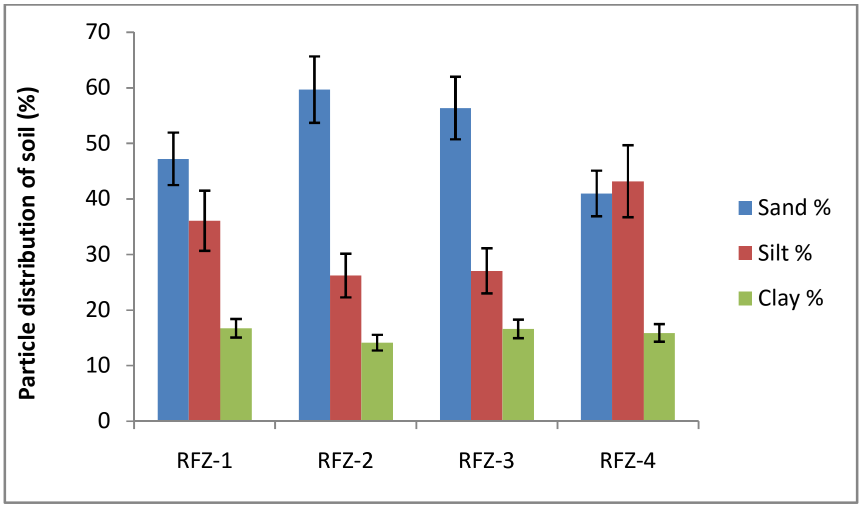


Figure 20: Soil particle fractions (particle size distribution) for each rainfall zone (RFZ).

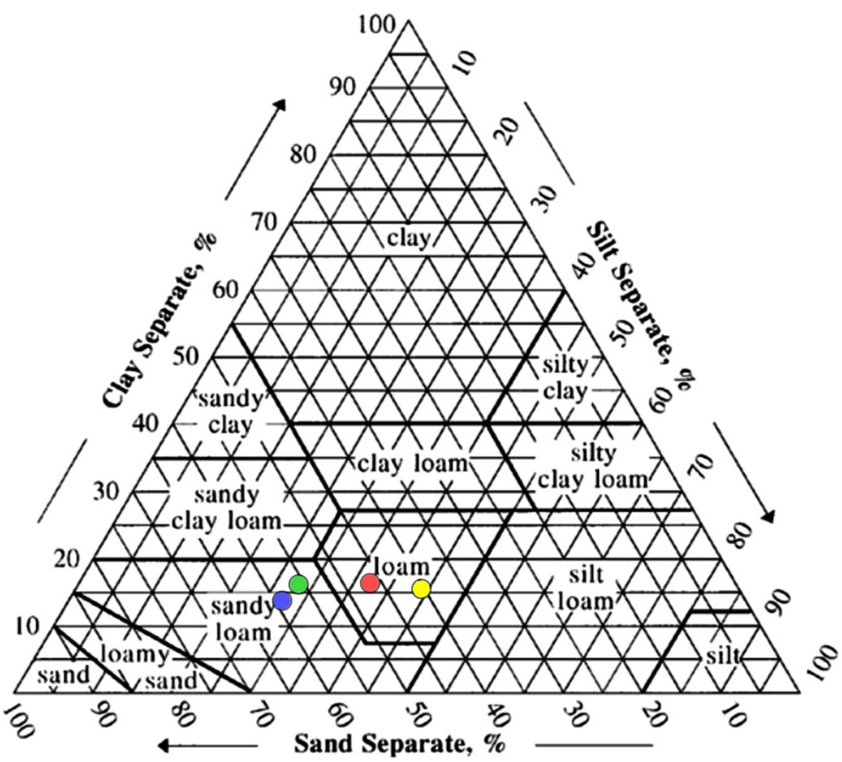


Figure 21: Soil particle size distribution (mean values) across the RFZ – 1 to 4 (red, blue, green, and yellow points respectively). (Source of calculation: http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/survey/?cid=nrcs142p2_054167)

3.4.2. Chemical Parameters

Soil organic carbon (SOC, Mg ha^{-1}) values coming from the four RFZs showed significant differences across different depths (top 0–5, 5–10, 10–15, 15–20, and 20–25 cm) in soil and between four RFZs (Figure 22). The magnitude of the variation was found to be different at each zone. Across the zones, SOC values showed a typical vertical distribution, with higher values in the top layer as compared to the one beneath. Lowest SOC values found at bottom soil layer and maximum SOC content at top soil layer in all RFZs (figure 22). SOC values ranged from 9.15–25.68 and 3.12–9.59 Mg ha^{-1} for 0–5 cm and 20–25 cm depths respectively. Figure 22 shows highest SOC found at both depths across RFZ–4 and lowest across RFZ–1. SOC values of top soil showed increasing pattern with increase in rainfall from RFZ–1 to 4. This variability in SOC was much higher in top soil across RFZs. Soil from bottom depth showed lesser magnitude in increase from RFZ 1–4.

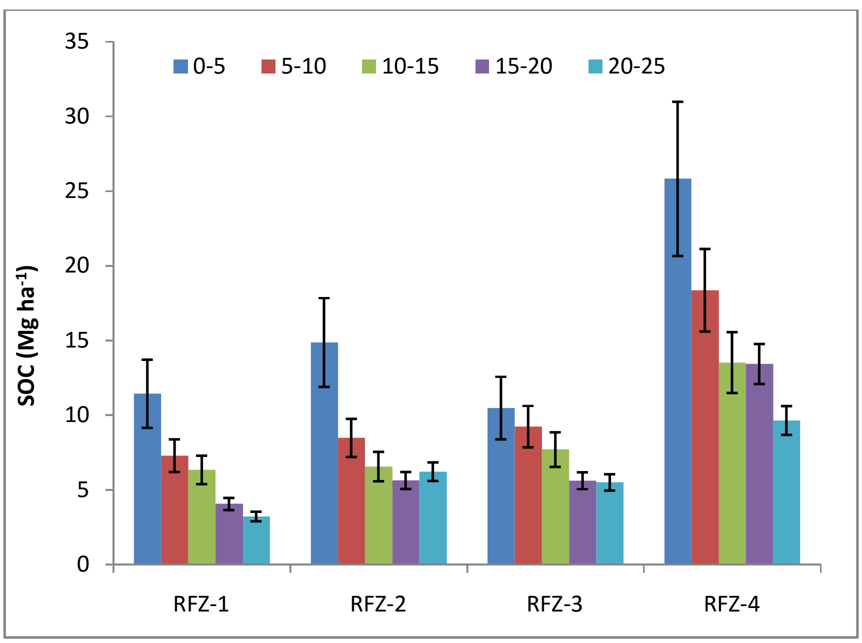


Figure 22: Mean soil organic carbon (SOC, Mg ha^{-1}) for different depths (top 0–5, 5–10, 10–15, 15–20, and bottom 20–25 cm) in soil for each rainfall zone (RFZ).

SOC values measured up to 25 cm depth in soil across the study area are given in figure 23. RFZ–1 showed lowest values for SOC between 16.86–43.08 (mean SOC 32.37±7.4) Mg ha^{-1} up to 25 cm depth. RFZ–2 and 3 showed mean SOC values of 41.78±24.9 (5.88–92.64) Mg ha^{-1} and 38.56±29.5 (2.94–92.01) Mg ha^{-1} respectively (Figure 23). Higher SOC values were seen at RFZ–4 where mean SOC value was 80.81±33.3 Mg ha^{-1} ranged between 34.08–147.84 Mg ha^{-1} (Figure 23). The increase of SOC with increase in MAP (excepting for RFZ–3) was gradual across RFZs. Vegetation cover significantly influenced SOC values across the RFZs. Least diversed plots (1–3 species) showed minimum mean SOC values (26.93±12.73 Mg ha^{-1}). Plots with moderate diversity (~8 species, ranged between 6–10) showed 49.8±27.8 Mg ha^{-1} SOC. Mean SOC was 82.9±21.7 Mg ha^{-1} for plots with higher diversity (~20 species, ranged between 17–37) across RFZ–3 and 4. Invasive species *Prosopis* influenced the SOC content compared to other plots. *Prosopis* plots showed mean SOC value (up to 25 cm depth) of 31.38 Mg ha^{-1} at RFZ–1. SOC values (23.96 Mg ha^{-1} up to 25 cm depth) were relatively lesser in plots of RFZ–2 dominated by *Prosopis* as compared to the ones occupied by native species stands (59.30 Mg ha^{-1}).

SOC data of this study (measured up to 25 cm depth) was extrapolated to obtain SOC values up to 100 cm depth (Jobbágy and Jackson 2000, 2001; Yang et al. 2011). This helps in knowing the amount of carbon stored across these RFZs up to 100 cm as this is the depth mostly referred in Global carbon cycle models (Jobbágy and Jackson 2000; Guo and Gifford 2002). Values projected indicate that the existing forest covers of RFZs 1–4 hold 5.28 to 421.85 Mg ha^{-1} SOC (up to 100 cm). RFZ–1 and 2 hold 61.50 (19.26–184.22) Mg ha^{-1} SOC up to 100 cm soil depth.

Mean SOC value for RFZ–3 and 4 was 92.21 (5.28–421.85) Mg ha^{-1} up to 100 cm soil depth.

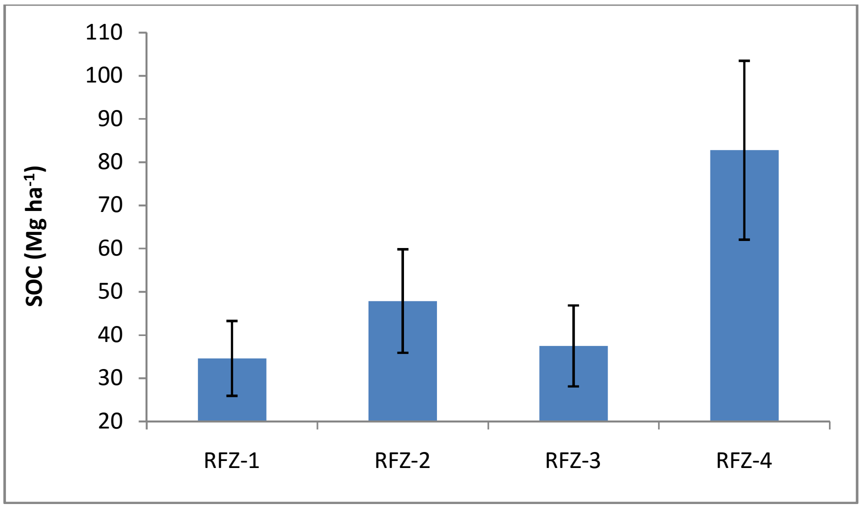


Figure 23: Mean soil organic carbon (SOC, Mg ha^{-1}) up to 25 cm depth in soil in each rainfall zone (RFZ).

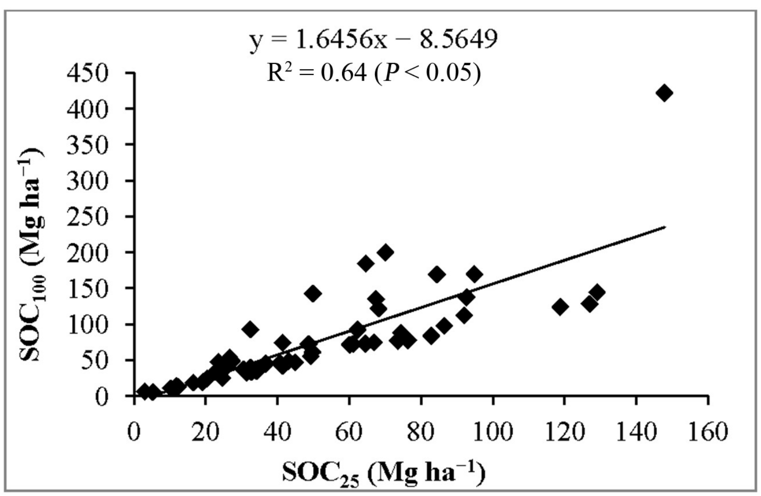


Figure 24: Relationship between SOC_{25} (Soil organic carbon, SOC at 25 cm soil depth) and SOC_{100} (SOC at 100 cm soil depth) across four rainfall zones (RFZs) (n = 95).

3.4.3. Microbial biomass carbon (MBC)

Mean values for MBC (Mg ha^{-1}) of soil samples collected from five depths (top 0–5, 5–10, 10–15, 15–20, and bottom 20–25 cm) across the RFZs has been showed in the figure 25. MBC values found to be significantly different across RFZs and different depths in soil. Top layer of soil showed higher values of MBC compared to lower layers across the zones (figure 25). MBC values gradually decreased with increase in soil depth. Mean soil MBC was maximum (0.11 Mg ha^{-1}) in top 5 cm and minimum (0.03 Mg ha^{-1}) in 20–25 cm depth across the four RFZs (Figure 25). Field observations indicate that this is related with large fresh organic carbon inputs (in the form of fallen litter) to the top soil. There was an increase observed in MBC value (up to 25 cm depth in soil) with increase in MAP across the RFZs. Maximum (0.40 Mg ha^{-1}) and minimum (0.16 Mg ha^{-1}) mean values of MBC were found in RFZ–4 and RFZ–1 respectively. RFZ–2 and 3 showed MBC values of 0.24 and 0.28 Mg ha^{-1} respectively. MBC values across the zones differed in tune with MAP, AGB and SOC. However, MBC values did not show significant variation corresponding to species richness across RFZ–3 and 4.

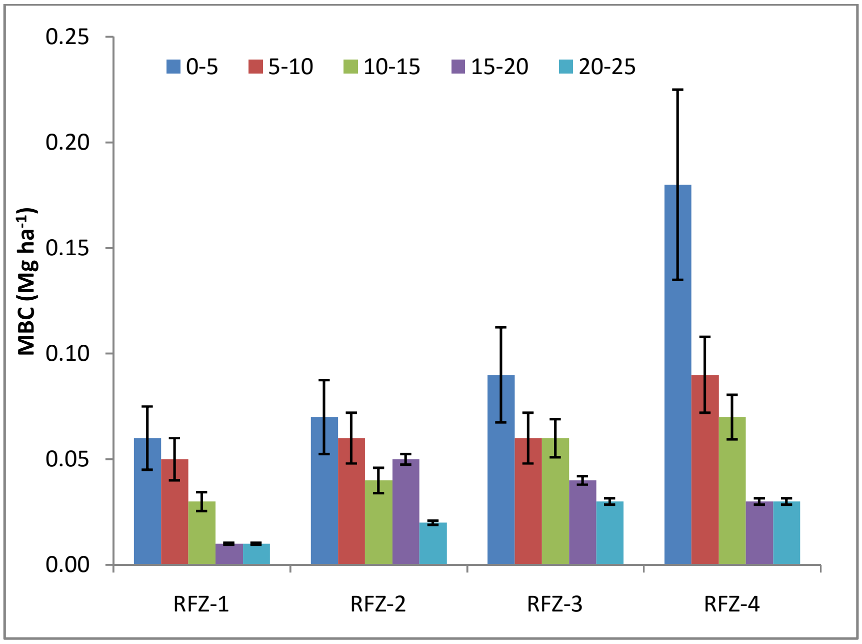


Figure 25: Mean microbial biomass carbon (MBC, Mg ha^{-1}) for different depths (top 0–5, 5–10, 10–15, 15–20, and bottom 20–25 cm) in soil in each rainfall zone (RFZ).

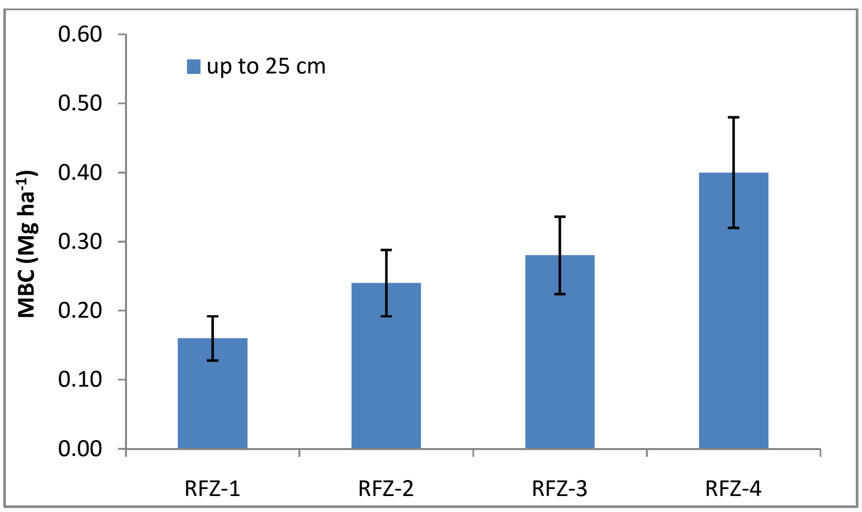


Figure 26: Mean microbial biomass carbon (MBC, Mg ha^{-1}) up to 25 cm depth in soil in each rainfall zone (RFZ).

3.5. Litter Decomposition Experiment

This experiment has been carried out to evaluate the impact of measured leaf traits on leaf litter decomposition.

3.5.1. Leaf characteristics measured

Measured leaf characteristics are expressed as mean values derived from 10 leaves for each species (Table 6). Leaf area showed a range of 12.87–1079.63 cm^2. Mean leaf dry weights were 0.04 to 10.62 g. SLA for the selected species was between 100.52–300.54 $cm^2\ g^{-1}$. Dried leaf samples contained 22.98–57.44 % nonstructural carbohydrates and 42.56–77.02 % structural carbohydrates. Amongst the structural components, lignin was 3.41–34.91 % and, holocellulose was 31.42–42.41 %. LCI ranged between 0.08–0.46. LCI values increased after 270 days of decomposition. ANOVA results showed that differences seen in all these parameters are statistically significant (at 5% level). MBC levels of the soil samples (prior to placing the litter bags) across sites (at two depths) were significantly different (at 5% level) and ranged from 44.88 to 190.08 mg kg^{-1}. Among the three plots at Vadodara, farm house showed the highest MBC followed by arboretum and botanical garden.

All the ten species (categorized as trees, shrubs and herbs) showed distinction in the measured parameters. SLA estimates were smaller in trees (100.52–101.95 $cm^2\ g^{-1}$) followed by shrubs (151.44–279.55 $cm^2\ g^{-1}$) and herbs (245.83–300.54 $cm^2\ g^{-1}$). The SLA value of Bamboo was 220.34 $cm^2\ g^{-1}$. Structural carbohydrates were high in trees (60.44–67.67 %) followed by shrubs (50.35–59.84 %) and herbs (42.56–57.93 %). Nonstructural carbohydrates showed a reverse pattern. Bamboo (perennial grass) had the highest content of structural carbohydrates (77.02 %).

Table 6: Measured leaf characteristics for selected species for litter decomposition experiment. [SLA: Specific leaf area (cm^2 g^{-1}); LCI: Lignocellulose index; *k* values: Decomposition rate (g g^{-1} yr^{-1}); ± Values indicate standard deviation from the mean]

Species	SLA	Component (%)				LCI	*k* values
		Non-structural	Structural	Holo-cellulose	Lignin		
Teak	101.68±15.18	32.33±1.85	67.67±1.85	40.36±1.01	27.31±1.59	0.40±0.02	1.68±0.85
Mango	100.52±0.07	39.56±1.42	60.44±1.42	32.57±4.35	27.88±4.06	0.46±0.13	2.63±0.35
Madhuca	101.95±4.04	36.42±3.94	63.58±3.94	36.27±3.89	27.32±0.55	0.43±0.03	1.45±0.29
Bamboo	220.34±9.27	22.98±1.16	77.02±1.16	42.11±4.60	34.91±5.45	0.45±0.07	1.86±0.93
Hibiscus	279.55±6.20	48.82±4.72	51.18±4.72	42.41±4.72	8.77±0.97	0.17±0.02	--
Datura	151.44±6.19	49.65±1.23	50.35±1.23	39.03±2.74	11.33±3.86	0.22±0.07	3.09±0.55
Bougainvillaea	176.68±23.32	40.16±1.30	59.84±1.30	34.45±1.10	25.39±1.14	0.42±0.01	1.86±0.08
Cyperus	300.54±21.42	42.03±1.12	57.97±1.12	38.38±1.45	19.59±0.12	0.34±0.11	2.42±0.63
Spinach	245.83±23.91	57.44±0.69	42.56±0.69	39.15±2.47	3.41±1.91	0.08±0.05	3.83±0.42
Vinca	250.37±24.54	55.93±3.59	44.07±3.59	31.42±1.16	12.65±2.94	0.29±0.05	2.50±0.61

a

b

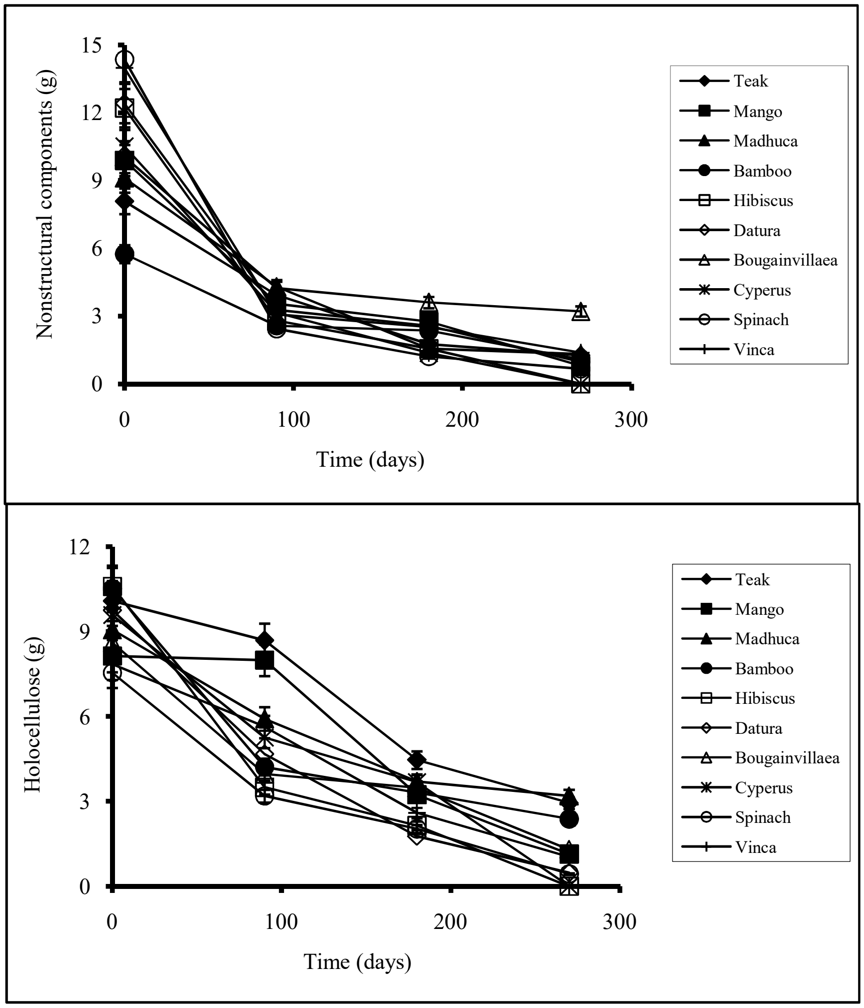


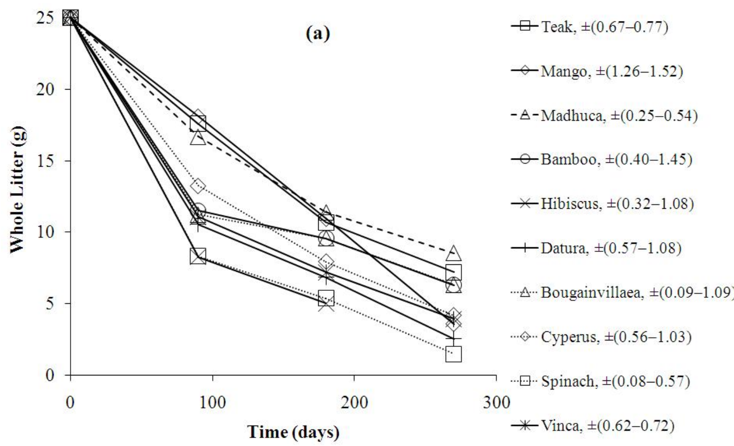
Figure 27: Decomposition pattern for Nonstructural components (a) and Holocellulose (b) in all the species.

3.5.2. Decomposition rates (*k* values)

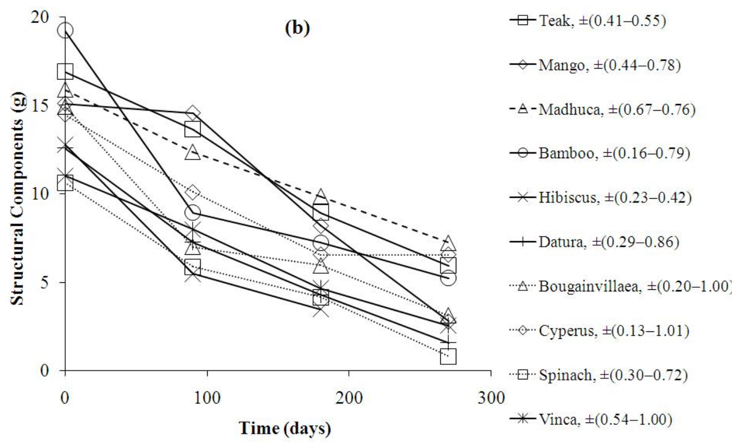
Differences seen in the weight loss of leaf litter of a species placed at two soil depths (0–5 cm and 15–20 cm) at each site did not show any significant difference (at 5% level). In spite of differences in MBC values, decomposition rates for each species coming from the three points (arboretum, botanical garden and farm house) did not show significant variations. Hence data were presented as a mean of samples from two depths and at 3 sites (3×3×2=18 samples). Outliers were discarded (2 highest and 2 lowest, 25% lower or higher than the median value of 18 observations). Mean values are derived from 14 observations for each species at each sampling time (90, 180 and 270 days). After 90 days of being placed in the soil, the minimum *k* value observed was 1.31 (for mango) while maximum was 4.50 (for *Hibiscus*) (Figure 29). The *k* values ranged from 1.45 to 3.83 (Table 6) at 270 days. The *k* values were higher in herbs followed by shrubs and trees (Figure 29). Decomposition was faster in spinach (1.47 g remaining), while much of the original material remained for the same amount of time with *Madhuca* (8.54 g remaining). Sample collection was improper for *Hibiscus* at 270 days and therefore, it was excluded. Nonstructural carbohydrates decomposed relatively faster than structural carbohydrates ranging in *k* values from 1.54 to 4.16 (Fig. 27, 28, 29). The structural carbohydrates are utilized slowly (*k* values ranging from 1.07 to 3.49) (Fig. 27, 28, 29). Leaves of different species with similar proportion of structural carbohydrates showed no significant difference in *k* values. The *k* values of lignin are 0.71 to 2.88 for all the species at 270 days. MBC values increased 12 to 150 % (from the initial values) by the end of 90 days of decomposition. During 90 to 180 days interval, MBC values remained stable. At 270 days MBC values gradually decreased (6–43 % from peak levels at 180 days) and at some points values decreased to initial levels (Fig. 30).

SLA showed positive correlation when plotted against *k* values of all species (R^2=0.74 at 270 days). *k* values were correlated positively (R^2=0.67) with nonstructural and negatively (R^2=0.67) with structural components. Holocellulose did not show any correlation (R^2=0.02) with *k* values. Lignin content had a strong negative correlation (R^2=0.74) with *k* values across all species. LCI was inversely proportional to *k* values (R^2=0.73) (Table A3).

(a)



(b)



(c)

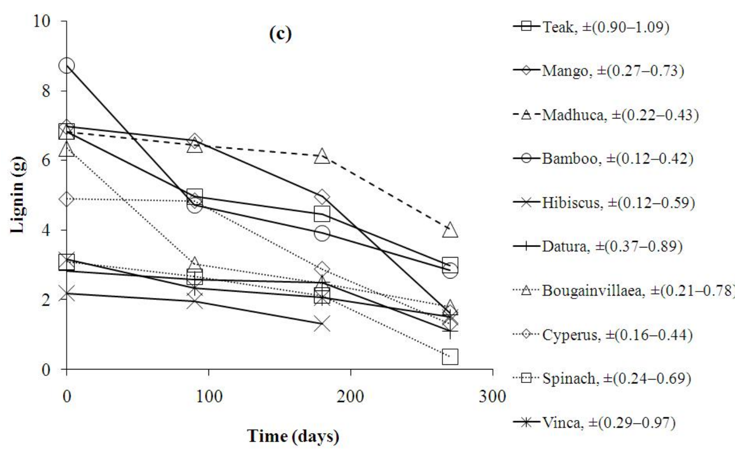
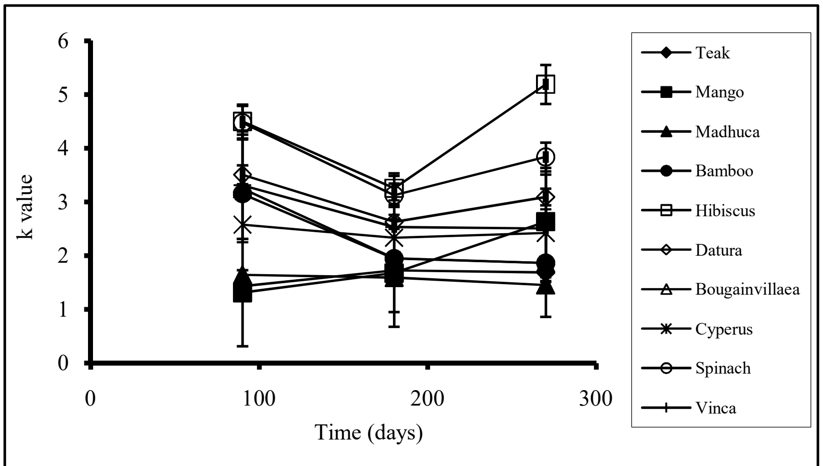


Figure 28: Weight loss of whole litter mass (a), structural components (b) and lignin (c) during decomposition (from 0–270 days, Vadodara site) of selected plant species. (Values in parenthesis indicate range of standard deviation from the mean)

a



b

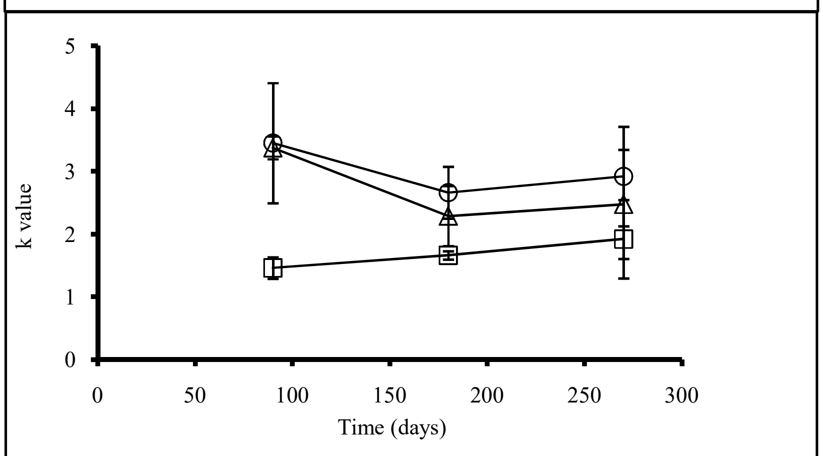


Figure 29: *k* values (g g^{-1} yr^{-1}) of all the species at different intervals (a) and a representative of trees, shrubs and herbs (b).

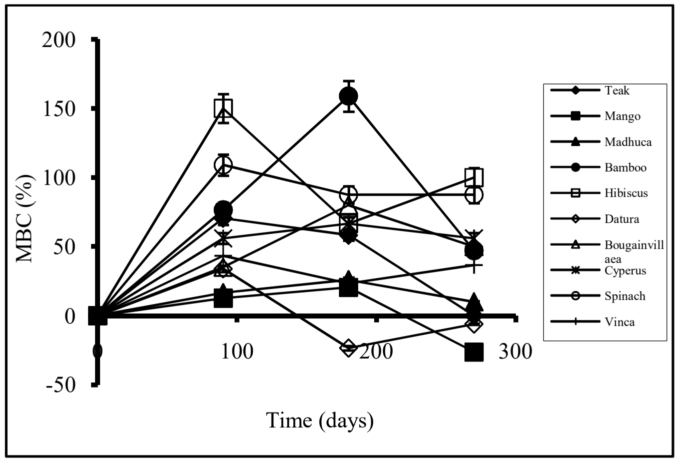


Figure 30: Changes in MBC levels (%) up to 270 days.

3.6. Relationship between AGB and SOC across RFZs

One way ANOVA showed that differences seen in the values of the parameters (AGB, SOC, MBC) across the RFZs 1–4 are statistically significant ($P<0.05$). Both linear and logarithmic regressions were performed to find the best fit line describing the relationship between parameters. AGB and SOC pair showed the best fit curve with logarithmic regression within a RFZ and across RFZs 1–4 (Figure 31). SOC and MBC values were more linearly related. SOC and MBC values coming from 0–5 cm and 0–25 cm showed higher R^2 values (0.78 and 0.71) as compared to the one coming from 20–25 cm (R^2=0.59) (Figure 34). This is attributed to the quantity and quality of litter reaching these depths.

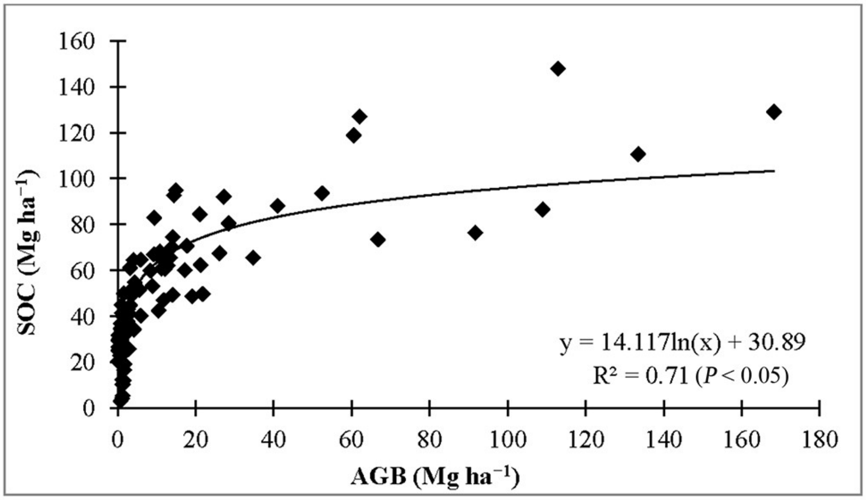


Figure 31: Relationship between above ground biomass (AGB, Mg ha^{-1}) and soil organic carbon (SOC, Mg ha^{-1}) up to 25 cm soil depth, n=95 across the rainfall zones (RFZs).

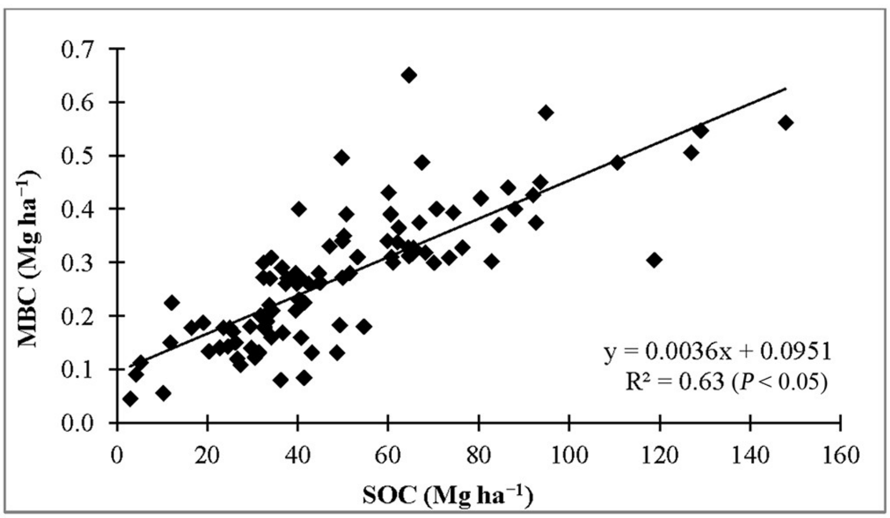


Figure 32: Relationship between soil organic carbon (SOC, Mg ha^{-1}) and soil microbial biomass carbon (MBC, Mg ha^{-1}) up to 25 cm soil depth, n=95 across the rainfall zones (RFZs).

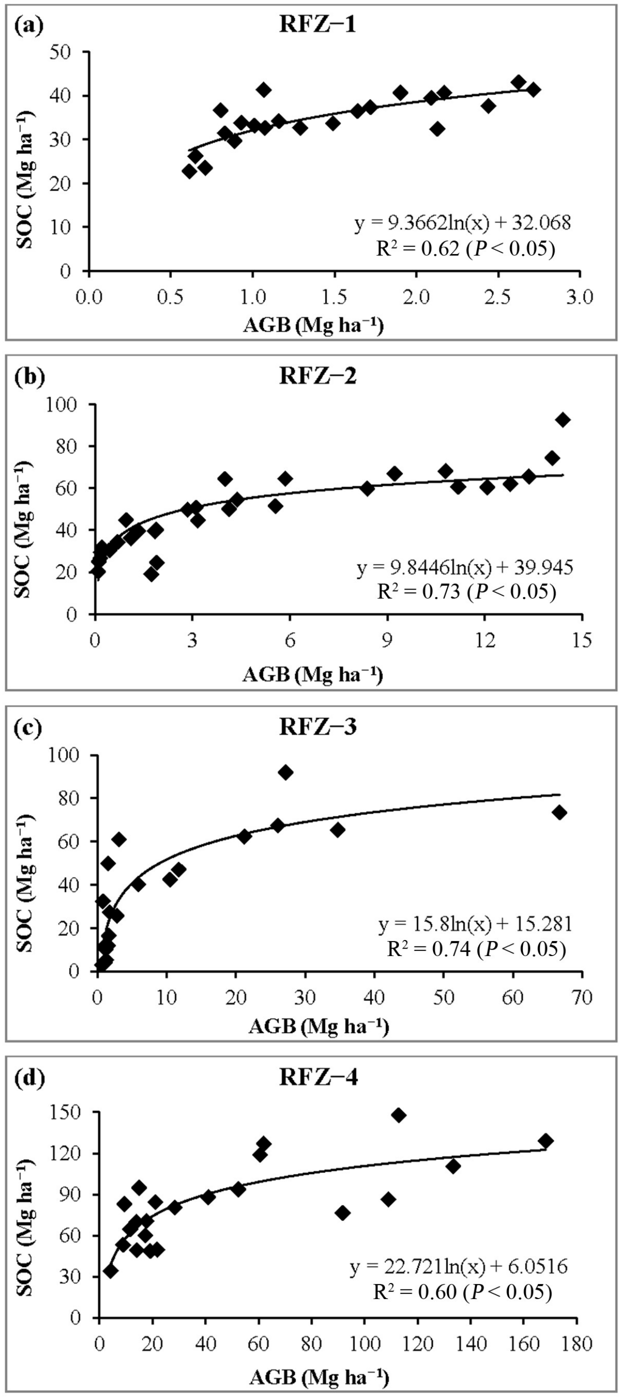


Figure 33: Relationship between aboveground biomass (AGB) and soil organic carbon (SOC, up to 25 cm soil depth) across four rainfall zones (RFZs), a) RFZ–1 (n = 22), b) RFZ–2 (n = 31), c) RFZ–3 (n = 20), and d) RFZ–4 (n = 22).

MAP values of RFZs 1–4 regressed with mean values of density, diversity, DBH, SOC and MBC showed linear relationship (Table 7), while mean values of AGB showed logarithmic increase with the changes in MAP of RFZs 1–4 (Table 7). Coefficient of correlation values of these regression lines ranged between 0.77–0.99. MAP and AGB (r=0.99, R^2=0.98) and, MAP and SOC (r=0.93, R^2=0.86) showed the highest correlationship compared to MAP and tree diversity (r=0.77, R^2=0.59) (Table 7). Higher coefficient of correlation for the parameters density, diversity, DBH, AGB, SOC and MBC with MAP indicated their sensitivity towards fluctuations in rainfall (Table 7). All the regressions are statistically significant (P<0.05).

Table 7: Regression equations and correlation values (r) of mean values of the observed parameters with mean annual precipitation (MAP, mm yr^{-1}) across four rainfall zones (RFZs) (n = 4, P<0.05).

Parameter	**r value**	**Regression equation**
Species Diversity of trees	0.77	y = 0.0281x + 6.7114, R^2 = 0.59
Family Diversity of trees	0.77	y = 0.0171x + 4.0545, R^2 = 0.60
Density (number of trees ha^{-1})	0.93	y = 0.1394x + 58.677, R^2 = 0.87
Diameter at breast height (DBH, cm)	0.89	y = 0.0215x + 14.378, R^2 = 0.80
Aboveground Biomass (AGB, Mg ha^{-1})	0.99	y = 44.621ln(x) − 282.53, R^2 = 0.98
Soil organic carbon (SOC, Mg ha^{-1}) up to 25 cm soil depth	0.93	y = 0.0439x + 10.367, R^2 = 0.86
Microbial biomass carbon (MBC, Mg ha^{-1})	0.94	y = 0.0002x + 0.1097, R^2 = 0.89

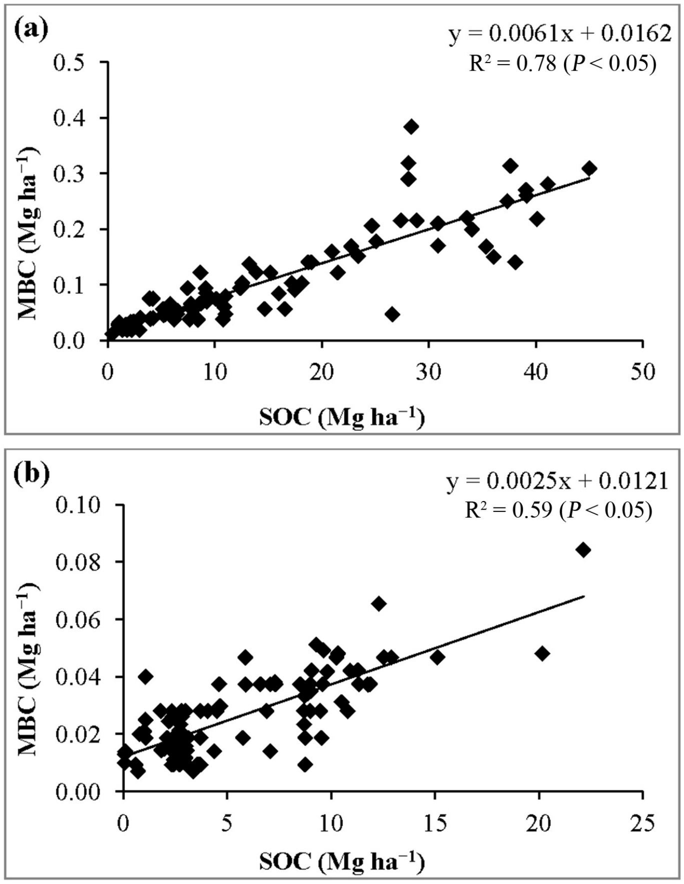


Figure 34: Relationship between soil organic carbon (SOC) and microbial biomass carbon (MBC) across four rainfall zones (RFZs) for, a) 0–5 cm soil depth (n = 95), and b) 20–25 cm soil depth (n = 95).