CHAPTER VI

IMPACT OF FIRE ON MEDICINAL PLANTS

6.1. INTRODUCTION

Fire is known to cause major impacts on plant communities. It kills the seedlings of fire-sensitive species (Naidu and Srivasuki 1994). Depending on its frequency, intensity and temperature it reduces the tree cover and promotes the growth of grasses (Kozlowski and Ahlgren 1974). Fire intensity affects vegetation structure and dynamics through differential effects on survival of plants and propagules on the site and differential effects on the physical and biological factors that define the regeneration niche of any given species. Frequent fire also reduce the number of species (Pinard and Huffman 1997) and the resulting changes in the species composition have tremendous impact on the carrying capacity of the ecosystem. Season in which fire occurs also affects structure of vegetation because it interacts with plant phenology and post fire weather to moderate plant survival and reproduction (Kruger 1984). Fire plays a typical role in maintaining the different plant communities of woodlands and closed forests (Kozlowski and Ahlgren 1974; Tyler 1995). Effect of fire on different plant communities was extensively studied in many parts of the world (Hill and Read 1984; McFarland 1988; Sirois and Payette 1989; Goto *et al* 1996; Pinard and Huffman 1997; Pausas *et al* 1999; DeSimone and Zedler 1999; Hoffmann 1999; Fule and Covington 1999). In India, several workers have studied the effect of fire on different forest communities (Toky and Ramakrishnan 1983; Prasad 1985; Khan and Tripathi 1989; Paulsamy 1992; Naidu and Srivasuki 1994; Paulsamy *et* *al* 1995; Kikkim and Yadava 1998; Senthilkumar *et al* 1998).

Though several workers have studied the various vegetation structure in NBR (George and Varghese 1984; Sharma *et al* 1986; Manilal *et al* 1986, 1989; Singh *et al* 1988; Sukumar *et al* 1992), information about the Impact of fire on the abundance and regeneration on plant populations is scanty (Puyravaud *et al* 1995). Moreover, ecological impact of fire varies markedly from vegetation to vegetation and seasons (Kruger 1984). As far as NBR is concerned the major vegetation is of dry deciduous type (Pascal 1988) and are subjected to severe fire and fire is often set by the local people for getting new grazing material for their cattle. Therefore, during this study, an attempt was made to assess the impact of fire on medicinal plant abundance and regeneration in this habitat. The objectives of this study were;

i) to examine the Impact of fire on plant species composition and abundance and to

ii) assess the regeneration of medicinal plant populations.

A proper and desirable method would be to follow an experimental approach to evaluate the Impact of fire and other anthropogenic factors. However, due to time constraint such a study was beyond the scope of the present study. Fieldwork was conducted during 1996 to 1997 in the Muthanga range of Wayanad Wildlife Sanctuary (WLS), which forms a part of the western portion of the NBR (11^0 33' to 11^0 51' N and 76^0 02' to 76^0 27' E). The vegetation of the Sanctuary is mostly of deciduous type. The dry deciduous forests of the Sanctuary are subjected to severe fire and fire is often set by the local people for getting new grazing material for their cattle. In the present study, I have compared the species richness, density and regeneration between a less-fire-frequent area and an adjoining higher-fire-frequent area. The above categorisation was based on the information collected from the local tribal people and forest officials.

6.2. METHODS AND ANALYSES

Impact of fire on the abundance of medicinal plant species was studied in a less- fire-frequent (Less burnt) and a higher-fire-frequent (Severely burnt) area in the dry deciduous forest. The vegetation in each site was sampled in five different strata viz., trees, shrubs, herbs, seedlings and saplings.

A total of twenty 0.1 ha. (50 x 20 m) quadrats were laid each in less and severely burnt area. In each 0.1 ha. quadrat, all the woody vegetation above 20cm Girth at Breast Height (GBH) was enumerated. For each individual, GBH was measured using a measuring tape at 1.3 m above ground level. Four 5 x 5 m quadrats were laid within the 0.1 ha. quadrat and number of individuals of shrub and climber species and their percentage cover were recorded. In each 5 x 5 m quadrat, four 1 x 1 m quadrats were laid at random. Number of individuals of each herb species and their percentage cover were noted. Analysis of vegetation data was done separately as discussed in the chapter IV for the two areas and the abundance of medicinal plants was compared between these habitats. For herbs and shrubs, Importance Value Index was calculated adding relative density and relative frequency only. Horn's similarity index was calculated between quadrats for tree species both in the less and severely burnt area.

Population structure was analysed at community level and for selected species of medicinal plants. Size class selected for community level ranged from 20 cm to 250 cm GBH, but for individual species the size class category varied based on the maximum girth attained. Percentage of individuals in each size class was calculated.

To study the Impact of fire on regeneration of medicinal plants, seedlings (<10 cm GBH) and saplings (10-19 cm GBH) were sampled by quadrat method. A total of eighty 5 x 5 m quadrats was laid each in the less and severely burnt areas. Density of seedling and sapling of each species per hectare was calculated and compared between these habitats.

Statistical analyses were done using Statistical Package for Social Sciences (Norusis 1990). Differences in plant species diversity, density and basal area between less and severely burnt areas were tested using Mann-Whitney U test (M-W U test). Kolomogorov - Smirnov two sample test (Siegel and Castellan 1988) was used to analyse the difference between the girth class distributions of trees in the less and severely burnt areas.

6.3. RESULTS

6.3.1. Forest structure and composition

A total of 99 plant species belonging to 86 genera of 43 families (excluding unidentified species) were recorded in the less and severely burnt areas of dry deciduous forests (29 trees, 22 shrubs and 48 herbs). Of the 43 families, 24 families were represented by one species and19 families were represented by more than one species. Fabaceae were the dominant family represented by 11 species followed by Poaceae with 10 species. Only eight genera exhibited more than one species *Desmodium, Grewia* and *Terminalia* (each with 3 species), *Andrographis, Chlorophytum, Mariscus, Phyllanthus* and *Themeda* (each with two species).

Of the 99 plant species recorded, 45 were used by tribals as medicine. Three medicinal plant species such as *Rauwolfia serpentina*, *Pseudarthria viscida* and *Schrebera swietenioides*, which are listed in the "Red list" of medicinal plants of south India (Anon. 1997) were also recorded from the fire affected areas. All the above three species of medicinal plants were recorded from the less burnt area while only *Schrebera swietenioides* was recorded in the severely burnt area. The less burnt area had a higher species richness (80, which includes 29 trees, 18 shrubs and 33 herbs) than that of the severely burnt area (61, which includes 22 trees, 13 shrubs and 26 herbs). However, the percentage of medicinal plant species showed not much difference between the less (53.75%) and severely burnt area (52.45%).

6.3.2. Trees

6.3.2.1. Species diversity and richness

Shannon -Weiner diversity index showed no significant difference between the less and severely burnt area (Table 6.1). Number of tree species was higher in the less burnt (29) than in the severely burnt (22) area. Number of tree species in individual quadrat ranged from 6 to 14 (Mean=10.2, SD=2.69) in the less burnt habitat and from 5 to 12 (Mean=8.4, SD=2.27) in the severely burnt habitat.

Percentage of medicinal trees was higher in the severely burnt area (77%) than that of the less burnt area (72%). Similarity index between any two transects in the less burnt varied from 0.84 to 0.98 (Mean=0.926, SD=0.04458) and in the severely burnt area from 0.86 to 0.98 (Mean=0.937, SD=0.04099), indicating that there was appreciable homogeneity among the quadrats in both the areas.

Table 6.1. Tree species richness and diversity index in the less and severely burnt area.

Habitat	Species richness			H'
	Total	Medicinal trees	Other trees	
Less burnt	29	21 (72%)	8 (28%)	2.29
Severely burnt	22	17 (77%)	5 (23%)	2.10

6.3.2.2. Size class distribution

Girth class distribution of all individuals (GBH >20cm) was L-shaped for both the areas (Figure 6.1). Higher number of individuals in lower GBH classes in the less burnt area shows recruitment of individuals. However, the size class distributions of individuals of all the tree species were not significantly different between these areas (Kolomogorov-Smirnov test D=0.590, p<0.87). Medicinal tree species such as *Buchanania lanzan, Kydia calycina, Randia dumetorum, Stereospermum colais* and *Tamilnadia uliginosa* were recorded only from the less burnt area. Number of smaller trees of *Bauhinia racemosa, Cassia fistula, Dalbergia latifolia, Lagerstroemia parviflora* and *Phyllanthus emblica* (Figure 6.2) were more in the less burnt area than in the severely burnt area.

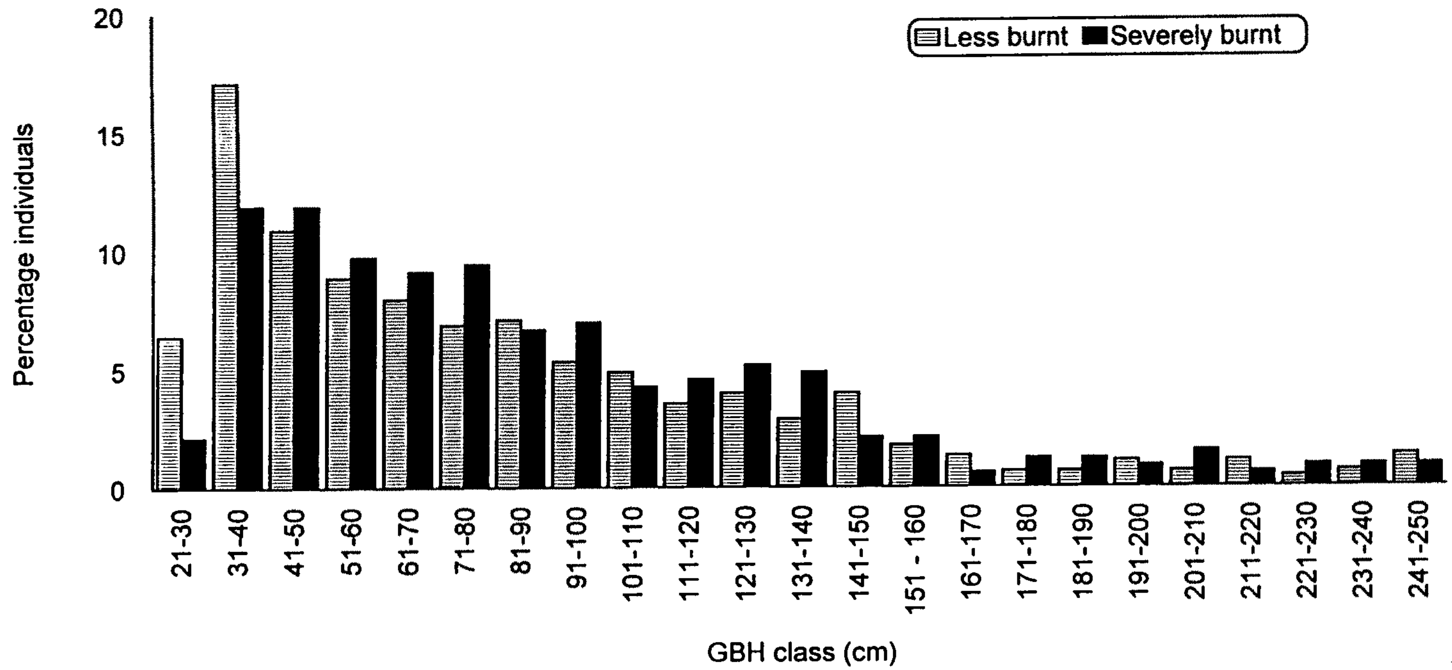

Figure 6.1. Size class distribution of trees (GBH $\geq$20 cm) in the less and severely burnt area

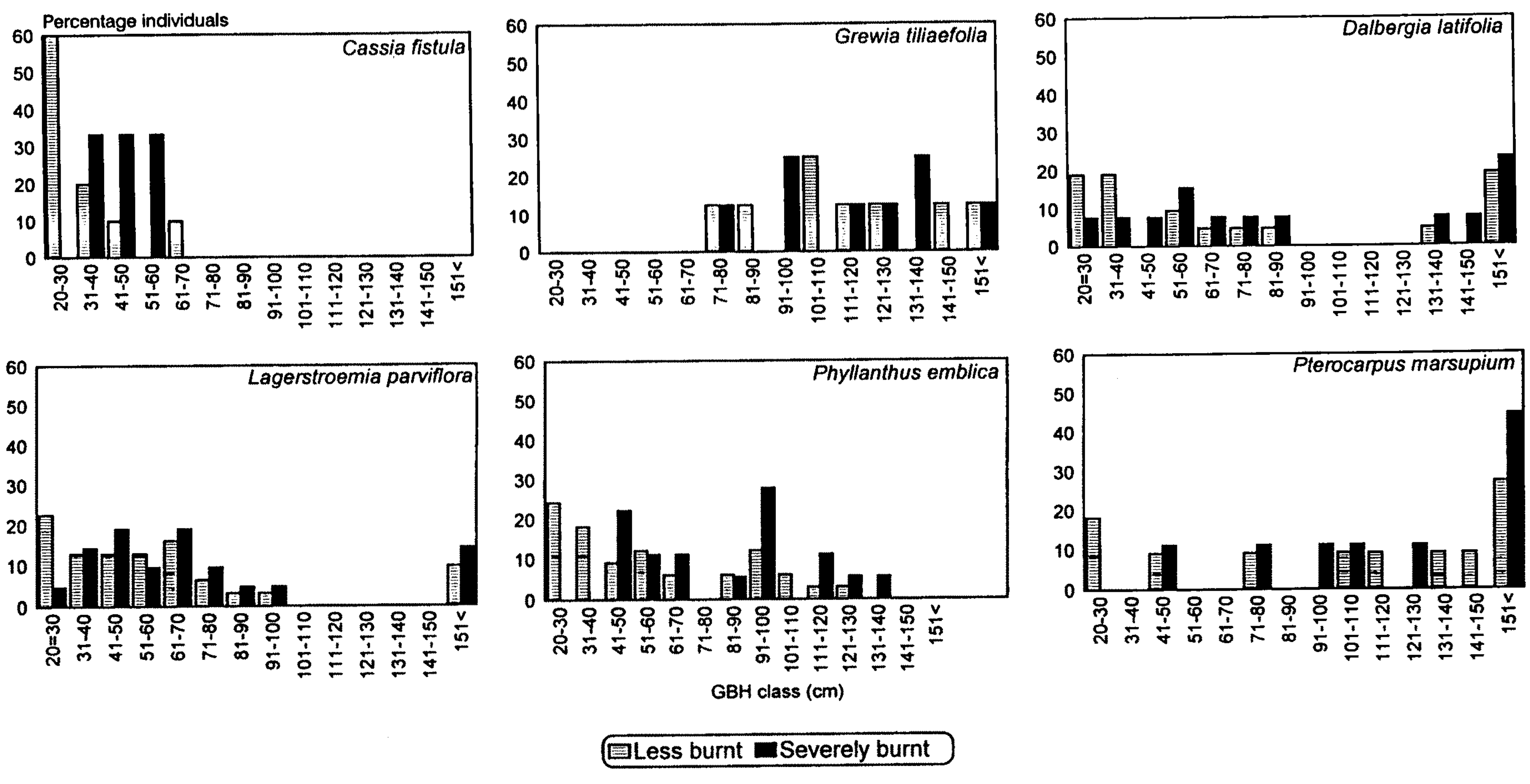

Figure. 6.2. GBH class distribution of some medicinal tree species in the less and severely burnt area

6.3.2.3. Density

Total tree density showed no significant difference (M-W test U=29.5, P=0.12) between the less and severely burnt area. Density of medicinal trees also showed no significant difference (M - W test U= 30, P= 0.13) between these habitats (Table 6.2). *Anogeissus latifolia* was the most common species (142 in less burnt, 117 in Severely burnt) in both the areas. Medicinal trees such as *Anogeissus latifolia, Bauhinia racemosa, Cassia fistula, Dalbergia latifolia, Lagerstroemia parviflora, Phyllanthus emblica, Pterocarpus marsupium, Semecarpus anacardium, Shorea roxburghii* and *Terminalia paniculata* had greater density in the less burnt area than in the severely burnt area. However, the difference was not statistically significant (Table 6.3).

Table 6.2. Tree density in the less and severely burnt area.

Habitat	Number of trees /ha		
	Total	Medicinal	Other trees
Less burnt	449 ± 45.4	329 ± 41.3	120 ± 16
Severely burnt	328 ± 40	240 ± 33.2	88 ± 12. 4
M-W test	*n.s*	*n.s*	*n.s*

M-W - Mann-Whitney U test; n.s - No significance.

6.3.2.4. Basal area

Total basal area of trees (GBH ≥ 20 cm) was higher in the less burnt area (28.3m^2/ ha) than in the severely burnt area (26.88m^2/ha). However, the difference was not significant (M-W test U=42, P=0.54). Basal area of medicinal trees also showed no significant difference between these areas (Figure 6.3).

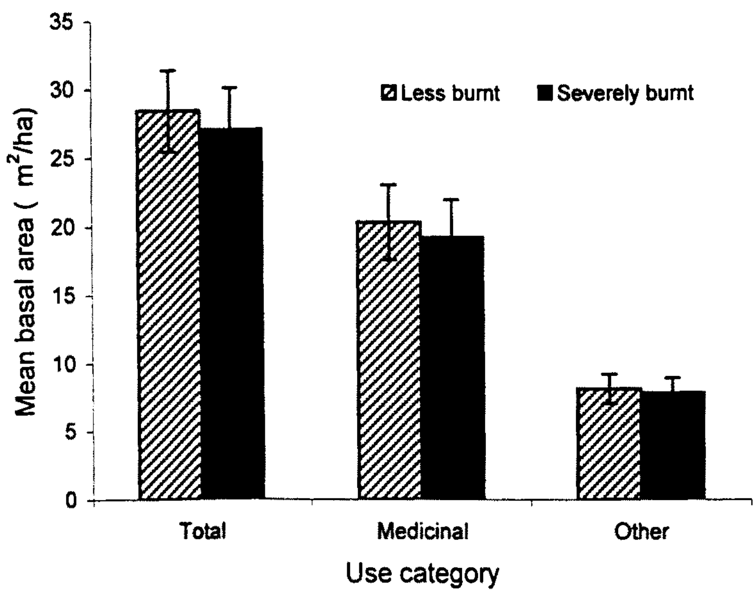

Figure 6.3. Mean basal area ± SE of trees in the less and severely burnt areas

Table 6.3. Abundance, density, basal area and IVI of tree species in the less burnt (LB) and severely burnt (SB) areas.

Species	Less burnt area				Severely burnt area			
	Abundance	Density[1]	Basal area[2]	IVI[3]	Abundance	Density[1]	Basal area[2]	IVI[3]
MEDICINAL TREES								
Anogeissus latifolia	14.2	142	53150	60	11.7	117	49510	66
Bauhinia racemosa	8	8	770	3	4	4	710	3
Bridelia retusa	1	1	560	1	1	1	480	2
Buchanania lanzan	1	1	260	1	-	-	-	-
Careya arborea	1	2	210	2	1	1	260	2
Cassia fistula	2	10	890	7	1.5	3	530	3
Dalbergia latifolia	2.63	21	16910	19	1.86	13	15450	17
Diospyros montana	1.25	5	1910	6	1	2	1770	4
Kydia calycina	1	1	70	1	-	-	-	-
Lagerstroemia parviflora	4	28	6220	15	2.57	18	5100	15
Lannea coramandelica	1	3	4330	5	1	3	4410	6
Phyllanthus emblica	3.67	33	8630	19	2.57	18	8690	16
Pterocarpus marsupium	3.67	11	17730	13	3	9	17210	12
Randia dumetorum	1	1	70	1	-	-	-	-
Schrebera swietenioides	1	2	2180	3	1	2	2180	4
Semecarpus anacardium	2	2	1560	2	1	1	800	2
Shorea roxburghii	2.25	9	11150	10	1.33	4	10950	9
Tamilnadia uliginosa	1	1	50	1	-	-	-	-
Tectona grandis	3.56	32	64830	41	3.44	31	63480	44
Terminalia chebula	1	2	2020	3	1	2	1990	4
Terminalia paniculata	2	14	9270	13	1.83	11	8490	14
OTHER TREE SPECIES								
Butea monosperma	7	7	1610	3	4	4	40	3
Casearia esculenta	1	1	250	1	-	-	-	-
Cordia domestica	2	2	190	2	1	1	110	2
Eriolaena quinquelocularis	1	1	130	1	-	-	-	-
Grewia tiliaefolia	2	8	9510	9	2	8	9730	11
Streospermum colais	1	1	40	1	-	-	-	-
Terminalia crenulata	9.9	99	69080	56	7.4	74	66830	59
Zizyphus xylopyrus	1	1	360	1	1	1	170	2
Total		**449**	**283940**	**300**		**328**	**268890**	**300**

Density[1] denotes number of individuals per ha.; Basal area[2] in cm^2 per ha.; IVI[3] - Importance Value Index.

6.3.2.5. Importance Value Index

Anogeissus latifolia was the dominant species with an importance value of 60.1 in the less burnt and 65.8 in the severely burnt area. Importance Value Index of medicinal trees such as *Cassia fistula, Diospyros montana, Phyllanthus emblica* and *Shorea roxburghii* were lower in the severely burnt area than in the less burnt area while for *Anogeissus latifolia, Bridelia retusa, Lagerstroemia parviflora, Lannea coramandelica, Pterocarpus marsupium, Schrebera swietenioides, Tectona grandis, Terminalia chebula* and *T. paniculata* the IVI was greater in the severely burnt area than in the less burnt area. There were nine species with ≤1 IVI in less burnt area, compared to five such species in severely burnt area.

6.3.3. Shrubs

Of the twenty-two species of shrubs recorded in both the areas, the tribals used twelve as medicine while five were commercially exploited in large scale.

6.3.3.1. Species diversity and richness

Although, shrub species diversity index was greater in the less burnt area (H'= 1.76) than in the severely burnt area (H'=1.66), the difference was not significant (M-W test U=26.5, *P*= 0.07). Total number of shrub species was higher in the less burnt area (18) than in the severely burnt area (13). Similarly, number of medicinal shrubs was also higher in the less burnt area (11) than in the severely burnt area (7).

6.3.3.2. Density

There was no significant difference between the two sites with respect to the total density of shrubs (M-W test U=37.5, *P*=5.4; Table 6.4). Similarly, the density of medicinal shrubs also showed no significant difference (M-W test U=42, *P*=0.80) between the less (15.82/25m^2) and severely burnt areas (15.6/25m^2). Most of the medicinal shrubs had greater density in the less burnt area than in the severely burnt area (Table 6.4). Commercially valuable medicinal plants such as *Asparagus racemosus, Clerodendrum serratum* and *Helicteres isora* were recorded only in the less burnt area while *Desmodium velutinum* was recorded in both the areas. *Leea indica* had the highest density both in the less (10) and severely burnt (8) areas. Density of *Chromolaena odorata,* an exotic weed was significantly (M-W test U= 0.0001, *P*= 0.003) higher in the severely burnt area than in the less burnt area.

6.3.4. Herbs

Of the 48 herb species recorded in the less and severely burnt areas, eighteen were used by the tribals as medicine.

6.3.4.1. Species richness and diversity

Total number of herb species was higher in the less burnt area (33) than in the severely burnt area (26). Similarly, number of medicinal herbs was also higher in the less burnt area (13) than in the severely burnt area (9, Table 6.5). Herb species diversity index was significantly higher (M-W test U=7.5, *P*=0.03) in the less burnt area (H'=2.69) than in the severely burnt area (H'=2.12).

6.3.4.2. Density

Total density of herbs was higher in the severely burnt area (17.5/m^2) than in the less burnt area (14.98/m^2, Table 6.5). However, the difference was not significant (M-W test U= 15, P= 0.22). Similarly, density of medicinal herbs also showed no significant difference (M-W test U= 14, P=0.17) between the severely burnt (10.31/1m^2) and less burnt area (5.93). Among the medicinal herbs, *Curculigo orchioides* exhibited the highest density both in the less (2.25/ m^2) and severely burnt (6.11/m^2) areas. The difference was significant (M-W test U=3.5, P=0.007).

Table 6.4. Abundance, density and IVI of medicinal shrubs in the less burnt (LB) and severely burnt (SB) habitats.

Species	Less burnt area			Severely burnt area		
	Abundance	Density[1]	IVI	Abundance	Density[1]	IVI
MEDICINAL SHRUBS						
Argyreia cuneata	-	-	-	2	0.1	1.21
Asparagus racemosus	3.5	0.5	6.69	-	-	-
Chromolaena odorata	2.6	0.5	6.93	9.5	6.2	55.99
Clerodendrum serratum	2.3	0.4	5.74	-	-	-
Desmodium velutinum	3	0.5	7.33	3	0.4	6.69
Flemingia strobilifera	4.8	2.6	28.3	-	-	-
Gomphostemma heyneanum	1	0.01	0.78	2.5	0.3	5.1
Grewia hirsuta	1.8	0.9	16.9	5	0.3	3.17
Helicteres isora	1.3	0.1	2.46	-	-	-
Lantana camara	1.4	0.3	5.84	3	0.2	2.67
Leea indica	11.5	10	76.7	9	8.1	75.4
Solanum indicum	1	0.01	0.78	-	-	-
OTHER SHRUBS						
Cymbopogon flexosus	-	-	-	6.1	1.2	13.84
Decaschistia crotonifolia	2	0.3	4.56	11	0.6	4.68
Desmodium pulchellum	4.2	0.6	7.23	1.5	0.1	2.3
Grewia rotundifolia	2	0.3	4.56	-	-	-
Heteropogon contortus	2.8	0.9	13.2	-	-	-
Imperata cylindrica	4	0.1	1.18	18.5	0.9	6.56
Pavetta tomentosa	1.7	0.3	5.2	-	-	-
Sophora velutina	2.2	0.3	5.61	-	-	-
Themeda cymbaria	-	-	-	6.8	1.4	14.47
Themeda triandra	-	-	-	2.8	0.4	7.9
Total		**18.62**	**200**		**20.2**	**200**
Species diversity Index (H')		**1.76**			**1.66**	

Density denotes number of individuals per 25 m^2; IVI - Importance Value Index.

Table 6.5. Abundance, density and IVI of herbs in the less burnt and severely burnt areas.

Species	Less burnt area			Severely burnt area		
	Abundance	Density	IVI	Abundance	Density	IVI
MEDICINAL PLANTS						
Ageratum conyzoides	5	1.02	11.2	-	-	-
Andrographis neesiana	2	0.02	0.34	1.6	0.08	1.62
Andrographis serphyllifolia	-	-	-	1	0.03	0.87
Anisomeles malabarica	-	-	-	2.2	0.22	3.56
Arisaema tortuosum	-	-	-	1	0.01	0.29
Cissampelos pareira	1	0.01	0.28	1	0.01	0.29
Curculigo orchioides	3.5	2.25	28.7	6.92	6.11	55.86
Cyclea peltata	2.3	0.18	2.84	-	-	-
Hemidesmus indicus	1.6	0.14	2.79	1.43	0.1	2.19
Mimosa pudica	4.5	1.41	16.1	-	-	-
Naravelia zeylanica	1.3	0.04	0.88	-	-	-
Pimpinella monoica	2	0.04	0.67	1.25	0.05	1.21
Premna herbacea	-	-	-	6.79	2.53	23.31
Pseudarthria viscida	3.6	0.18	2.22	-	-	-
Rauwolfia serpentina	1	0.02	0.54	-	-	-
Sida rhomboidea	2.2	0.4	6.62	-	-	-
Urena lobata	2.8	0.22	3.1	-	-	-
OTHER HERBS						
Aneilemma sp.	-	-	-	2.83	1.17	16.45
Apluda mutica	2	0.02	0.34	-	-	-
Arisaema tortuosum	1.3	0.04	0.88	-	-	-
Blumea membranacea	4.2	0.7	8.18	1.5	0.06	1.27
Chlorophytum laxum	1	0.04	1.09	-	-	-
Cholrophytum tuberosum	1.7	0.05	0.95	-	-	-
Coleus malabarica	-	-	-	1	0.03	0.87
Commelina sp	1.8	0.81	15	-	-	-
Curcuma montana	1.9	0.42	7.58	2.8	1.1	15.59
Cynoglossum furcatum	1	0.03	0.82	-	-	-
Cyanotis tuberosa	-	-	-	2.14	0.15	2.47
Desmodium sp	4.6	2.63	29.6	-	-	-
Desmodium triquetrum	2	0.56	9.75	1.57	0.11	2.25
Dioscorea wallichi	1.2	0.07	1.7	-	-	-
Digitaria adscendens	-	-	-	2	0.04	0.69
Globba bulbifera	2.9	0.46	6.4	2.4	0.82	12.86
Indigofera linnaei	1.9	0.19	3.31	2.39	0.66	10.28
Leucas ciliatus	1	0.03	0.82	1.67	0.05	0.98
Mariscus paniceus	-	-	-	4.6	2.34	25.5
Mariscus pictus	-	-	-	1	0.01	0.29
Opilismenas compositus	2.5	0.26	4.05	-	-	-
Paspalidum flavidum	-	-	-	5.03	1.48	15.44
Phyllanthus sp	1.3	0.05	1.16	-	-	-
Polygala sp	-	-	-	1	0.03	0.87
Pteris pellucida	8	1.41	13.2	-	-	-
Scilla sp	-	-	-	1	0.01	0.29
Setaria pallidifusa	3	0.03	0.41	-	-	-
Thunbergia alata	1	0.01	0.28	-	-	-
Trichosanthes sp	-	-	-	1	0.03	0.87
Triumfetta rotundifolia	2.7	1.25	18.3	-	-	-
Vigna radiata	-	-	-	3.44	0.3	3.84
Total		14.98	200		17.5	200
Shannon-Wiener diversity index		2.69			2.12	

Density denotes the number of individuals per m^2; IVI - Importance Value Index..

6.3.5. Regeneration of medicinal trees

6.3.5.1. Seedlings

Density of medicinal plant seedlings showed significant difference (M-W test U= 3, P<0.001) between the less (1930/ha) and severely burnt area (7050/ha). In the less burnt area, *Dalbergia latifolia* exhibited the highest density of seedlings followed by *Anogeissus latifolia* (Table 6.6.). While in the severely burnt area *Phyllanthus emblica* exhibited the highest density of seedlings followed by *Shorea roxburghii* and *Anogeissus latifolia*. The seedlings of *Lagerstroemia microcarpa, Schrebera swietenioides, Semecarpus anacardium* and *Zizyphus xylopyrus* were recorded only in the severely burnt area. The opposite was true in the case of *Pongamia pinnata* and *Randia dumetorum*. Medicinal trees such as *Cassia fistula, Lagerstroemia parviflora, Phyllanthus emblica, Pterocarpus marsupium, Shorea roxburghii* and *Terminalia paniculata* showed higher density of seedlings in the severely burnt area than in the less burnt area (Figure 6.4). But, *Dalbergia latifolia* produced higher number of seedlings in the less burnt area (450/ha) than in the severely burnt area (210/ha) however, the difference was not significant.

6.3.5.2. Saplings

Species contributing a higher number of seedlings in the severely burnt area had fewer individuals in the saplings. However, *Lagerstroemia parviflora, Phyllanthus emblica* and *Shorea roxburghii* produced higher number of saplings in the severely burnt area (Figure 6.4). Although, density of medicinal plant saplings was higher in the severely burnt area (2800/ha) than in the less burnt area (1480/ha), the difference was not statistically significant (M-W test U= 31, *P*=0.13). In the less burnt area, *Shorea roxburghii* exhibited the highest density of saplings followed by *Grewia tiliaefolia* (Table 6.6) while in the severely burnt area, *Shorea roxburghii* exhibited the highest density followed by *Phyllanthus emblica*. The saplings of *Lannea coromandelica* and *Sophora velutina* were recorded only in the less burnt area while *Bridelia retusa* and *Semecarpus anacardium* were recorded only in the severely burnt area. *Terminalia chebula* which had mature trees both in the less and severely burnt area lacked regeneration. The ratio between the number of individuals of adults and seedlings and saplings were greater in the severely burnt area for most of the medicinal plants than in the less burnt area (Table 6.6).

Table 6.6. Density/ha of seedlings and saplings in the less and severely burnt areas

Species	Less burnt area				Severely burnt area			
	A	SE	SA	Ratio*	A	SE	SA	Ratio*
Anogeissus latifolia	142	390	10	1:3	117	870	280	1:10
Bauhinia racemosa	8	50	-	1:6	4	80	-	1:20
Bridelia retusa	1	40	-	1:40	1	250	80	1:330
Cassia fistula	10	70	30	1:10	3	90	-	1:30
Dalbergia latifolia	21	450	230	1:32	13	210	-	1:16
Grewia tiliaefolia	8	100	300	1:60	8	300	-	1:3
Lagerstroemia microcarpa	-	-	-	1:0	-	340	-	0:340
Lagerstroemia parviflora	28	50	-	1:2	18	240	120	1:20
Lannea coramandelica	3	-	10	1:3	3	-	-	1:0
Phyllanthus emblica	33	260	90	1:11	18	1460	560	1:112
Pongamia pinnata	-	20	-	0:20	-	-	-	-
Pterocarpus marsupium	10	110	20	13	9	270	-	1:30
Randia dumetorum	1	90	140	1:230	-	-	-	-
Schrebera swietenioides	2	-	-	1:0	2	160	-	1:80
Semecarpus anacardium	2	-	-	1:0	1	560	80	1:640
Shorea roxburghii	9	100	410	1:57	4	1210	1480	1:673
Sophora velutina	-	-	80	0:80	-	-	-	-
Tectona grandis	32	110	130	1:8	31	350	200	1:18
Terminalia chebula	2	-	-	2:0	2	-	-	2:0
Terminalia paniculata	14	90	30	1:9	11	580	-	1:53
Zizyphus xylopyrus	1	-	-	1:0	1	80	-	1:80
Total		1930	1480			7050	2800	

A - Mature trees, SE - Seedlings, SA - Saplings; Ratio between the number of individuals of adults and seedlings and saplings.

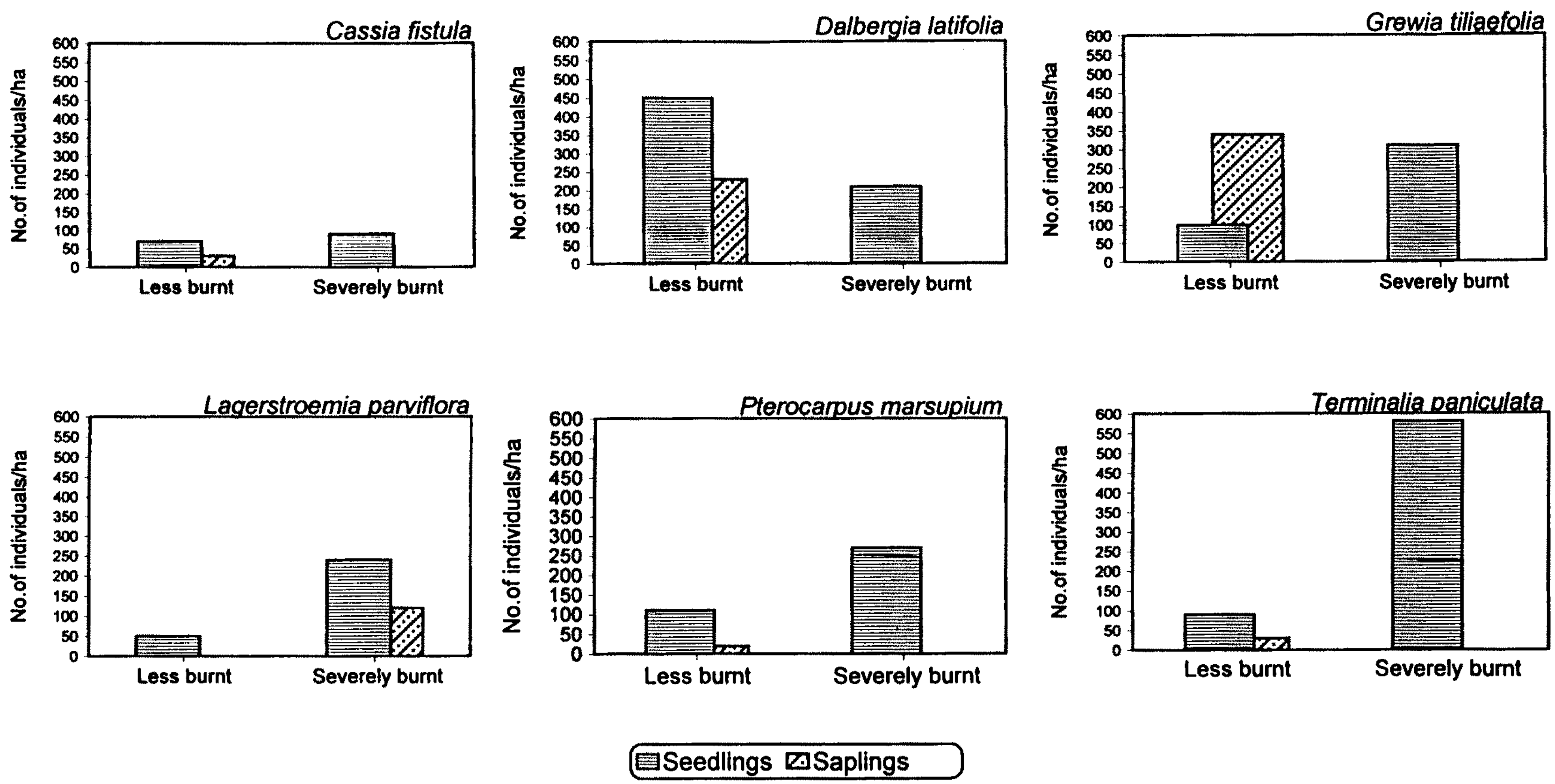

Figure. 6. 4. Density/ha of seedlings and saplings of some medicinal tree species in the less and severely burnt area

6.4. DISCUSSION

The main causes of the dry-season fire are undoubtedly due to man for getting grazing material for their cattle. It is especially difficult to protect dry tropical forests from the pyrogenic activities of humans in the densely populated lands in Asia (Goldammer 1990). In Wayanad WLS, fire is often set by local people to produce new grazing material. Grass species such as *Imperata cylindrica* and *Themeda* spp. were abundant in the burned areas. The dead shoot materials of these grass species form an acute fire hazard (Mueller-Dombois and Goldammer 1990).

Fire also promotes the growth of grass species than the other woody species (Goldammer 1990; Kinnaird and O'Brien 1998), in other words fire affects the species composition. Fire also increases biomass production in burned natural grasslands in southern India (Senthilkumar *et al* 1998). In the present study, grasses such as *Themeda cymbaria* and *T.triandra* were recorded only from the severely burnt area while *Imperata cylindrica* had higher density in the severely burnt area. Similarly, density of *Chromolaena odorata*, an exotic weed was significantly higher in the severely burnt area than in less burnt area. This exotic weed competes with other native species mainly for space, nutrients, light and water (Ramakrishnan 1991). *C. odorata* is capable of resprouting after burning and converts the forest in to thickets by its vigorous growth and sprawling habit (Ramakrishnan 1991) and it is also highly allelopathic to other plants (Sahid and Sugau 1993). Thus, the present study indicates that fire not only changes the species composition but also promote the growth of grass and exotic weed species.

6.4.1. Impact of fire on species richness, diversity and density

It has been observed that frequent fire reduce the species richness (Pinard and Huffman 1997). In the present study, shrub species richness was higher in the less burnt than the severely burnt area. In tropical forests species richness may vary from 19 to 39 species per hectare (Sukumar *et al* 1992). Therefore, the observed differences may not be ecologically significant.

Tree and shrub species diversity index showed no significant difference between the less burnt and severely burnt area. However, herb species diversity index was significantly higher in the less burnt area than in the severely burnt area. Lesser herb species diversity index in the severely burnt area could be due to lack of nutrients and lack of propagules.

There was no significant difference between the two sites with respect to the total and medicinal density of trees, shrubs and herb species. However, density of medicinal plant seedlings was significantly higher in the severely burnt area than in the less burnt area. The higher seedlings density in the severely burnt area could be due to the availability of more sun light because of tree mortality, immigration of seeds through wind and animals, reduced competition and germination of seeds.

Frequent fire clearly affect the size-class distribution of the trees by widening the gap between the mature overstorey and regeneration (Goldammer 1990). However, in Wayanad WLS, the size class distributions of trees (GBH $\geq$ 20cm) were not significantly different between the less and severely burnt area.

Lesser number of trees in lower GBH classes of the severely burnt area indicate the mortality of young trees due to burn injury. The high mortality rates in the lower size classes could also be due to self-thinning (Harper 1977), grazing and other human disturbances.

6.4.2. Impact of fire on regeneration

Species regeneration and recruitment in the fire affected areas occurred from resident sources such as resprouting stumps and rhizomes, seed bank germination, and from immigration of seeds, such as via wind and birds. Homer *et al* (1998) have also reported the same in Melajo Nature Reserve, Trinidad and Tobago. The present study showed that seedlings density was significantly higher in the severely burnt area than in the less burnt. Several authors (Puyravaud *et al* 1995; Kikkim and Yadava 1998; Calvo *et al* 1999) have also reported the enhanced germination after fire. The higher regeneration in the severely burnt area may be due to the creation of large number of microsites by forest burning, which might help in germination of large number of tree seeds (Reader *et al* 1995). Removal of overstorey trees might have also favoured germination and seedling establishment through increased solar radiation on the forest floor and consequent increase in surface temperature and reduced competition from the trees of upper canopy (Noble and Slatyer 1980). On the other hand, poor seedling population in the less burnt area may be due to the unavailability of the same favourable conditions. Besides, thick layer of litter also acts as a mechanical barrier for seedling emergence.

The seedlings of *Lagerstroemia microcarpa, Schrebera swietenioides, Semecarpus anacardium* and *Zizyphus xylopyrus* were recorded only in the severely burnt area. Burning may induce the recruitment of seedlings of these species by removing seed coat coupled with the availability of more nutrients from ash. The enhanced germination after fire has been reported as an adaptation to recurring fire (Tarrega and Luis 1987 and Goto *et al* 1996).

However, survival of the seedlings seems to have been affected by fire in the study area. Most of the species that had a higher number of seedlings in the severely burnt area had fewer individuals in the sapling classes. Puyravaud *et al* (1995), Cochrane and Schulze (1999) have also recorded the reduced abundance of saplings after fire in a dry deciduous forest in the Bandipur National Park and in the tropical forests of eastern Amazon respectively. It has been reported that frequent fire is the most important factor that affect the natural regeneration in the forest and cause its degradation (Rai and Saxena 1997; Kikkim and Yadava 1998).

Anogeissus latifolia exhibited higher density of mature trees and seedlings in the severely burnt area. It shows the fire tolerance of this species. Fire tolerance of *Anogeissus latifolia* was also recorded by Naidu and Srivasuki (1994) in Seshachalam Hills, south India. *Dalbergia latifolia* produced higher number of seedlings in the less burnt area, which is consistent with Puyravaud *et al* (1995). This could be due to the sensitiveness of this species to fire. The failure of regeneration of *Terminalia chebula* both in the less burnt and severely burnt areas may be due to the devastation of its seed during fire and commercial extraction of fruits. Srivastava *et al* (1998) also observed the failure of regeneration of *T.chebula* after fire in the Eastern Ghats. However, it is essential to look into the possible impacts of other anthropogenic pressures such as grazing, harvesting of NTFP and Impact of exotic weeds to arrive in the role of fire on medicinal plant regeneration. In order to do so we require elaborate experimental studies for a long term period.

6.4.3. Impact of human activities

Human beings have impacted the forests in Wayanad WLS for a very long time. Paniyas, Kurumbas and Bettakurumbas are the tribal groups who have been living in these areas for several years, gathering forests products, practising shifting cultivation and hunting wild animals (Prabhakar 1994). The differences in the species composition, abundance and regeneration between the less burnt and severely burnt area could also be due to differences in history and current land use patterns. Differences in microclimate, soils and grazing could also influence the outcome.

The present study supports the observation that frequent fire reduce the species richness and change the species composition by promoting the growth of grass species (Pinard and Huffman 1997). Fire also promotes the growth of *Chromolaena odorata,* an exotic weed, which is a rapid coloniser and it is highly allelopathic to other indigenous species. Though, fire promotes the regeneration of seedlings, it affected the saplings. However, the effect of fire in ecosystems can vary considerably, depending on its succession stage, condition of the vegetation and fuels, season, and the nature of fire. Therefore, long-term monitoring of impacts of fire on the status, distribution and regeneration of medicinal plants over a larger area will give more information. As the Impact of fire on plant population may vary between habitats, studies on Impact of fire on medicinal plants in other fire prone habitats are suggested.

6.5. SUMMARY

Impact of fire on the structure, species composition and regeneration of medicinal plant population in dry deciduous forests were studied in the less and severely burnt areas of Wayanad WLS. Categorisation of less and severely burnt area was based on the information collected from the local tribal people and forest officials.

i Total tree species richness, diversity index, tree density and basal area showed no significant difference between the less and severely burnt area. Similarly, size class distribution of trees (GBH $\geq$ 20cm) also showed no significant difference between the less and severely burnt area.

ii. Species richness, diversity index and density of medicinal shrub species also showed no significant difference between the less and severely burnt sites. However, herb species diversity index between these two sites showed significant difference. Although total density of herbs was higher in the severely burnt area than in less burnt area, the difference was not significant.

iii. Density of seedlings was significantly higher in the severely burnt area than in the less burnt area. However, density of saplings showed no significant difference between these two habitats.

iv. The present study supports the earlier findings that the fire changes the species composition of habitat by promoting the growth of grass and exotic plant species. However, the Impact of fire on plant populations may vary between the area, year and season. Therefore, long term studies on the Impact of fire on other areas of NBR are suggested to get more supportive information on this matter.