Effect of Fire on Plant Diversity And Germination

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Abstract- **A forest fire is a natural disaster & poses a threat not only to the forest wealth but disturbs the biodiversity & the environment of a region. Fire are a widespread phenomenon in Indian forests. In India forest areas prone to forest fires annual range from 33% in some state to over 90% in others. Fire occur during early January to June each year with the highest fire frequency in March-April with the proliferation of forest fire in the study area it is necessary to understand the effect of fire on the diversity, regeneration. The burned forest had, in general much lower tree species than the fire free forest. This is due to recurrent fire in fire impacted area over the year. In sampled plots, in the post fire season of the 31 species, 16 species are found regeneration & 15 species with poor regeneration. Burned forests are valuable and should conserved with long term monitoring programs.**

Key words: Forest fire, Diversity, Regeneration. Fire impacted area, Conservation.

INTRODUCTION

A forest fire is a natural disaster and poses a threat not only to the forest wealth but disturb the bio-diversity and the ecology and environment of a region. Forests fires are as old as the forests themselves. Natural fires have been a disturbance of several ecosystems throughout evolution thus plants have adapted to this regime. Man-made fires have also coexisted in equilibrium with ecosystems for centuries, but the continuous increment in pressure on forests and unmanaged fire use by stakeholders, has led to adverse consequences for the diversity and structure of forests.

The occurrence of fires in the tropics is regular and frequent and they have been associated with the dynamics of tropical savannas (Budowski, 1956; Clayton, 1961). There are two types of forest fire- the surface fires, spreading along the ground as the surface litter (senescent leaves and twigs and dry grasses etc.) on the forest floor and is engulfed by the spreading flames and crown fires, in which the crown of trees and shrubs burn, often sustained by a surface fire. Most fires today are thought to be human-caused and are commonly considered to be a major cause of forest degradation.

Forests play a crucial role in climate change mitigation and adaptation. The burning of vegetation gives off not only carbon dioxide but also a host of other, noxious gases such as carbon monoxide, methane, hydrocarbons, nitric oxide and nitrous oxide, that lead to global warming and ozone layer depletion.

Fires are a widespread phenomenon in Indian forests. In India, forest areas prone to forest fires annually range from 33% in some states to over 90% in others. An estimated annual economic loss of Rs.440 crores is reported on account of forest fires over the country (Bahuguna and Singh, 2002).

In India, of the 63 million ha of forests, an area of around 3.73 million ha can be presumed to be affected by fires annually (Roy, 2003) and fires occur during early January to June each year with the highest fire frequency in March-April.

There is need to carry out operational fire monitoring and its impacts on biodiversity in India in response to concerns over the loss of forests and effects of widespread burning on global atmosphere since our knowledge on its causes, their effect on forest ecosystems is extremely limited.

With the proliferation of forest fires in the study area, it is necessary to understand the effects of fire on the diversity, regeneration, forests before and after it has been disturbed by fire. The key objective of the present study is to assess and compare the diversity patterns, regeneration in burnt and un-burnt plots of the study area.

REVIEW OF LITERATURE

IMPACTS OF FOREST FIRES

Sowmya and Somashekar (2010) developed forest fire risk zone mapping using remote sensing and at Bhadra wild life sanctuary in India. They are studied 6.59% area falls in the very high fire risk, followed by 3.72% in high fire risk, 32.34% in medium fire risk, 49.55% in low, 7.72% and 0.05% in water and built up area respectively.

FOREST FIRE-GLOBAL CLIMATE

Forest fires affect the global carbon cycle, and thus the climate, in three main ways (Kasischke and Stocks, 2000). First, fire releases large quantities of carbon into the atmosphere through the combustion of plant material and surface soil organic matter.

Second, fire-killed vegetation decomposes over time emitting carbon. Third, the vegetation on newly burned sites may not absorb as much carbon from the atmosphere as the decaying vegetation emits, or as much as the pre-fire vegetation absorbed, for several years or decades after a fire.

Some studies suggest universal increases in fire frequency with climate warming (Overpeak *et al.* 1990). According to Price and Rind (1994), 44% increase in lightning-caused fires with an associated 78% increase in area burned for the 2XCO2 scenario.

FIRE EFFECTS ON VEGETATION AND PLANT DIVERSITY

Forest function, structure and vegetation composition of any region is primarily influenced by forest fires (Flannigan *et al.*, 2005). Frequent disturbances such as fires may influence the relative abundance of species that are able to reproduce vegetatively, causing a shift in species composition, favoring species capable of vegetative reproduction (Hoffmann, 1998; Setterfield, 2002).

Forest fires affect vegetation by suppressing certain species and promoting other species causing changes in vegetation structure and altering successional pattern (Syaufina & Ainuddin, 2011).

The effects of fire on vegetation are often due to the independent or combined effects of fire-related cues, the immediate and obvious cues being heat and smoke (Paradesa, 2008). For fire-prone environments, dry heat has long been recognized as an effective cue for breaking dormancy in seeds of a number of species (Baskin and Baskin, 1998; Light and Van Staden, 2004).

FIRES ON PLANT GROWTH AND GERMINATION

Dry season fires are more destructive not only due to its intensity but also this period coincides with the time that woody plants higher moisture content, hence higher thermal conductivity and rapid transfer of heat to the interior of the plant tissues (Frost and Robertson 1977. Fire tends to favour those woody species which have protected meristems and below-ground reproductive organs and seeds that can survive fire and in which heat triggers germination (West, 1972; Everhan and Brokan, 1996).

In dry savannas, fires seldom occur frequently enough to limit the density of woody plants, though when they occur, often after prolonged period of above-average rainfall, mature woody plants may experience considerable mortality (Younes, 1986).

FIRE EFFECTS ON REGENERATION

According to Barlow *et al.*, (2003) there is a two-fold increase in mortality of large trees between 1 and 3 years from low-intensity fires in tropical forests. Sonali Saha and Howe (2003) observed in their experiments that low intensity ground fires killed seedlings (< 1 year old), resulting in a 30% decrease in seedlings diversity in burnt relative to unburned plots in Central India. Mohamed *et al.* (2011) found that regeneration of *Acacia origena* increased significantly after fire but in contrast, *Juniperus procera* was very sensitive to fire and most burned trees failed to recover or regenerate.

MATERIALS AND METHODS

Three-fold objectives of the present study are: to look at the plant diversity patterns and analyse regeneration of tree species in two selected fire-impacted areas (Mogilipenta and Tabellaru) in Ballapalle all located in Rajampeta Forest Division, Kadapa district, Andhra Pradesh . Rajampeta Forest division fall in Seshachalam hill ranges, Eastern Ghats of Andhra Pradesh.

STUDIES ON PLANT DIVERSITY AND REGENERATION

For the purpose of studying plant diversity patterns and tree regeneration in fire affected forest areas, two localities: Mogilipenta and Tabelleru were selected in Ballapalli Forest range, the former representing high-fire zone and the latter and no-fire zone. Geography and biotic interference factors of both the localities are presented in **Table 1a.**

SAMPLING DESIGN

TREES

Trees were enumerated in 4 plots of size 20 x 20m lay in four corners ((North-East, North-West, South-East and South-West) of 1000 x 1000m site area .

SHRUBS AND REGENERATION OF TREES

A total of 16 quadrates of 5 x 5m were laid within 1000 x 1000m site area for shrub, seedling and sapling enumeration: 4 quadrates in four within corner tree plots of 20 x 20m size; and one 5 x 5m quadrate for every 250m distance along the site border (total 12 quadrates).

HERBS/VINES

A total of 22 quadrates of size 1 x 1m were laid within 1000 x 1000m site area for herbaceous taxa enumeration: 4 quadrates within 4 corner shrub plots of 5 x 5m; 12 quadrates along the site border separated by 250m and 6 in the central portion of the sample site placed at a distance of 250m.

RESULTS AND DISCUSSION

For the purpose of studying plant diversity patterns and tree regeneration in fire affected forest areas, two localities: Mogilipenta and Tabelleru were selected in Ballapalli forest range, the former representing high-fire zone and the latter and no-fire zone. Both

destructive and non-destructive approach of biomass estimation has been done in three burnt and three unburnt sampling sites in Rajampeta Forest Division.

PLANT DIVERSITY OF THE SAMPLE PLOTS

In all the sampling plots laid for studying plant diversity, a total of 125 species belonging to 54 families were recorded. present systematic enumeration of plant taxa based on Bentham and Hooker's classification. Of these, 34 species were trees, 13 shrubs, 7 climbers and 71 herbs (**Table 2**). Contribution of herbs to the total species is high (56.8%), followed by trees (27.2%), shrubs (10.4%) and climbers (5.6%). Poaceae is the largest family with 28 species followed by Euphorbiaceae 9, Fabaceae 8 and Acanthaceae 6 species.

SPECIES DISTRIBUTION IN PRE-FIRE AND POST-FIRE SEASONS

In pre-fire season, in high fire zone, 44 species are recorded; in no fire zone, 74 species. In post-fire season, in high fire zone 55 species are recorded and no-fire zone, 88 species. It is clearly evident that species diversity is more in no-fire zone than in high fire zone (**Table 2**).

COMMON TO NO-FIRE AND HIGH-FIRE ZONES

A total of 26 plant species recorded common in no-fire and high fire zones in both the seasons.

EXCLUSIVE TO PRE-FIRE SEASON

Four species are exclusive to high-fire zone are: climber (1)-*Thunbergia fragrans;* herbs (3)-*Apocopis vaginata, Senecio tenuifolius,* and *Tragia involucrata* var. *angustifolia.*

EXCLUSIVE TO POST-FIRE SEASON

Twenty seven species are exclusive to no-fire zone

.In the present study, burned forest had, in general, much lower tree species richness than the fire-free forest (**Table 2**). In case of trees, of the 34 recorded,.

TREE REGENERATION

Regeneration is a key process for the existence of species in a community. Presence of seedlings and saplings of tree species in a forest is an indication of its regeneration and complete absence of seedlings and saplings is an indication of its poor regeneration. In the sampled plots, in the post-fire season, of the 31 species, 16 species are found with fair regeneration and 15 species with poor regeneration (**Table 4**). Absence of seedlings and saplings of some species in the forest area is attributed to their poor seed germination, establishment of seedlings and biotic pressure (**Fig. 1**).

Our observations have revealed that anthropogenic fires stunt the regeneration of many tree species, although its impact is less on species diversity. Change in species composition is accompanied by reduction in stature of regenerating tree species caused by anthropogenic fires to over and above due to seasonal drought. The dry deciduous forest showed a significant tendency of increase in the proportion of coppices with increased fire frequency. When comparing the inventories, it was found that the ability of species to re-sprout increased tremendously over time, independently of fire occurrence and vegetation type

CONCLUSIONS

In all the sampling plots laid for studying plant diversity, a total of 125 species belonging to 54 families were recorded. Of these, 34 species were trees, 13 shrubs, 7 climbers and 71 herbs. Poaceae is the largest family with 28 species. In pre-fire season, in high fire zone, 44 species are recorded; in no fire zone, 74 species. In post-fire season, in high fire zone 55 species are recorded and no-fire zone, 88 species. It is clearly evident that species diversity is more in no-fire zone than in high fire zone.

A total of 26 plant species recorded common in no-fire and high fire zones in both the seasons. Four species are exclusive to high-fire zone and no tree is recorded in this category. It is interesting to note that no tree species exclusively recorded in this season meaning that all trees recorded in the terrain have one or other level tolerance to fire. Twenty seven species are exclusive to no-fire zone including 8 trees. These species appear withstanding fire impact on their growth.

In the present study, burned forest had, in general, much lower tree species richness than the fire-free forest. This is due to recurrent fire in fire impacted area over the years. Trees slowly return by sprouting or from the seed bank but are dominated by grasses. Trees sprouts occur with low density and lower growth rate, but account for a significant part of the richness of the community.

Regeneration is a key process for the existence of species in a community. In the sampled plots, in the post-fire season, of the 31 species, 16 species are found with fair regeneration and 15 species with poor regeneration. *Buchanania axillaris, Ochna obtusata, Pterocarpus santalinus, Syzygium alternifolium, Terminalia alata* and *T. pallida* trees shown good regeneration compared with other trees. Our observations have revealed that anthropogenic fires stunt the regeneration of many tree species, although its impact is less on species diversity.

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TABLE 1a: FEATURES OF SAMPLE SITES FOR PLANT DIVERSITY AND REGENERATION STUDIES

ZONES	HIGH-FIRE	NO-FIRE
Location	Mogillipenta	Tabelleru
Geo. coordinates	13° 46' 17.6" N 79°17' 14.3" E	13° 47' 47.6'' N 79° 14' 45.4'' E
Altitude	839 m	843 m
Forest Division	Rajampeta	Rajampeta
Forest Range	Balla palli	Balla palli
District	Kadapa	Kadapa
Edaphic factors		
Soil type	Loam	Loam
Soil color	Black	Black
Topographic factors		
Canopy	60%	80%
Slope	35°	10°
Biotic interference		
Lopping	Absent	Absent
Collection of litter	Absent	Absent
Grazing	Absent	Absent
Weeds	Low	Absent
Extraction	Absent	Absent
Encroachment	Absent	Absent
Foot paths/Roads	>25km	>15km
Cut stumps	Absent	Absent
Soil Removal	Absent	Absent
Fire	High	Absent

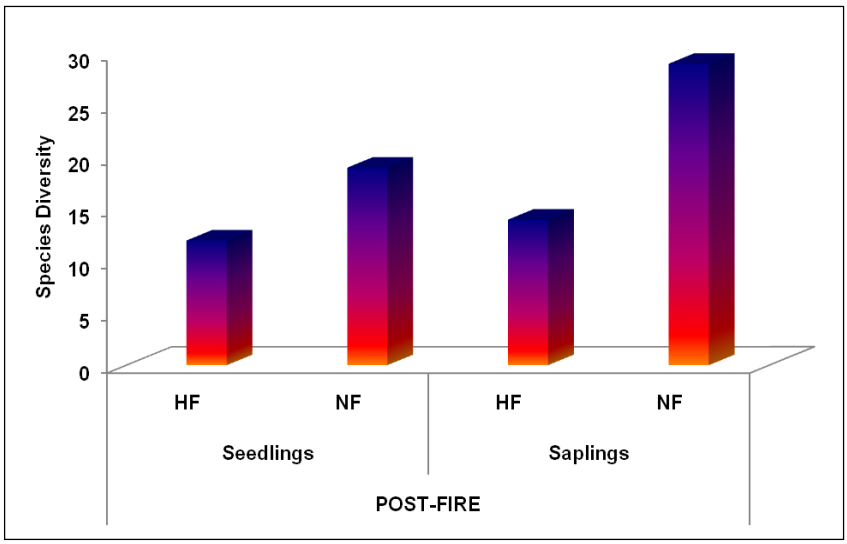

Figure -1: Regeneration of tree species diversity of post-fire season

TABLE 2: LIFE FORM WISE OCCURRENCE IN HIGH-FIRE AND NO-FIRE ZONES

S. No	NAME OF THE SPECIES	FAMILY	PRE-FIRE		POST-FIRE	
			HF	NF	HF	NF
TREES						
1	*Actinodaphne madraspatana*	Lauraceae	-	-	-	+
2	*Anogeissus latifolia*	Combretaceae	+	+	+	+
3	*Bridelia airy-shawii*	Euphorbiaceae	-	+	+	+
4	*Buchanania axillaris*	Anacardiaceae	+	+	+	+
5	*Careya arborea*	Lecythidaceae	-	+	-	+
6	*Casearia elliptica*	Flacourtiaceae	-	+	-	+
7	*Chloroxylon swietenia*	Flindersiaceae	-	-	-	+
8	*Cycas beddomei*	Cycadaceae	+	+	+	+
9	*Diospyros melanoxylon*	Ebenaceae	-	-	-	+
10	*Dolichandrone atrovirens*	Bignoniaceae	+	+	+	+
11	*Eriolaena hookeriana*	Sterculiaceae	-	-	-	+
12	*Erythroxylum monogynum*	Erythroxylaceae	-	-	+	+
13	*Gardenia gummifera*	Rubiaceae	+	+	+	+
14	*Glochidion velutinum*	Euphorbiaceae	-	-	+	+
15	*Helicteres isora*	Sterculiaceae	-	-	-	+
16	*Holarrhena pubescens*	Apocynaceae	-	+	-	+
17	*Madhuca indica*	Sapotaceae	-	-	-	+
18	*Memecylon edule*	Melastomataceae	-	-	-	+
19	*Miliusa tomentosa*	Annonaceae	-	+	-	+
20	*Ochna obtusata* var. *obtusata*	Ochnaceae	+	+	+	+
21	*Phoenix loureirii*	Arecaceae	+	+	+	+
22	*Phyllanthus emblica*	Euphorbiaceae	+	+	+	+
23	*Polyalthia cerasoides*	Annonaceae	-	+	-	+
24	*Pterocarpus santalinus*	Fabaceae	+	+	+	+
25	*Semecarpus anacardium*	Anacardiaceae	-	-	+	+
26	*Shorea tumbuggaia*	Dipterocarpaceae	-	+	-	-
27	*Suregada angustifolia*	Euphorbiaceae	-	+	-	+
28	*Syzygium alternifolium*	Myrtaceae	+	+	-	+
29	*Syzygium cumini*	Myrtaceae	-	-	+	+
30	*Tectona grandis*	Verbenaceae	-	-	-	+
31	*Terminalia alata*	Combretaceae	+	+	+	+
32	*Terminalia pallida*	Combretaceae	+	+	+	+

TABLE 3: TREE REGENERATION POST-FIRE SEASON

S. No.	Name of the species	POST-FIRE			
		Seedlings		Saplings	
		HF	NF	HF	NF
1	*Actinodaphne madraspatana*	0	0	0	4
2	*Anogeissus latifolia*	2	9	1	19
3	*Bridelia retusa*	0	3	3	20
4	*Buchanania axillaris*	36	13	58	40
5	*Careya arborea*	-	-	-	-
6	*Chloroxylon swietenia*	0	0	0	3
7	*Cycas beddomei*	0	3	5	32
8	*Diospyrus melanoxylon*	0	3	0	3
9	*Dolichandrone atrovirens*	0	0	0	3
10	*Eriolaena hookeriana*	0	0	0	1
11	*Erythroxylum monogynum*	6	0	6	2
12	*Gardenia gummifera*	14	8	17	20
13	*Glochidion velutinam*	1	1	4	3
14	*Helicteres isora*	0	0	0	8
15	*Holarrhena pubescens*	0	0	0	4
16	*Madhuca indica*	0	1	0	2
17	*Memecylon edule*	0	0	0	4
18	*Ochna obtusata*	43	22	42	50
19	*Phoenix loureirii*	-	-	-	-
20	*Phyllanthus emblica*	0	1	0	8
21	*Polyathia cerasoides*	0	1	0	1
22	*Pterocarpus santalinus*	18	22	22	37
23	*Semecarpus anacardium*	2	2	2	17
24	*Shorea tumbaggaia*	0	1	0	3
25	*Sygygium cumini*	0	0	0	2
26	*Syzygium alternifolium*	80	34	138	92
27	*Tectona grandis*	0	0	0	1
28	*Terminalia alata*	3	11	5	32
29	*Terminalia pallida*	26	8	53	25
30	*Wendlandia tinctoria*	2	6	2	21
31	*Ziziphus xylopyrus*	0	2	0	4
Total		**233**	**151**	**358**	**461**

HF-High Fire; NF-No Fire