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# Comparative study of effect of prescribe fire on fungal distribution in Rajaji National Park, Uttarakhand India

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**ABSTRACT**

Prescribe fire used as a management tool by the foresters. It affects the biogeochemical cycle that may be positive or negative which completely depend on the duration and intensity of fire. After fire it leaves a short term and long term effect on soil property. Fungal spores are heat sensitive due to which they go under disturbance and take a long time to recolonize in their natural habitat. The present study designed to investigate the effect of prescribe fire on the fungal population at Raja ji National Park Uttarakhand, India. We examined the effects of burning on microfungal species in burnt and unburnt sites by soil dilution plate method. It would be interesting to know that the fungal population seemed to be decreased in burnt soil as compare to unburnt and quantitatively the fungal species were decline significantly on burnt site. Genera Aspergillus found to be dominated in both the sites but comparatively in burn it was 42% (less) and in unburnt it was 52% (high). *Aspergillus fumigatus, Aspergillus versicolor, Rhizopus spp, Curvularia spp* and Sterile colony C & D was absent in burnt site during the study.

**Keyword:** Prescribe fire, fungal population, ecosystem

## INTRODUCTION

A forest fire can severely change the basic structure of the forest ecosystem. The effect of fire is quite complex to understand, ranging from the removal of aboveground biomass to affecting the physical, chemical, and biological attributes of soil ecosystems (Neary *et al*., 1999). The changes produce after fire depends on the duration of fire, deposition of fuel load and their combustion rate, type of vegetation (woody and herbaceous both), nature of climate, topography and type of soil etc (Robichaud *et al*., 2000). Microorganism present in soil plays a very important role to maintain the fertility of soil. Fire induce changes in microbial community by altering the

property of soil. As we know microbial biomass, abundance and diversity have been used as the indicator of soil health. Many studies proved that microorganisms work as decomposer, help in nutrient cycling and act as Plant growth regulator (Pietikäinen and Fritze, 1995a; Neary *et al*., 1999; Thirukkumaran and Parkinson, 2000). Microorganisms are the most important link in ecosystem nutrient cycling, if their activity alters in any way positively or negatively, it will affect the ecosystem. Several studies have been conducted to determine the behavior of fire and to analyze its effects on ecosystem at different points with various parameters. Wildfire is one of the widest spread disastrous disturbance in forest ecosystem. To overcome the incidences of wildfire, a low intensity treatment fire is practiced in forests, which reduces the load of fuel (flammable material) and remove fire sensitive vegetations from the forest floor. (Waldrop *et al*., 1992; Glitzenstein *et al*., 1995; Harden *et al*., 2003; Certini, 2005; Callaham *et al*., 2012). But treatment fire also affects the microbial habitat in soil. Fungi are good decomposer and help to maintain soil fertility and act as a key factor in turn-over of carbon and nitrogen. Fire adversely affects soil moisture level which results in the reduction of fungal habitat and their population because fungi thrive in moist condition at low temperature in soil (Neff *et al*., 2005; deRoman and deMiguel, 2005). After fire, ground vegetation burnt completely or partially which may results in release of nutrients like N, P,K organic carbon and micronutrient to the soil, thus availability of nutrients increase to the microorganism. In ancient times when fertilizers were not available, a controlled treatment fire was the most prominent method of fertilization. Therefore it becomes interesting to see the effects of nature of fire in forest. The purpose of this study was to investigate the effects of prescribe fire followed by forest department on fungal population.

## MATERIAL AND METHODS

**Site description:** The study area is located at Chilla Forest range, Raja ji National Park Uttrakhand India. Chilla is one of the third sanctuaries i.e. Chilla, Motichur, and Rajaji which were combined to form Rajaji National Park (Now Rajaji Tiger Reserve). It is situated along the hills and foothills of Shivalik range in Himalaya foothills which spreads over 820.42 sqkm. The Park extends from latitude 29°52' to 30°05' N and 77°55' to 78°19' E longitude. The forest is blessed with luxuriant deciduous and evergreen forest mainly of Sal, Teak and Rohini with grasses and shrubs.

**Isolation and Identification of Fungi**:
Soil samples were collected from burnt and unburnt site from the park. Total 15 samples were collected from each plot in sterile condition at 0-10 cm depth. The samples were brought to the laboratory for further analysis. Make two composites of samples separately as burnt and unburnt. Soil dilution plate method employed for isolation of fungal load (Waksman, 1922). In this method 1 gm of soil sample was suspended in 10 ml buffer solution, shaken well to obtain a solution, before settling of soil particles, it was serially diluted. After that prepared dilutions were inoculated to previously prepared Potato dextrose Agar (PDA) and Rose Bengal Agar (RBA) supplemented with streptomycin to avoid the bacterial growth (in triplicate). Then the plates were incubated for fungal growth at $25^0$C for 10 days (Burges, 1967). The colonies developed after incubation were counted carefully. After that isolated colonies were transferred on Czapex Dox Agar slant for further study and then fungal colonies were studied both macroscopically by colony color and texture and microscopically by lactophenol cotton blue staining method under a compound microscope for the conidial and spore arrangement. The cultures were finally identified with the help of literature. Barnett and Hunter, 1972; Domsch *et al*., 1980; Subramanian, 1983; Ellis, 1993 and Watanabe, 1994; Gilman, 2001 and Nagamani *et al*., 2006.

**Diversity assessment:**
Diversity assessment: All the isolates were assessed for their individual distribution in both the samples for, Fre quency, Abundance, and Density using the following for mulae-(Daniels et al., 1996).

$$Frequency = \frac{\text{Total no. of. Plates in which species occurred}}{\text{Total no. of. Plates studied}} X100$$

$$Abundance = \frac{\text{Total no. of. individual of species}}{\text{Total no. of. Plates in which species occurred}}$$

$$Density = \frac{\text{Total no. of. individual of species}}{\text{Total no. of. Plates studied}}$$

## RESULTS

Distribution pattern of fungal population in burnt and unburnt soil were concluded in Table 1 and figure 1-5. From the present study it is found that the total number of fungal species decreases and their individual species also get affected by fire. Total 21 fungal genera isolated from both samples, genera *Aspergillus Alternaria, Fusarium Cladosporium*, *Rhizopus, Penicillum, Curvularia* and 4 sterile colonies were also isolated. *Aspergillus* is found to be most dominant genera in both the samples. But individually the percentage distribution of *Aspergillus spp* was more followed by *Penicillium spp* and *Fusarim spp* in unburnt soil. Results showed that *Aspergillus fumigatus and Aspergillus versicolor* are not found in burnt soil similarly *Rhizopus spp and Curvularia spp* were also not seen in the burnt soil sample during this study. Total 4 colonies were found as sterile A, B, C and D, out of which sterile colony C and D were absent in burnt during study (Fig 1&2). The frequency of fungal species were found different in burnt site as compare with unburnt site. *Aspergillus okazakii* and *A. tamarii* were found less frequent in burnt soil than that of unburnt. Genera *A. flavipes. A niger, P. notatum* were seem to be same in frequency in burnt as unburnt site i.e. 100% (Fig3). All the fungal species were found most abundantly in unburnt site than burnt site. In unburnt soil *A. flavus*, *F. sambucinum* and *C. chlorocephalum* were observed more abundant followed by others, whereas in burnt soil *A. humicola* and sterile A were more abundant than the other fungal isolates (Fig 4). The density of *Alternaria tenuis* and *Aspergillus niger* were observed higher ( 4.00 and 4.67 individual per gm ) in unburnt soil and in burnt soil density of *Aspergillus niger* was more than other one i.e. 4.33 individual per gm (Fig 5). Overall results show that all the identified genera were more in their frequency, abundance and density in unburnt soil than that in burnt soil except the sterile colonies A & B. (Table 1).

**Table 1-** Distribution pattern of fungal species in burnt and unburnt soil with respect to their frequency (F), Abundance (A) and Density (D).

| Sr. No. | Name of organism | Unburnt site | | | Burnt site | | |
|---|---|---|---|---|---|---|---|
| | | F | A | D | F | A | D |
| 1 | *Alternaria tenuis* | 100 | 4.00 | 4.00 | 67 | 3.00 | 2.00 |
| 2 | *Aspergillus flavipes* | 100 | 3.33 | 3.33 | 100 | 1.67 | 1.67 |
| 3 | *Aspergillus flavus* | 67 | 5.50 | 3.67 | 100 | 3.00 | 3.00 |
| 4 | *Aspergillus fumigatus* | 67 | 3.50 | 2.33 | - | - | - |
| 5 | *Aspergillus humicola* | 100 | 3.00 | 3.00 | 67 | 3.50 | 2.33 |
| 6 | *Aspergillus niger* | 100 | 4.67 | 4.67 | 100 | 3.33 | 3.33 |
| 7 | *Aspergillus versicolor* | 100 | 2.33 | 2.33 | - | - | - |
| 8 | *Aspergillus okazakii* | 67 | 4.50 | 3.00 | 33 | 3.00 | 1.00 |
| 9 | *Aspergillus tamarii* | 100 | 3.00 | 3.00 | 33 | 3.00 | 1.00 |
| 10 | *Blastomyces spp* | 33 | 1.00 | 0.33 | 67 | 1.50 | 1.00 |
| 11 | *Cladosporium chlorocephalum* | 33 | 6.00 | 2.00 | 67 | 2.50 | 1.67 |
| 12 | *Curvularia spp* | 67 | 2.50 | 1.67 | - | - | - |
| 13 | *Fusarium sambucinum* | 67 | 5.00 | 3.33 | 100 | 3.00 | 3.00 |
| 14 | *Mucor spp* | 100 | 2.00 | 2.00 | 67 | 2.00 | 1.33 |
| 15 | *Penicillium notatum* | 100 | 2.67 | 2.67 | 100 | 1.67 | 1.67 |
| 16 | *Rhizopus spp* | 67 | 2.50 | 1.67 | - | - | - |
| 17 | *sterile colony A* | 67 | 3.50 | 2.33 | 67 | 5.50 | 3.67 |
| 18 | *sterile colony B* | 33 | 3.00 | 1.00 | 100 | 2.33 | 2.33 |
| 19 | *sterile colony C* | 67 | 2.00 | 1.33 | - | - | - |
| 20 | *sterile colony D* | 33 | 3.00 | 1.00 | - | - | - |
| 21 | *Penicillium spp* | 33 | 3.40 | 0.33 | - | - | - |

Note = (-) indicate absence/not found

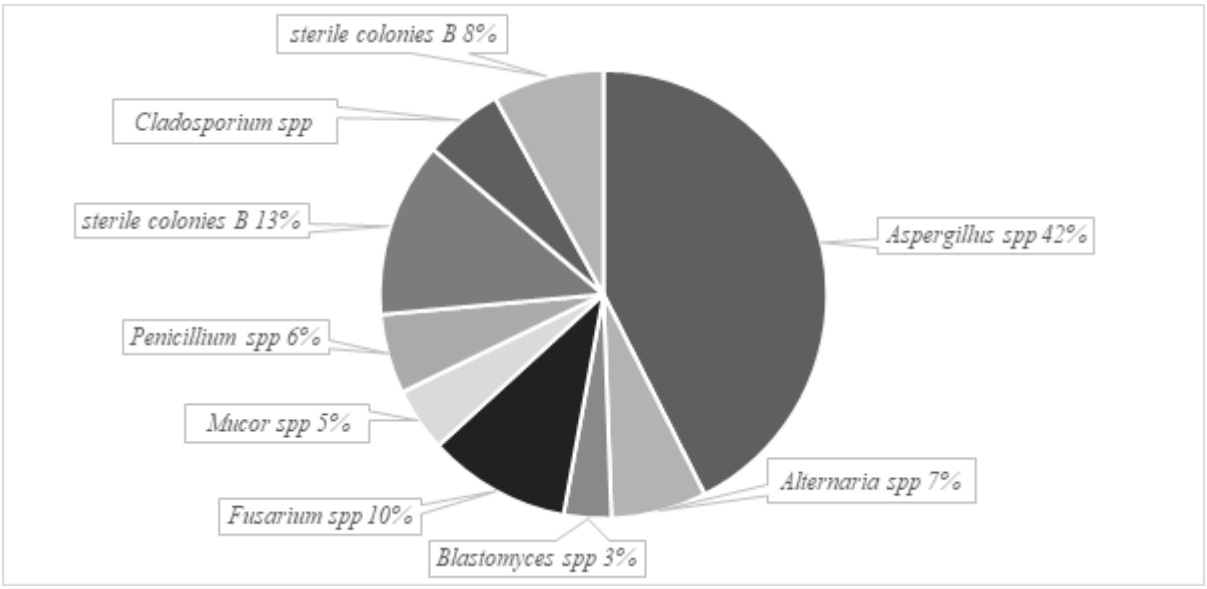


**Fig 1- Distribution percentage of fungal population in burnt site.**

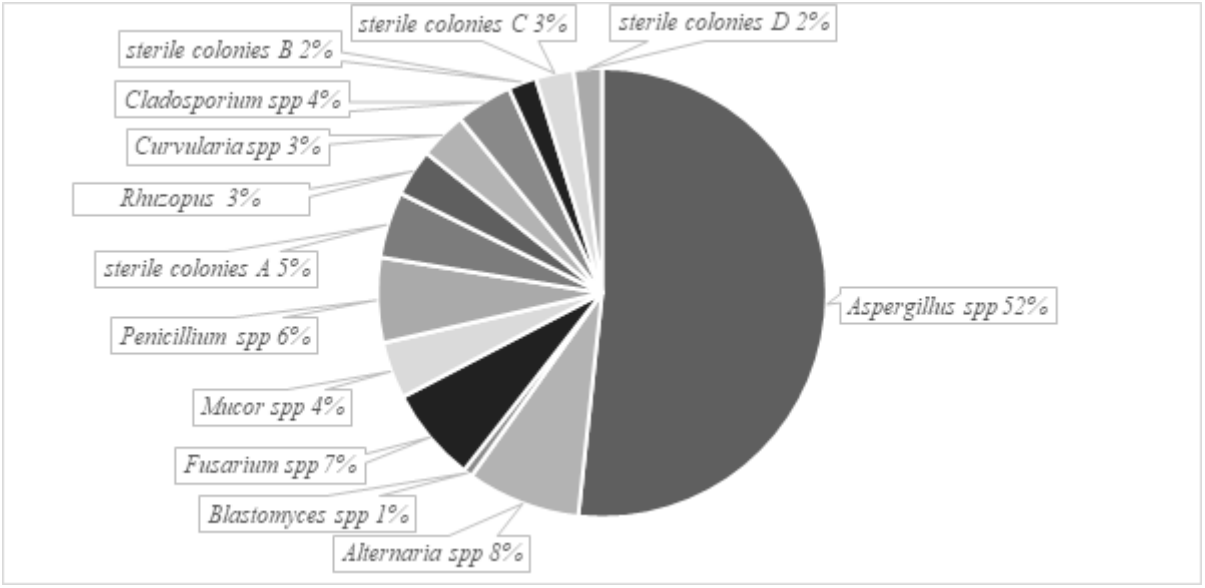


**Fig 2- Distribution percentage of fungal population in unburnt site.**

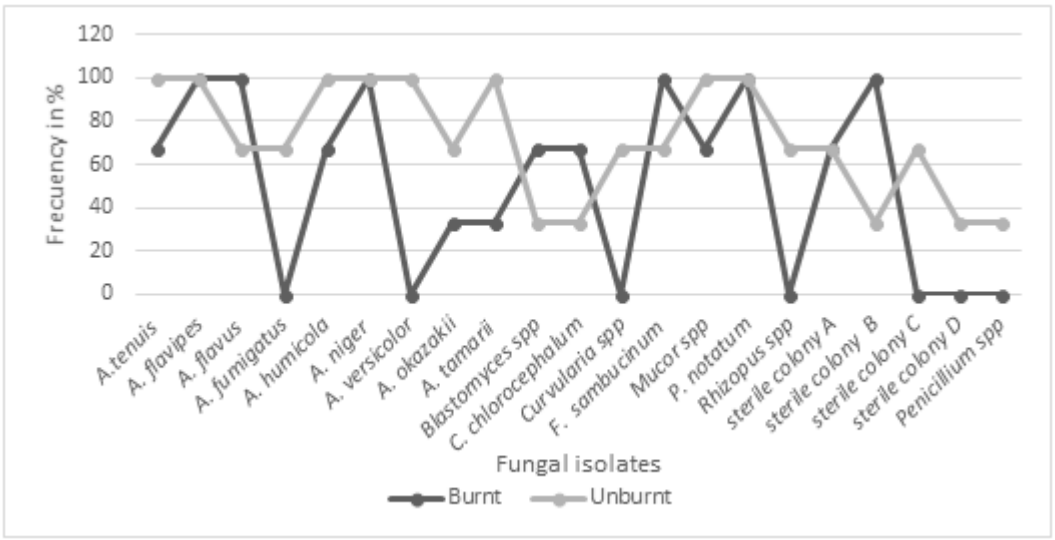


**Fig 3 Frequency Percentage of fungal population in burnt and unburnt sites.**

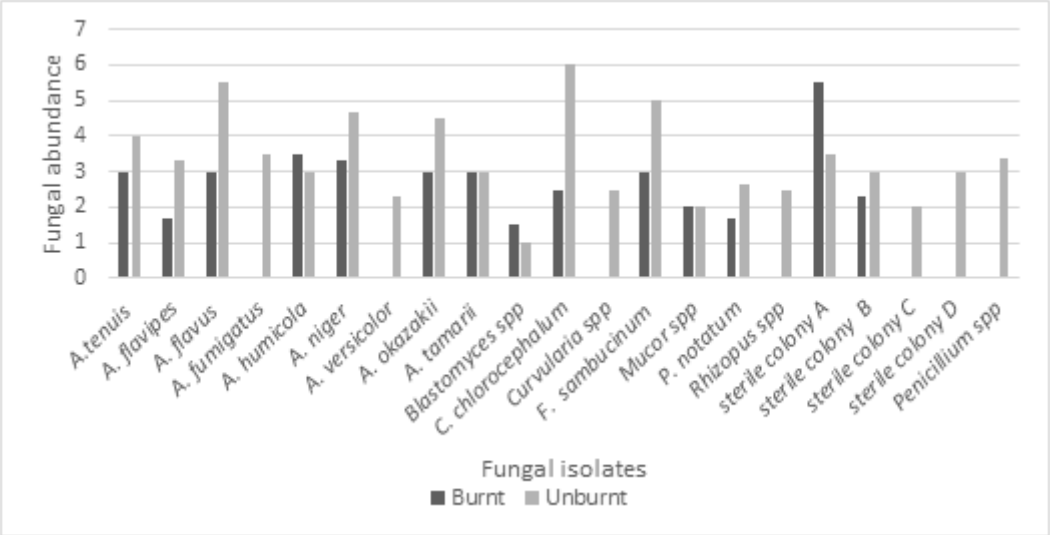


**Fig 4 Abundance of fungal population in burnt and unburnt sites.**

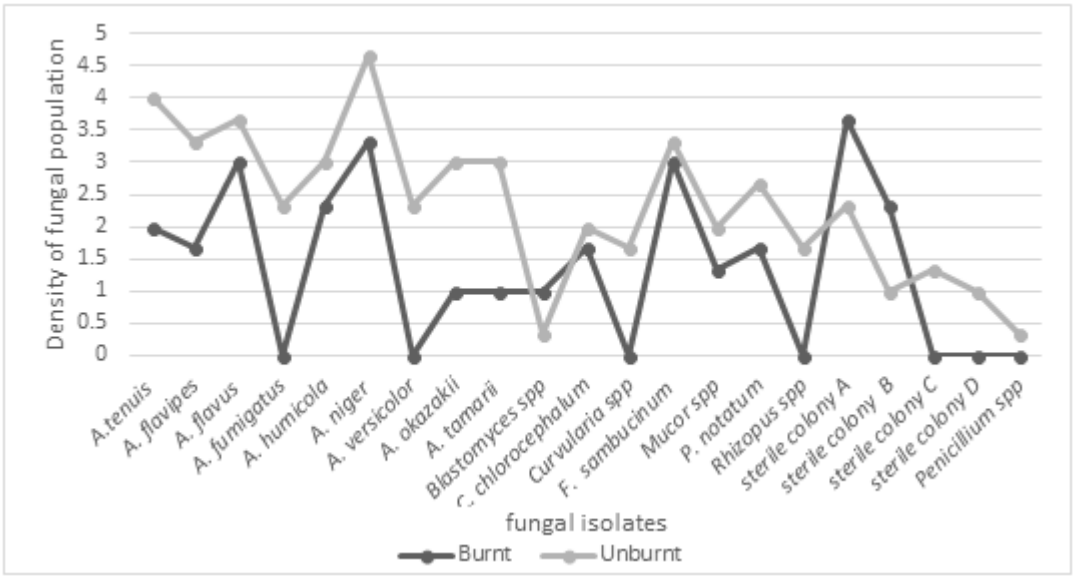


**Fig 5 Density of fungal isolates in both burn and unburn sites.**

## DISCUSSION

As the results show that the fungal population dynamics is different in burnt than that in unburnt sites. Dunn et al., 1985; Pietikäinen and Fritze 1995b studied that fungi are more sensitive to fire than bacteria. According to Saravanan *et al*., 2013 fire severely affect the fungal population resulting in decrease in their number. Fungal spores are responsible for the reproduction of fungi, because of the sensitivity of fungal spores against fire it get eliminated and the number of overall species richness and their individual number decreases. Ranbuss *et al.,* 1973 observed that fungal population grows slow in burnt as compare to unburnt area. Wicklow and Zak, 1979 reported that fire increase the hydrogen ion concentration in soil which favors the germination and recolonization of some species and decreases the competitive potential of other potential fungi. Cooke, 1971 found that *Trichoderma, Penicillium* and *Fusarium* were killed after fire because of their poor recolonization. Ayse and Osman, 2002 reported that Genera such as *Aspergillus, Penicillium* and *Alternaria* were having greater densities while *Trichoderma* and *Cladosporium* were lesser in normal forest. According to Liu *et al*., 2001 fire exerts its effect on the fungal population, it showing a decline in their number after one month of fire. The soil profile also helps microorganism to better adapt. Several studies revealed that soil moisture, pH (Ramo Rao, 1970), salt concentration (Hasenekoglu and Sulun, 1991) and organic matter (Behera and Mukerji, 1985) influence the activity of soil microorganism.

## CONCLUSION

Generally microbial population is found in upper layer up to 0-10 cm depth. Treatment fire burn the upper profile of soil including litterfall, vegetation, macro and microorganism. After prescribe fire, the deposition of ash content favors the growth of herbaceous vegetation, but microorganism goes under pressure for some time because of their being sensitive to heat. Fungi are decomposer and plant growth regulator, which helps to regulate the biogeochemical cycle in the ecosystem. The present study was focused on the distribution of fungal population in burnt and unburnt soil only, which revealed that after prescribe fire fungal population changes quantitatively, but no significant difference was observed qualitatively. Because of the nature of surface fire, in which top soil being exposed to it immediately and the microflora present on the top layer falls into extreme environment. The fungal spores of some species are unable to survive in such condition because of their heat sensitivity so they can not adapt to survive and undergo in declining phase.

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**Conflicts of interest:** The authors stated that no conflicts of interest.

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