Effect of burning on humus soils of Melghat forest

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Abstract

Forest fire is the most common hazard; it produces threat not only to forest wealth, but also to ecology of the region. In the dry season, during the summer where seasonal level of the litter is at its maxima, there is no rain, the forest floor becomes covered with dry litter which could burst into flames due to human ignorance or purposeful sparking. Burning of litter and organic matter of soil leaves ash, charcoal and fire altered material on the forest floor. The fire alters chemical properties of soil. Ash increases pH, total nitrogen content of humus soil, humic acid which is bounded to organic matter, is partially lost. The organic matter, organic carbon and phosphorous of humus soil and Humic acid containing carbon content also decreases.

Key words- litter, organic matter, humus soil, humic acid, fire, burning

Introduction

Fire is important disturbance regime for forested terrestrial systems. Tropical forests are subjected to fire, initiated by humans. The forest fires are caused by heat generated in the litter in summer through carelessness of people or purposely caused by local inhabitants.

The frequency and the intensity of fires depend upon climate, quality of fuel, vegetation tree species, moisture status, topography and human impact (Zackrisson 1977; Engelmark 1984; Masters 1990; Larson 1997; Lehtonen *et al.,* 1997; Larsen *et al.,* 1998). The severity of fires is determined by properties of fuels mainly its surface–to-volume ratio, density and moisture content. In general thin fuels ignite more easily because they conduct heat to the interior poorly (Pietikainen 1999).

The forest fires results in plant mortality and soil get affected by fire both through the increased temperature resulting from burning of the biomass it supports and through the input of ash from the burnt materials (Wondafrasg *et al.,* 2005). Depending upon fire severity, surface fire can consume forest floor litter, above ground biomass, releasing minerals and altering in chemical composition of soil shows long term effects on forest (Simard *et al.,* 2001).

The temperature gradient between the flame zone and mineral soil is usually very steep , flames reached 800 ^{0}C ,the moist humus layer is heated only to 60 ^{0}C (Vasander 1985). This wide difference between temperatures was explained by high insulation capacity of moist humus. Humus is complex organic compound, extractable in alkali, resists further decomposition by microbial attack.

In Melghat Forest, fire which burns the surface litter and debris of the forest floor as well as low vegetation; fire behavior is variable depending upon conditions, may some times reach into tree crown. The fires have been used for hunting, farming, pasteurization, reduction of fire hazards (fire line). The fires are at present more frequent than they would be naturally.

The objective of this work is to asses the impact of surface fires on top soil and Humic acid isolated from the soil from burned and unburned forests.

Materials and Methods

Study area

The study was carried out in Melghat Tiger Reserve, where Melghat Forests form an integral part of the Satpura-Maikal Ranges with high hills and deep valleys. It is the north-western compact block extending over 3075 sq. km in the Amravati district of Maharashtra. It is situated on the branch of a Gavilgarh hills being the name of the fort on the one of the southern spurs. The soil types vary considerably, probably due to different conditions of weathering and considerable variation in the rainfall within tract. The local types of soil usually found in Melghat are - bouldery, clayey, alluvium, lateritic loam and gritty loam.

The climatic conditions, this area receives 800 to 1600 mm of average annual rainfall, the average humidity is 65% and minimum temperature recorded were 5 °C and maximum 46 °C.

Study site

The study site was at compartment number 856 of Dhakana Range Forest, a buffer zone of Melghat Tiger Reserve and very close to core area. This area was burned during summer. For the study , the litter and humus /top soil samples was collected from unburned and burned area, which was separated by a road barrier.

Sampling

The litter was sampled from unburned and burned sites in 0.5 X 0.5 m area. The litter load was calculated by drying litter in oven then its weight. The living surface- vegetation, fresh litter, big roots and rock fragments carefully removed by wearing plastic gloves by avoiding contamination. At unburned site, normally undisturbed forested areas above the normal mineral soil, a black colored organic material (humus) and top soil from burned site was collected with the help of large steel spoon in plastic bags. Each sample is composite sample, which is collected at least 4-5 locations within area of 50 X 50 meters by random sampling. During the collection, sufficient distance was maintained to avoid through fall precipitation from the trees. The sampled quantity of humus and top soil was enough (1-1.5 Kg.). Then plastic bags were labeled as indicating location, date, time of sampling.

Analysis

The litter load was calculated by taking weight of oven dried litter. The oven dried humus soil samples were analyzed for organic matter content and carbon content by standard *Walkley and Black Method*. Remaining parameters was determined by using standard methods.

Results and Discussion

The forest floor plays an important role in the nutrient dynamics, containing up to 72 % of the available soil nutrients (Foster *et al.,* 1987).The result on forest floor dry mass , organic carbon content and humus depth all illustrate the capacity of fire to consume organic matter (Simard *et al*., 2001).

Litter load

The litter load at unburned site was 12 t/ha, whereas at burned site it was nil (Table-1). The litter composed of leaves, this thin material after ignition, gives flaming and responsible for surface fire, resulted in to no remains of litter at burned site.

The forest floor (LFH) in the burned stand the L and F layers get burned totally was lacking litter the L and F layers totally burned only partially burned large twigs, wooden logs was remained, whereas at control stand , the thickness of litter was 4.8 cm. The forest floor mass at unburned stand was very high.

Litter Characters	Forest sites	
	Unburned	Burned
Litter load	12 t/ha	nil
Litter thickness	4.8 cm	nil
Intact leaves	80 %	nil
Small twigs	10 %	Nil
Graminoids	10 %	nil

Table - 1 litter characteristics

Humus soil

pH is the function of alkaline cations (Ca^{+2}, $Mg^{+2,}$ K^{+}), ash contains inorganic elements that were bound to litter or vegetation before fire. An excess of bounded cations in ash leads to increase in pH, following the surface fire, the pH was significantly higher than the control stand, and it was 10.3.

The electrical conductivity value due to fire, it was increased from 0.0431 dS/m to 0.683 dS/m, and this was attributed to after burning the ionic species become free forming components of ash.

Organic material accumulation is net result of the processes of primary production and decomposition. The humus layer is more seriously affected because due to dry season humus layer lacking moisture otherwise it conducts heat poorly and has high insulation capacity (Pietikainen 1999). The accumulation organic matter in humus soil at unburned site was 17.83 %, after fire it was decreased to 8.75 %. Due to the surface burning, the net loss of organic matter and organic carbon from humus soil was 49.07 %.

The total nitrogen was decreased from 0.63 - 0.12 % .The total nitrogen which is mainly bound to organic compounds, is partly lost due to burning (Pietikainen 1999). The N- cycling particularly sensitive to changes induced by fire due to substantial loss of the element through volatilization. The total nitrogen lost during the burning while it was mainly bound as organic matter, this elemental transformations during the combustion affects cycling and availability of nutrients for the many years.

The heat affected the available phosphorous content of the humus soil significantly; the P (phosphorous) value recorded at burned stand was 90 % greater than that of unburned stand value. This may be the result of heating induced mineralization of the organic P and release of sorbed P (Giovannini *et al.,* 1990). Marcos *et al*., in 1994 also reported that, heating at 200 ^{0}C increased soil available P.

For the humus soil, the C/N and C/P ratio values get decreased after fire, this may attributed to heating induces the loss in carbon and total nitrogen content, the gradual increase in P content responsible for minimization in ratio of C/P.

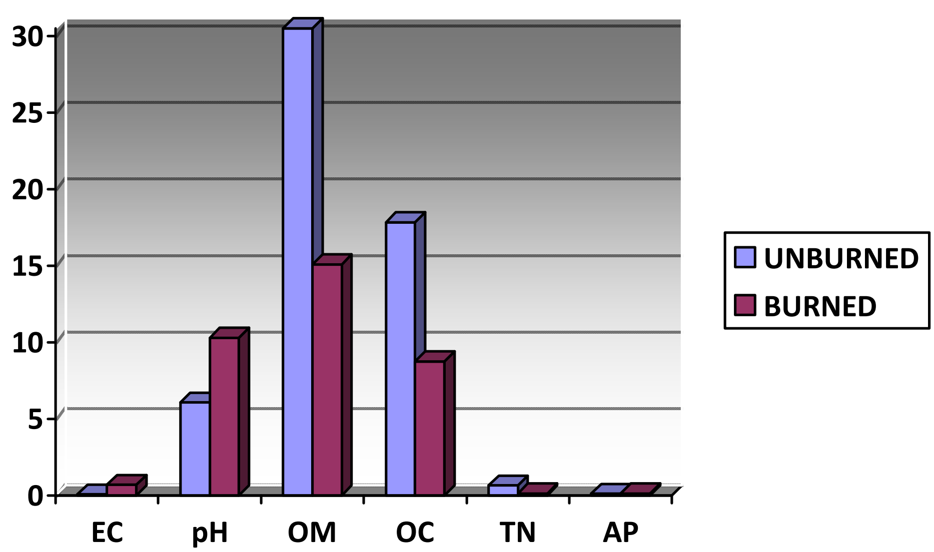

Fig. –1. Comparative changes in characteristics of humus soil due to fire.
(EC- electrical conductivity, OM- organic matter, OC- organic carbon, TN- total nitrogen, AP- available phosphorous).

Characters	Humus Soil	
	Unburned	Burned
pH	6.05	10.3
EC dS/m	0.0431	0.683
OM %	30.74	15.09
OC %	17.83	8.75
TN %	0.63	0.12
AP %	0.090	> 0.1
C/N	28.30	72.91
C/P	198.11	> 87.5

Table -2 Chemical characteristics of humus soil

Conclusion

The data from this study and the literature, it was conclude that, in the forest of Melghat the surface fires resulted in to -

- Loss of forest floor organic matter, organic carbon.
- Ash contains inorganic elements, the alkaline cations (Ca^{+2}, $Mg^{+2,}$ K^{+}) that were bound to litter or vegetation before fire.
- The burning of litter and soil heating significantly increases available P content.
- The loss of total nitrogen may attribute to volatilization of N from organic N compounds and its mineralization.

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