Effects of Wildfire on Soil Properties in Lateritic Soils of Konkan Region

Abstract

An investigation was carried out to study the effects of wildfire on soil properties in lateritic soils of Konkan region at Central Experiment Station Wakawali, Dr. B.S. Konkan Krishi Vidyapeeth, Dapoli, Dist. Ratnagiri during March to September, 2008. A total number of fifteen soil samples were collected from fifteen grass cover observation spots, each of 1 sq.m. size and analyzed. As regards the impact of wild fire on soil physico-chemical properties, the effect was of temporary nature and not severe. As recorded at the post-monsoon stage, the values of most of the soil properties got recovered and came back to the original level. In many cases, the magnitude of the values was more when compared with pre-fire stage.

Keyword: wildfire, pH, organic carbon, available nutrient, micronutrients)

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Introduction

Forest fires are a calamity for forests of temperate climate zones in view of the fact that the damage they cause to the forest economy is considerably greater than all the damage caused by harmful insects and diseases of wood taken together. Forest fires retard the vital activity of forest crops, subsequently encouraging the multiplication of pests and fungal diseases.

In spite of the development of many fire control methods and techniques, large forest fires continue to remain a common phenomenon. Past research has identified many fire-related impacts on soil conditions. Forest fires whether planned or not, usually decrease the total site nutrient pool through some combination of oxidation, volatilization, ash transport, leaching, and erosion. Volatilization sends carbon, hydrogen, and oxygen, into the atmosphere, along with varying amounts of sulphur, and phosphorus depending on the composition of the organic matter burned and the degree of combustion (Raison, 1979). Fire significantly affects soil properties because organic matter located on, or near, the soil surface is rapidly combusted. The changes in organic matter, in turn, affect several chemical, physical, and microbiological properties of the underlying soil. Although some nutrients are volatilized and lost, most nutrients are made more available. Fire acts as a rapid mineralizing agent (St. John and Rundel, 1976) that releases nutrients instantaneously as contrasted to natural decomposition processes, which may require years or, in some cases, decades.

Occurrence of wild fires, in summer season every year, especially in Ratnagiri and Sindhudurg districts of Konkan region is a common feature and the information on consequent effects of wild fire on available nutrient status of soil is meager. Hence this investigation was conducted with the objective to assess the effect of wildfire on fertility status of lateritic soils in Konkan region of Maharashtra.

Materials And Methods

The present investigation was conducted on a hilly area with a gentle slope and with a representative lateritic soil at Central Experiment Stati

on, Wakawali, Dr.B.S. Konkan Krishi Vidyapeeth, Dapoli, Dist. Ratnagiri, Maharashtra during March to September, 2008. A representative area of 0.25 ha with cashew grafts plantation, a few wild bushes/shrubs and with moderate grass cover was selected and was set on fire to burn it completely after taking initial soil samples. After 2-3 days of extinguished wild fire, post-fire soil sampling was done from the same selected spot. Fifteen surface (0-30 cm depth) soil samples from selected spots, each of 1 sq.m. size, equidistant and grid pattern covering the entire area at pre-fire, post-fire and post-monsoon stages were collected and analyzed for physico-chemical properties and DTPA extractable micronutrients using standard methods. The paired 'T'-tests' as described by Panse and

Sukhatme (1967) was applied for the different physico-chemical properties to compare the values at pre-fire, post-fire and post-monsoon stages.

Result And Discussion

The significant increase in soil pH at post-fire stage compare to the pre-fire stage was observed, which attributed to ash accretion (Table 1). The mineral substances released through ash are either oxides or carbonates that usually have an alkaline reaction. When compared with post-fire stage, the decrease in soil pH at post-monsoon stage was non-significant. Thus, for a limited period, wild fire had a positive effect in changing the soil pH. This observation is in agreement with those reported by Raison (1979), Cade-Menun *et al*. (2000) and Giardina *et al*. (2000).

As per the 'T' test, there was significant reduction in the organic carbon content at post-fire stage as against the pre-fire stage (Table 1). It was due to loss of organic matter due to burning. However, there was significant and distinct gain in the value at post-monsoon stage, in comparison with both, the pre-fire and post-fire stages. It was on account of re-establishment of grass cover and consequent incorporation of roots and above ground grass residues in to the soil during monsoon period. Thus, wild fire didn't cause irrecoverable loss in organic carbon content of soil.

The lowering of the available nitrogen at the post-fire stage was recorded which may be due to volatilization losses. However, the extent of loss depends upon fire intensity, amount of green material and fuel moisture (Table 2). The value at post-monsoon stage (469.7) was significantly higher when compared with both, at pre-fire and post-fire stages. Thus, wild fire had no persistent impact on lowering in available nitrogen content.

The reduction in available phosphorus at post-fire stage was significant when compared with the value at the pre-fire stage. It was on account of transformation of the available form to the non-available form. The increase in the value at post-monsoon stage was negligible and non-significant when compared with the values at pre-fire and post-fire stages (Table 2).

The mean available potassium content at post-fire stage (539.21 kg ha^{-1}) was significantly lower when compared with pre-fire stage (545.0 kg ha^{-1}). However, it got recovered at the post-monsoon stage (575.2 kg ha^{-1}). This gain in the content at post-monsoon stage was significant when compared with the values at pre-fire and post-fire stages (Table 2). These observations are in general agreement as those reported by Raison (1985) and Murphy *et al*. (2006).

It is evident from paired 'T' test that DTPA extractable iron in soil was significantly increased at post fire compared with pre fire stage. But the increased in the value at post monsoon stage over post fire stage was statistically non significant. As regards the status of available Mn, it is observed from paired 'T' test that available manganese in soil was significantly increased at post-fire when compared with pre-fire stage. At post monsoon stage it again significantly decreased when compared with pre-fire and post-fire stages. It is noted from the paired 'T' test that the decrease in the content of Zn and Cu at post fire and post monsoon stages when compared with pre fire stage and was statistically non significant (Table 3).

Conclusion

In the case of wild fires occurring in summer season in south Konkan region grass being the exclusive fuel material which has negligible fuel value, the fire burns superficially & rapidly. As regards the impact of wild fire on soil chemical properties and nutrient status, the effect was of temporary nature and not severe. As recorded at the post-monsoon stage, the values of most of the soil properties got recovered and came back to the original level.

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Table 1

Effect of wildfire on Soil reaction (pH) and Organic carbon (%) at different stages.

Soil Sampling Spot No.	Soil reaction (pH)			Organic carbon (%)		
	Pre Fire (A)	Post Fire (B)	Post Monsoon (C)	Pre Fire (A)	Post Fire (B)	Post Monsoon (C)
1	5.21	5.43	5.2	3.675	3.240	4.275
2	5.10	5.3	5.33	2.895	2.880	3.555
3	5.44	5.48	5.18	2.475	2.160	3.735
4	5.32	5.51	5.31	2.925	1.170	4.275
5	5.36	5.4	5.23	2.400	2.385	3.645
6	5.24	5.38	5.32	2.430	2.430	4.050
7	5.27	5.46	5.43	2.985	2.250	3.600
8	5.32	5.18	5.32	2.300	1.575	4.815
9	5.29	5.32	5.4	3.060	1.845	4.095
10	5.06	5.22	5.26	3.705	3.525	4.320
11	5.01	5.29	5.2	2.475	1.935	3.915
12	5.32	5.47	5.14	2.490	2.310	4.320
13	5.20	5.28	5.2	3.120	3.120	3.690
14	5.03	5.12	5.18	3.330	3.060	4.770
15	5.06	5.12	5.23	2.805	2.490	4.230
Mean	**5.22**	**5.33**	**5.26**	**2.870**	**2.430**	**4.090**
S.Em ±	0.03	0.03	0.02	0.12	0.17	0.10
Median	5.25	5.32	5.23	2.87	2.43	4.09
Paired t-test value	A & B	B & C	A & C	A & B	B & C	A & C
	4.31	1.77 N/S	1.20 N/S	3.48	8.14	8.52

'T' value = 2.14 (at 14 d.f.)

Table 2.

Effect of wildfire on available nutrient content (kg ha^{-1}) at different stages

Soil Sampling Spot No.	Available Nitrogen (kg ha^{-1})			Available Phosphorus (kg ha^{-1})			Available Potassium (kg ha^{-1})		
	Pre Fire (A)	Post Fire (B)	Post Monsoon (C)	Pre Fire (A)	Post Fire (B)	Post Monsoon (C)	Pre Fire (A)	Post Fire (B)	Post Monsoon (C)
1	457.505	426.144	479.456	10.57	9.23	9.98	545.660	5010.720	568.512
2	444.960	451.232	488.864	9.74	9.04	9.27	549.696	534.912	556.416
3	460.640	435.552	485.728	8.2	8.01	8.3	525.504	526.848	407.232
4	435.552	413.600	407.361	11.36	9.74	10.25	501.312	512.064	583.296
5	438.688	416.736	480.732	8.2	7.09	7.74	555.072	548.352	610.176
6	432.416	488.864	479.456	10.25	9.48	10.01	572.544	568.512	604.800
7	448.096	492.000	497.920	9.58	8.98	9.00	552.384	551.040	628.992
8	457.504	432.416	467.008	9.23	8.59	9.58	547.008	549.696	510.720
9	454.368	416.736	473.084	9.74	8.61	9.91	551.04	544.320	585.984
10	438.688	426.144	482.592	10.25	9.44	10.01	541.632	536.256	611.520
11	432.416	407.328	413.600	10.05	9.92	10.12	528.192	524.160	623.616
12	470.048	451.232	485.407	9.23	8.51	9.77	559.104	553.728	569.856
13	454.368	435.552	490.517	9.74	8.44	8.98	552.384	547.008	600.786
14	460.64	470.048	483.663	10.77	9.25	9.74	549.696	536.256	610.176
15	435.552	410.464	429.770	9.23	8.74	9.13	544.32	544.32	556.416
Mean	**448.100**	**438.270**	**469.680**	9.74	8.87	9.45	545.04	539.21	575.23
S.Em ±	3.12	7.04	7.37	0.21	0.17	0.17	4.27	4.07	14.45
Median	448.10	432.42	480.73	9.74	8.98	9.74	549.70	544.32	585.98
Paired t-test value	A & B	B & C	A & C	A & B	B & C	A & C	A & B	B & C	A & C
	1.38 N/S	4.91	3.46	7.46	1.11 N/S	2.13 N/S	2.21	2.53	2.17

'T' value = 2.14 (at 14 d.f.)

Table 3
Effect of wildfire on DTPA extractable miro-nutrient content (mg kg-1) at different stages

Soil Sampling Spot No.	Iron (Fe) (mg kg-1)			Manganese (Mn) (mg kg-1)			Zinc (Zn) (mg kg-1)			Copper (Cu) (mg kg-1)		
	Pre Fire (A)	Post Fire (B)	Post Monsoon (C)	Pre Fire (A)	Post Fire (B)	Post Monsoon (C)	Pre Fire (A)	Post Fire (B)	Post Monsoon (C)	Pre Fire (A)	Post Fire (B)	Post Monsoon (C)
1	24.18	27.26	25.78	31.98	35.59	31.23	0.58	1.02	0.62	1.85	1.36	1.72
2	25.67	25.78	28.97	34.31	35.28	30.88	0.55	0.86	0.58	0.98	1.84	1.46
3	25.29	23.48	25.95	35.36	34.65	38.98	0.95	0.43	0.65	1.36	1.86	1.39
4	25.55	26.47	24.76	36.68	36.28	30.33	0.72	0.49	0.79	1.89	1.85	1.57
5	23.19	23.58	24.90	35.48	36.56	27.98	0.71	0.42	0.51	1.66	1.68	2.01
6	25.61	24.33	27.39	34.62	36.06	28.28	0.83	0.55	0.96	1.91	1.76	1.72
7	24.67	25.29	27.03	34.84	35.58	29.41	0.93	0.84	0.58	1.91	1.68	1.67
8	24.91	26.78	25.12	35.98	35.63	25.33	0.88	0.71	0.84	1.99	1.76	1.56
9	24.57	23.15	27.10	35.59	36.31	28.23	0.81	0.81	0.42	1.62	1.52	1.09
10	24.26	25.12	26.06	32.85	37.78	29.36	0.91	0.72	0.43	1.52	1.57	1.52
11	24.60	27.32	28.71	35.68	35.65	28.14	1.02	0.69	0.87	1.69	1.58	1.71
12	21.85	26.76	25.31	35.03	36.11	27.56	0.78	0.76	0.75	1.35	1.23	1.04
13	22.43	25.95	24.90	35.05	36.95	30.85	0.69	0.66	0.91	1.08	1.59	1.45
14	22.24	24.32	24.29	36.88	36.38	28.76	1.04	0.84	0.59	1.34	1.23	1.68
15	24.66	25.11	25.12	34.33	35.62	29.23	0.71	0.62	0.81	1.18	1.53	1.99
Mean	24.24	25.38	26.09	34.97	36.02	29.63	0.80	0.69	0.68	1.55	1.60	1.57
S.Em +	0.32	0.35	0.37	0.33	0.19	0.77	0.03	0.04	0.04	0.08	0.05	0.07
Median	24.60	25.29	25.78	35.05	36.06	29.23	0.81	0.71	0.65	1.62	1.59	1.57
Paired t-test value	A & B	B & C	A & C	A & B	B & C	A & C	A & B	B & C	A & C	A & B	B & C	A & C
	2.29	1.42 N/S	5.45	2.21	7.32	6.00	1.80 N/S	0.07 N/S	1.98 N/S	0.51 N/S	0.37 N/S	0.16 N/S

'T' value = 2.14 (at 14 d.f.)