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IMPACT OF COAL MINING ON LEAF MORPHOLOGY AND STOMATAL INDEX OF PLANTS IN KALAKOTE RANGE, RAJOURI (J&K), INDIA

Jagbir Singh and Shashi Kant
Department of Botany, University of Jammu, Jammu-180 006, (J&K), India

ABSTRACT

The phytodiversity of the Kalakote forest region is under severe threat of biotic interferences like coal mining, encroachments, overexploitation, tourism and other allied interferences. Coalfields are situated at Mahogala, Mehtka and Tatapani in the study area. Continuous creation of infrastructural facilities on surface for mining, beneficiation, housing and other activities take a heavy toll of forest wealth. Coal extraction leads to degradation of land, addition of pollutants to air and water, deforestation, and civic environment. Anatomical and morphological studies have been undertaken on the plants growing in coalfields and their stomatal and epidermal cell frequency and stomatal indices have been compared with control plants.

INTRODUCTION

Kalakote range (Rajouri) lies between 33°10' N latitude and 74°45' E longitude in Tehsil Kalakote of District Rajouri of Jammu & Kashmir State. The area mainly constitutes inner Shivaliks. The area is undulating with moderately sloped hills. Altitude of the area ranges from 600 m to 1070 m.

Jammu coal fields are known to occur in a tract of 70 km trending in NW-SE direction in Districts of Poonch, Rajouri, Doda and Udhampur of Jammu province. Jammu coalfields have assumed local names as they were locally developed in the past and are better known as Ladda (Jangal gali), Chinkah, Chakkar, Maga, Mahogala, Mehtka, Kalakote, Tatapani, Jigni, Dhandli and Dhansal-Sawalkote Lodhra coalfields.

In the study area coalfields are situated at Mahogala, Mehtka, Kalakote and Tatapani. Builtup of infrastructural facilities on surface for mining, beneficiation, housing and other activities take heavy toll of forest bearing areas. Right from the first stage of mineral extraction, the environmental degradation of land, addition of pollutants to air and water, and deforestation occur unchecked.

MATERIALS AND METHODS

Visual observations during different trips to the study area were recorded. Photographs were also taken from the degraded sites.

Stomatal index: The impression of the lower epidermis of the 4th leaf in the central region were taken (using quick fix) or scraped off with a safety-blade from lower epidermis with the help of fine needle and forceps, stained with 1% aqueous saffranin and mounted in pure glycerine. The number of stomata per mm^2 were counted by using haemocytometer. Stomatal frequency, l/b ratio, area and stomatal index (S.I.) were calculated using the formula of Salisbury (1927).

$$S.I. = \frac{S}{E + S} \times 100$$

Where, S = Number of stomata per unit area and E = Number of epidermal cell per unit area.

Leaf area: The leaf area was calculated by graph plot method, i.e., leaves were mapped on a graph paper and number of the squares covered by leaf on the graph paper were counted. From this the average area of leaf was calculated.

RESULTS

Surface mining of coal results in huge removal of overburden and mineral wastes, which are dumped into nearby fertile soil. Large excavations and denudation of vegetation in the coalfields have been commonly observed. One inch of fertile top soil takes 500-1000 years for formation but unfortunately in mining areas, no one bothers about this top soil and throws or mingles it casually. The trees, other vegetation and surface top soil are removed from coalfields that leads to denudation of the study area. Surface mining creates large voids and ugly scars over the entire area. It is reported that by open cast mining alone about 0.2 million ha land is being environmentally disturbed every year and forest forms a large proportion of this.

In Mahogala and Mehtka, where underground mining is done, subsidence of land is a common feature. Due to subsidence, depression of various sizes are formed affecting adversely the growing vegetation. In underground mining area, there is continuous seepage of water into mines, which is pumped out from the mines and ultimately disturb the soil and water in particular and ground water in general.

Anatomical and morphological studies: The data on the epidermal variations and leaf area of the plants growing in polluted and nonpolluted sites in the coalfield area are given in Tables 1 and 2. The damaging effect of air pollution on plants has been well known. Different plant species react differently when exposed to air pollution, showing characteristic morphological and anatomical changes. The selective response of plants to different air pollutants can be useful in air pollution monitoring. Leaves are highly exposed organs of plants which are effected most by air pollution. Epidermal layer of leaf being the outer most layer shows marked response to air pollution.

Epidermal cell size decreased in *Gymnosperia royleana, Carrisa opaca, Berberis lycium, Pyrus pashia, Mangifera indica* and *Ipomoea carnea* when compared to plants of control site (unpolluted site). Epidermal cell frequency increased in *Gymnosporia royleana, Adhatoda vasica, Pyrus pashia, Mangifera indica* and *Ipomoea carnea*. Epidermal cell frequency decreased in *Carrisa opaca, Cassia fistula* and *Berberis lycium* as compared to control site.

Table 1: Epidermal variations of eight species from polluted site and unpolluted site.

	Polluted site			Unpolluted site		
	Epidermal cell frequency mm^2	Stomatal Frequency mm^2	Stomatal index	Epidermal cell frequency mm^2	Stomatal frequency mm^2	Stomatal index
Gymnosporia royleana	2224	632	22.1	1922	376	16.36
Carrisa opaca	1776	380	17.66	1850	515	27.8
Adhatoda vasica	1864	400	17.6	1794	572	24.17
Cassia fistula	2058	474	18.72	2073	411	16.5
Berberis lycium	2276	614	21.3	2456	252	9.30
Pyrus pashia	1768	270	13.24	1764	202	10.27
Mangifera indica	2403	923	27.7	2113	540	20.35
Ipomoea carnea	1868	288	13.35	1848	350	15.92

Stomatal size increased in *Berberis lycium, Pyrus pashia, Mangifera indica, Ipomoea carnea, Gymnosporia royleana, Carrisa opaca, Adhatoda vasica and Cassia fistula* as compared to control site plants. *Gymnosporia royleana, Berberis lycium, Pyrus pashia* and *Cassia fistula* showed higher stomatal frequency in polluted areas. *Ipomoea carnea, Carrisa opaca* and *Adhatoda vasica* showed lowered stomatal frequency.

Table 2: Leaf area of some plants growing in coalfields and at control site.

Name of the plants	Leaf area in cm^2			
	Control site	Affected site		
		Mehtka	Tatapani	Mahogala
Adhatoda vasica	35.40	15.40	30.70	22.4
Gymnosporia royleana	2.40	0.84	2.25	1.4
Carrisa opaca	5.20	4.82	4.90	4.2
Cassia fistula	66.30	36.90	-	31.7
Pyrus pashia	26.20	-	11.50	-
Berberis lycium	2.35	-	1.31	-
Mangifera indica	62.40	46.70	-	-
Ipomoea carnea	63.10	49.20	-	-

Stomatal index increased in *Gymnosoria royleana, Cassia fistula, Berberis lycium, Pyrus pashia* and *Mangifera indica* in comparison to the plants of control site. *Ipomoea carnea, Carrisa opaca* and *Adhatoda vasica* showed decrease in stomatal index.

The total leaf area decreased in *Adhatoda vasica, Gymnosporia royleana, Carrisa opaca, Cassia fistula, Pyrus pashia, Berberis lycium, Mangifera indica* and *Ipomoea carnea* as compared to control. The plant studied showed variations in all the parameters in polluted and non-polluted areas.

DISCUSSION

The fine coal dust particles normally affect the growth of plants. Air pollution affects plants in two ways. First, incidence of high air pollution causes visible damage and secondly, chronic sublethal doses of air pollutants contribute to the eventual destruction of plant physiological life processes affecting the growth, productivity and quality of vegetation.

The data clearly show that air pollution has brought significant increase in the frequency of stomata, epidermal cells and stomatal indices on lower surface of *Gymnosporia royleana, Cassia fistula, Berberis lycium, Pyrus pashia* and *Mangifera indica* growing in coalfields. Similar findings have also been observed by Roa et al. (1990).

Prasad (1990) observed that dust and particulate pollutants cover the leaf surface, which clog stomatal pores and alters light penetration thereby interfering with the exchange of gases, disturbing photosynthetic activity and reducing plant growth in polluted sites. Acharekar & Salgare (1990) observed similar results. The increased frequency of stomata and epidermal cells on lower epidermis results in a significant increase in stomatal index on the lower leaf surface. Thus, micromorphological observations like stomatal and epidermal cell frequency and stomatal indices are excellent evidences of environmental impacts in which plants are growing. Dadhich (1981), Kasat & Agarwal (1982) and Saxena (1985) observed similar effect of air pollutants on frequency and stomatal index of plants growing in polluted area and explained that the plants act as bioindicators of air pollutants.

Decrease of stomatal frequency and stomatal index has been observed in *Carrisa opaca, Adhatoda vasica* and *Ipomoea carnea* in coalfields of the study area. The decrease of stomatal frequency and stomatal indices of plants in polluted areas indicates that the plants developed some sort of adaptive features so as to cope up with the effects of air pollution which otherwise might enter the leaf, injure the tissue and cause death. Similar observations have also been reported by Chattopadhay (1996) and Ferris & Taylor (1994).

Leaf area of plants growing in coalfields is much reduced than unpolluted areas. This is attributed to pollutants from coal, which affect the growth. Significant reduction in plant height, leaf area, net photosynthesis and ascorbic acid content was observed by Kamalkar (1992). Srivastava & Kumar (1995) and Krishnamurthy et al. (1994) revealed retarded growth and reduced leaf due to emission of pollutants.

Mined lands are associated with wide ranging ecological problems viz., depletion of floral and faunal populations, loss of fertile top soil, sliding and erosion, pollution of air and water and generation of high noise levels etc. It is common feeling that adverse ecological impacts happen to be associated with mineral excavation process alone, i.e., mining. However, the process of ecological degradation starts even before the actual mineral exploitation begins and continues even after that. Premining impacts are observed in the area with development of infrastructural facilities for extraction, i.e., road construction, transportation of heavy vehicle and machinery. Actual effects of ore extraction on the ecology are mining impacts, where the area is being cleared of vegetation. Surface mining of coal results in huge removal of overburden and mineral waste, which is dumped into nearby fertile soil. This has been commonly observed in the study area (Soni et al. 1989, 1991) and Varma et al. (1989) observed similar results.

In coalfields of Kalakote range dominance of unpalatable and exotic weeds like *Lantana camera, Parthenium hysterophorus, Cassia tora* and *Cassia occidentalis* etc. on the abandoned waste dumps, appears to be resistant to the pollution stress.

REFERENCES

Acharekar, C. and Salgare, S.A. 1990. Effect of ambient air on growth performance, micromorphology, chlorophyll content of leaf and organic contents of seeds of some wild plants. In: Advances in Environmental Sciences (Eds. Tripathi, A.K., Srivastava, A.K. and Pandey S.N.), pp. 153-191. Ashish Publishing House, New Delhi, India.

Chattopadhyay, S.P. 1996. Leaf-surface effects of air pollution on certain tree species in Calcutta. Ad. Plant Sci., 9(1): 1-14.

Dadhich, L.K. 1981. Recognition and monitoring of air pollutants with the aid of plants. Cent. Bd. Prev. Cont. Water Poll., Osmania University, Hyderabad, India, pp. 19-25.

Ferris, R. and Taylor, G. 1994. Stomatal characteristics of four native herbs following exposure to elevated CO_2. Annals of Bot., 73: 447-453.

Kamalakar, J.A. 1992. Response of plants to auto exhaust pollution. Acta Botanica Indica, 20: 84-88.

Kasat, M.L. and Agarwal, S.K. 1982. Effect of air pollution on epidermal structure. Acta Ecol., 4: 10-12.

Krishnamurthy, R., Srinivas, T. and Bhagwat, K.A. 1994. Effect of air pollution on some bund trees of the agricultural lands. J. Environ. Biol., 15(2): 97-106.

Prasad, R. 1990. Impact of coal mining and other coal based industries on the pigment concentration and productivity of paddy. In: Impact of Coal Mining on Environment (Ed. Trivedy, R.K. and Sinha, M.P.) pp. 165-174, Ashish Publishing House, New Delhi, India.

Rao, K.S., Prameela, K. and Prasad, H.R. 1990. Effect of air pollution on foliar epidermis of six species near Yellandu coal mines, Khammam district, A.P. In: Impact of coal mining on Environment. (Ed. Trivedy. R.K. and Sinha, M.P.) pp. 153-157, Ashish Publishing House, New Delhi, India.

Saxena, L.M. 1985. Air pollution induced changes in foliar pigment and ascorbic acid content in *Bougainvillea spectabilis* Willd. and *Cassia siama* Linn. Acta. Ecol., 7(1): 20-23.

Soni, P., Vasistha, H.B. and Kumar, O. 1991. Ecological rehabilitation of surface mined lands. Indian Forester, 117(6): 485-493.

Soni, P., Vasistha, H.B. and Kumar, O. 1989. Biological diversity in surface mined areas after reclamation. Indian Forester, 114(7): 475-482.

Srivastava, A.K. and Kumar, S. 1995. The disturbed mountain ecosystem - A case study of Salari village in Kumaon Himalaya. Indian Forester, 121(2): 103-109.

Varma, S.K., Jha, R.R. and Pandey, A.K. 1989. Impact of mining on the flora of Motijharna, Raj Mahal hills (Bihar). Indian Forester, 115(12): 934-935.