Effect of Copper Dust on Photosynthesis Pigments Concentration in Plants Species

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Abstract— **Effect of copper concentration was studied in the plants within the Malanjkhand Copper Mining Project (MCP), Balaghat, Madhya Pradesh (India). Copper affects vegetation were determined through biochemical parameter (paper chromatography) in the tree species like *Tectona grandis, Mangifera indica, Butia monosperma* and *Madhuca indica which* were exposed to different copper dust concentration load for short duration. Variations in biochemical parameter like different pigments in the leaves were separated by paper chromatography found significant in difference. This variation can be used as indicator of copper concentration for early diagnosis of stress as a maker for physiological damage to plants prior to the onset of visible injury symptoms. The present study reflects the elevated concentration of copper in the associated plant species within the Malanjkhand Copper Mining Site.**

I. Introduction

Mining has been one of the most common activities since ancient times and continues to remain so in the modern world. Mining is an important part of our economy. Minerals extracted raw from earth, are processed to yield basic substances such as metals, chemicals, building materials, fuels, fertilizers etc. industrial society could not exist without these essential commodities. A combined total of about 1150 million tones of heavy metals (copper, lead, cobalt, zinc, cadmium and chromium) have been mined by man since the Stone Age. It is further estimated that an annual output of 14 million tones of heavy metals is being mined with annual growth of 3.4% (Matagi *et al.,* 1998). The continued advancement in industrialization and the ever increasing demand for energy resources and minerals, have spurt in mining activities, bringing in its wake imbalances in ecological equilibrium and many environmental hazards (Wu *et al.,* 2007; Vamerali *et al.,* 2010).

Mining activities such as crushing, grinding, washing, smelting, and all other processes used to extract, concentrate generate waste products such as mine overburden and mine's waste soils. As a result, very significant volumes of wastes have been deposited on soil and wild plants and animals are exposed to elements contained in the residue. People living near these sites are also exposed through wind and soil erosion. The direct effect will be loss of cultivated land, forest or grazing land, and the overall loss of production. The indirect effects include air and water pollution and water pollution and siltation of water body. This will eventually lead to loss of biodiversity, amenity, and economic wealth (Yang *et al.,* 2002; Wong, 2003). The management of these waste materials is an important issue for mining industries worldwide.

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Copper is essential as micronutrient for microorganisms, plants and animals while others have no known biological function (Welch, 1995). All heavy metals at high concentrations have strong toxic effects and regarded as environmental pollutants (Nedelkoska and Doran, 2000; chehregani *et al.,* 2005). Contaminated soil negatively affects crop growth because of interference of phytotoxic contamination with metabolic processes and leading to plant death (Pal and Rai, 2010).

The present research aimed to investigate the influence of mining activity on the concentration of heavy metal as copper in the soil and vegetation surrounding copper mining sites at Malanjkhand located in Balaghat, Madhya Pradesh, India.

II. Materials and Method

A. Sampling Site

The study area Malanjkhand is located in the Balaghat district of Madhya Pradesh 250 km northeast of Nagpur (MH). The Malanjkhand town is connected by major arterial roads, some of which are NH 16 and other district road together constitute the primary network of major roads. Malanjkhand referred to as MCP (Malanjkhand Copper Project) is a open-pit copper mine in India, located near the town of Malanjkhand, 90 kilometers (56 miles) northeast of Balaght in Madhya Pradesh at an altitude of 576 MRL. It falls in the tehsil of Baihar, which is 22 km from the project site; on the way to Balaghat headquarter. Malanjkhand open-pit copper mine is largest metal mine in India. The special thematic mapping during 1991 & 1994 by Jaggi *et al.,*(GSI) has brought out the regional geological set-up. Malanjkhand copper belt lies between latitude 22º00'59"-22º02'24" and longitude 80º41'51"- 80º42'38" and from a part of Survey of India toposheet no. 64 B/12 (**Fig.1**).

Malanjkhand copper project was established in 1982. Initial project has been set up by Hindustan Copper Limited (HCL) to exploit the copper ore through an open-pit mine. Geological survey of India took systematic geological exploration as this deposit during 1969. Mining lease of the ore was granted to HCL during 1973. With advancement of time this project was enhanced with viable operational developments. In fact it is largest open cast mining is Asia. This area is the result of many cycles of erosion on the gneiss base during the Amgaon orogeny.

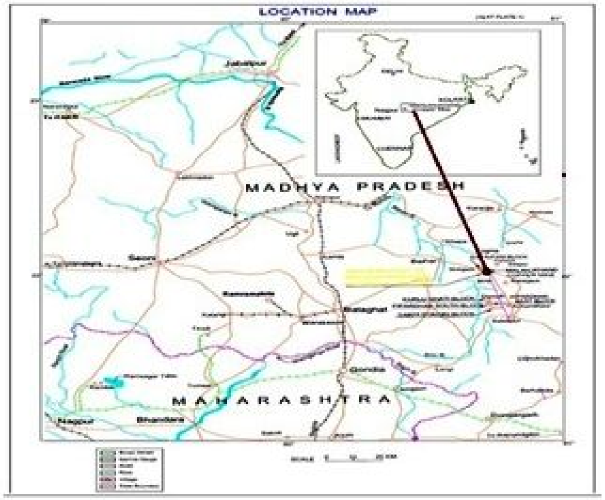


Figure 1: Geographical location of study site Malanjkhand, District- Balaghat, (M.P.), India.

B. Plant Sampling and Analysis

Firstly the leaves were plugged at chest level height of the ten plants of four species sampled nearby road side from where the ore were carried from mining to storage site with the trafficking of dumpers. The same species were sampled also from deep forest far away from the mining site having no affect of copper or any other dust. The plant species taken for this study were *Tectona grandis, Mangifera indica, Butia monosperma* and *Madhuca indica*. The leaves were plugged and collected in a full newspaper assuring not to loose any part of dust from leaf. Immediately leaf were washed with distilled water, filtered and dust were collected after drying filter paper. Further, the washed leaves were crushed in mortar and pestle and mixed with different solvents and for the separation of different pigments loaded on whatman filter paper no. 1 for paper chromatography assembly (**Fig.2**).

The Rf (retardation factor) value of the pigments were found with a particular solvents for the four planted species were shown in the **Table.1 and 2** without dust and with dust affected plant species leaves respectively.

III. RESULTS AND DISCUSSION

A. Deposition of Dust

Plant species leaves were collected and studied for the dust deposition at mining sites. Dust was collected through washing the leaves and evaporating the water. The dust an average was found ±1.344, ±0.783, ±0.839, ±0.731gm from *Tectona grandis* (Teak)*, Mangifera indica* (Mango)*, Butia monosperma* (Palash)*, Madhuca indica* (Mahua) respectively of an average of ten plants of each four species.

B. Separation of Pigments

The leaves affected by dust were studied for the carotinoid, xanthophylls, chlorophyll a and chlorophyll b content in all the four planted species at mining and as well as forest as control sites. Significant results were found while comparing the results of different pigmentation in the four plant species leaves in control and mining affected site.

The Rf value (Retardation factor) of carotiniod, xanthophylls, chlorophyll a, chlorophyll b pigments of control as well as copper mining affected plants were assessed.

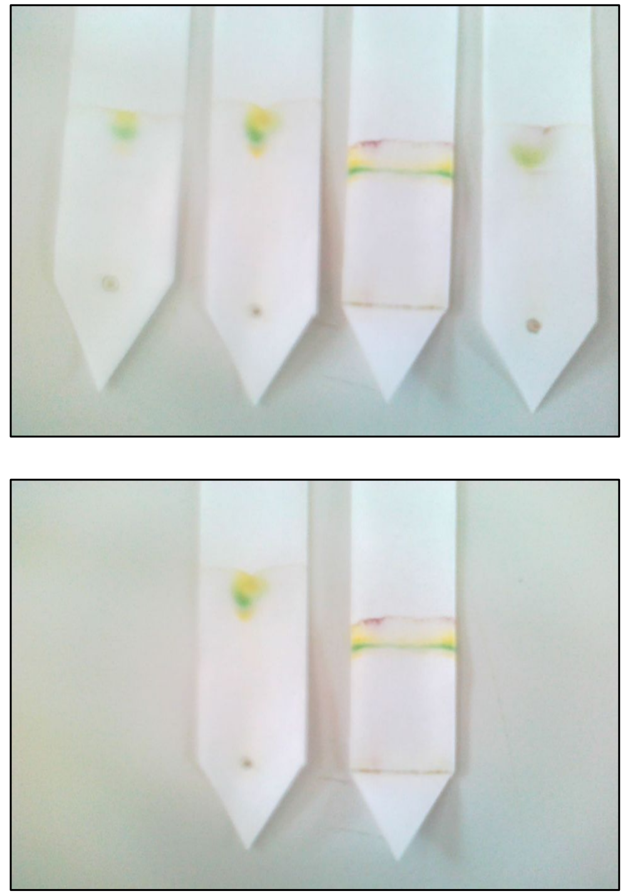


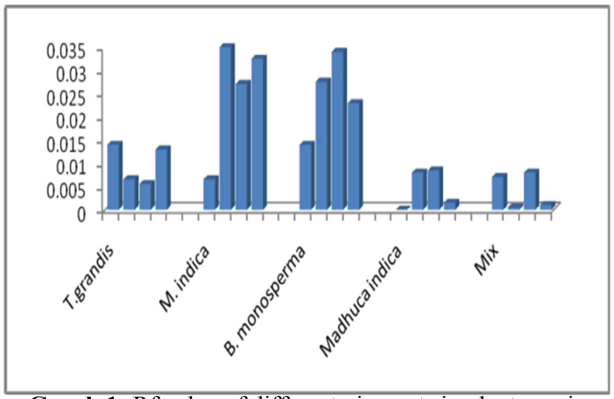
Figure 2: Shows the separation of pigments on whatman filter paper

The data were statistically analyzed for standard deviation of the Rf (retardation factor) value within all the four plants species in different photosynthesis pigments in leaves with dust and without dust .

Plant pigments	Mean (X)	Mode (Z)	Median (M)	Standard deviation (σ)
Tectona grandis				
Carotenoid	0.955	0.969	0.955	0.014
Xanthophylls	0.932	0.939	0.932	0.0065
Chlorophyll a	0.872	0.878	0.872	0.0055
Chlorophyll b	0.806	0.818	0.806	0.0130
Mangifera indica				
Carotenoid	0.977	0.984	0.977	0.0065
Xanthophylls	0.919	0.954	0.919	0.035
Chlorophyll a	0.882	0.909	0.882	0.027
Chlorophyll b	0.785	0.818	0.785	0.0325
Butea monosperma				
Carotenoid	0.956	0.970	0.956	0.014
Xanthophylls	0.927	0.955	0.927	0.0275
Chlorophyll a	0.876	0.910	0.876	0.034
Chlorophyll b	0.781	0.805	0.781	0.0229

Madhuca indica				
Carotenoid	0.955	0.955	0.955	000
Xanthophylls	0.903	0.911	0.903	0.008
Chlorophyll a	0.843	0.852	0.843	0.0085
Chlorophyll b	0.792	0.791	0.792	0.0015
Mix				
Carotenoid	0.964	0.971	0.964	0.007
Xanthophylls	0.9005	0.901	0.9005	0.0005
Chlorophyll a	0.808	0.816	0.808	0.008
Chlorophyll b	0.758	0760	0.758	0.001

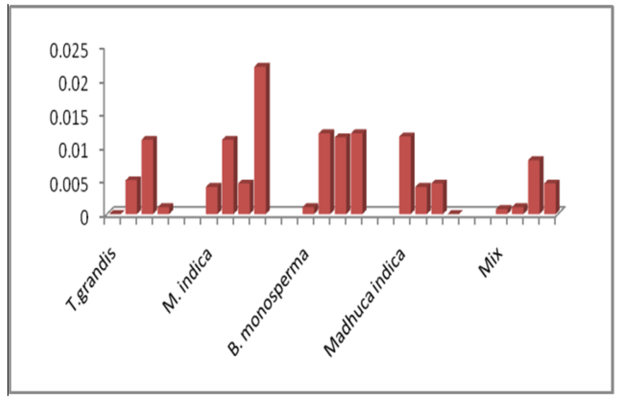
Table 1: Rf value of different pigments for the plant species leaves without copper dust



Graph 1: Rf value of different pigments in plant species leaves without copper dust

Plant pigments	Mean (X)	Mode (Z)	Median (M)	Standard deviation (σ)
Tectona grandis				
Carotenoid	000	000	000	000
Xanthophylls	0.895	0.9	0.895	0.005
Chlorophyll a	0.846	0.857	0.846	0.011
Chlorophyll b	0.727	0.728	0.727	0.001
Mangifera indica				
Carotenoid	0.767	0.771	0.767	0.004
Xanthophylls	0.711	0.722	0.767	0.011
Chlorophyll a	0.661	0.666	0.661	0.0045
Chlorophyll b	0.626	0.642	0.626	0.0219
Butea monosperma				
Carotenoid	0.846	0.847	0.846	0.001
Xanthophylls	0.748	0.760	0.748	0.012
Chlorophyll a	0.72	0.732	0.72	0.0114
Chlorophyll b	0.664	0.676	0.664	0.012
Madhuca indica				
Carotenoid	0.875	0.887	0.875	0.0115
Xanthophylls	0.841	0.845	0.841	0.004
Chlorophyll a	0.778	0.783	0.778	0.0045
Chlorophyll b	000	000	000	000
Mix				
Carotenoid	0.863	0.864	0.863	0.0007
Xanthophylls	0.836	0.837	0.836	0.001
Chlorophyll a	0.802	0.810	0.802	0.008
Chlorophyll b	0.679	0.684	0.679	0.0045

Table 2: Rf value **of d**ifferent pigment for the plant species leaves affected by copper dust



Graph 2: Rf value of different pigment in plant species leaves affected by copper dust

Graph.1 & 2 clearly reveals that deposition of copper dust has substantially lowered down the four pigments in all the four plant species studied having almost same age from both the sites.

Air pollutants, fly ash and dust emissions have a profound impact on the concentration of different photosynthetic pigments. Polluted and dusted leaf surface is responsible for reduced photosynthetic and thereby causing reduction in chlorophyll content (Kalyani, and Singaracharya, 1995). The similar impact of air pollutants in the concentration of chlorophyll contents have been reported by a number of other works (Nikova and Dushkova; Rabe and Kareeb, 1979; Dubey and Pawar, 1985; Shah, et., al.,1989; Saxena, 1991; Swami, et.al., 2004 and Tripathi and Gautam, 2007). The photosynthetic pigments are the most likely to be damaged by air pollution.

Chlorophyll pigments exist in highly organized state, and under stress they may undergo several photochemical reactions such as oxidation, reduction, pheophytinisation and reversible bleaching (Puckett, et.al.,). Hence any alteration in chlorophyll concentration may change the morphological, physiological and biochemical behaviour of the plant. Air pollution-induced degradation in photosynthetic pigments was also observed by a number of workers (Bansal, 1988; Singh, et al., 1990 and Sandelius, et.al., 1995).

In all the four plants species chlorophyll a and chlorophyll b content were reduced significantly at polluted site.

CONCLUSION

In the present study, effect of copper dust was seen on the concentration of four photosynthesis pigments in the leaves of four plants in and around mining and forest areas. The plant species were *Tectona grandis, Mangifera indica, Butia* *monosperma, Madhuca indica* plant species were studied to see the effects of road side dust such as copper dust, vehicular dust pollutants have been investigated and their effects are presented. From the studies it is concluded that the dust pollutants causes degradation in plant growth. Never the less the experiment conducted in the hypothesis of proving the significant effect of copper dust on the concentration of the pigmentation in four species leaves, which are highly sensitive and overall growth compared from same plant species at control condition species i.e., forest site.

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