COMPARATIVE ASSESSMENT OF BIOCHEMICAL CHANGES IN PADDY PLANT SYSTEM UNDER IRON AND STEEL FACTORIES POLLUTED ENVIRONMENT

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ABSTRACT

In the present investigation a much stress is given to detect a huge amount of biomolecular loss in paddy plant due to severe air pollution of steel industry. Paddy plant (Oryza sativa L.) was selected from the vicinity Agricultural field of Durgapur steel factory industrial zone (Tetultala colony) and another Agricultural site Burdwan University Farm was selected for comparative studies because this site is totally free from any kind of pollution. Mainly steel factory emitts gaseous pollutants. Besides the washed water of inside factory comes out from industry enter into the nearest paddy field can change a significant biomolecular loss and create a stress environment for this plant. The gaseous sulpher, nitrogen oxide, and different dust particle enter into plant leaf and create a superoxide can hamper this plant. Nitrogen di oxide hamper chlorophyll molecule and growth of plant reported by (Chen et.al.,2010). Besides the water with heavy metals comes from washing dust, coal, sprinkling to remove dust and washed inside the factory. In iron and steel factory the used water for cooling kilner the iron dust and coal dust mixed into this water, enter into paddy field and create a stress environment for this plant as a result a significant damage of this plant takes place and which ultimately effect biomolecule proportion as well as food production.

Keywords: Biomolecule, Heavy metal, Paddy Plant, Pollutants, Steel factory.

Introduction:

Now a days industrialization is very much needed for a country and worlwide for development of its socio economic condition, employment opportunity etc. But the mad race increasing of industries and industrialization in India and at global level is the main cause of industrial air pollution. Pollution is any additional matter or energy that degrades the environment for humans and other organisms. Iron and steel industry is growing globally so are its related environmental issues. India has emerged as the world's largest producer of sponge iron. The sponge iron industry emits gaseous pollutants. In the area of gaseous emissions, the Kyoto protocol and recently held Copenhagen Summit 2009 has put great pressure on the industrialized countries to reduce emissions and almost all nations are in agreement. Sponge iron industries release huge amount of carbon di oxide. Emission load of particulate matter of sponge iron industry is also very much high. A major vegetation portion is greatly affected. Thick black smoke, contaminated water, depleting vegetation, falling agricultural yields, premature death of domestic cattle and poor human health conditions are just some of the impacts. Macromolecules such as protein, carbohydrate,etc are the building blocks of the biological system. Any stress (physical, chemical) from of pollution or by others means play a significant role in the physiology, biochemical set up of any living system. Any form of stress leads to mal functioning of the system leading to abnormal metabolites, which reflect through the growth, vigour, morphological attributes. Protein is an essential biochemical constituent of plant to maintain the health condition of a tree. Protein contents in leaf, shoot and root is the fundamental need for enzymatic activity in plant species. Carbohydrates are important components of storage and structural material in plant species. They exists as free sugar and polysaccharide. A negative correlation is found in sugar content with air pollution level. Similar findings are reported by TJVKTHORA and KOLARVO (1996). The formation of carbohydrate content is directly proportional to chlorophyll content of leaf. If pigments are chocked by SO_2, the chlorophyll content will be reduced and ultimately hampered the photosynthesis. If photosynthesis hampered them it will affect the production of carbohydrate. Air pollution often inhibits the synthesis of chlorophyll molecule by inhibiting the availability of magnesium molecule.

The ascorbic acid is a strong reducing agent and it reduces the effect of air pollution basically the SO_x and protects the plant against oxidative damage, also acting as anti oxidant.

The significant of the study is to know the concentration of SO_x, NO_x, SPM in the iron and steel industrial zone and its effects on plant community through the symptoms, which include changes in plant anatomy, physiological nature, continually exchange of different gaseous pollutants in an out of the foliar system, ultimately affect the plant. It has been clearly shown that significant crop yield losses are due to ambient air pollutant level in industrial area (Heck et. al. 1988, Jager et. al. 1994).

The aims and objectives of this study was to assess the status of the air pollution and its impacts upon plant species under air pollution stress. The variations of biochemical parameters under study due to pollution level indirectly will plants sensitivity towards air pollution and subsequently the extent effect the air pollution stress in and industrial area.

Materials & Methods

Site Selection: For this study two specific sites were selected. One place is regarded as control site or safe site & other place is regarded as stress or polluted site. The Burdwan University farm (Burdwan) was regarded as control zone as it is situated towards north east of Burdwan town is however, a relatively pollution free zone, as it is surrounded by dense canopy of trees with less movement of vehicles. Tetultola colony (Durgapur) was regarded as polluted zone because it is industrial zone & heavy traffic load. The sampling sites paddy field was selected in close vicinity of this industry.

Species selection: One specific plant species was selected from both Burdwan University farm house & tetultala colony of Durgapur for observing the changes. The plant species was 1) *Oryza sativa* L. (IR-36)

Air quality analysis: During the exposure period from June to October,2010

ambient air quality in terms of common air pollutants i,e. SO_x, NO_x and SPM was analysed at all the bioindicator stations. Ambient air monitoring was done by High Volume Sampler following standard methods. For estimation of SO_x Indian standard methods of measurement of air pollution, part-II Sulpher Di Oxide 2001,IS:5182(part-II); for NOx Indian Standard methods of measurement of air pollution, PartVI Nitrogen oxides.1975:IS:5182(part VI); For SPM Indian Standard Methods of measurement of air pollution, Part IV Suspended Particulate Matter.1999 IS: 5182(Part IV). Sampling was done 12 hours & twice in a week during the exposure period. Average of 12 hr. such sampling was taken for final calculation.

Table:1 –Ambient air quality of Polluted zone.

Polluted zone	Pollutants($\mu g/m^3$)			Air pollution Index
	SPM	SOx	NOx	
	1320	16.22	821.03	320.56

Table:2 –Ambient air quality of control zone

Control Zone	Pollutants($\mu g/m^3$)			Air pollution Index
	SPM	SOx	NOx	
	117	2.40	10.43	24.84

Table-3: Air pollution index for bioindicator sites:

Index value	Remarks
0-25	Clean air
26-50	Light air pollution
51-75	Moderate air pollution
76-100	Heavy air pollution
>100	Severe air pollution

Air Pollution Index(API): The average of the sum of the ratios of three major pollutant concentrations to their respective air quality standards were obtained. The average was then multiplied by 100 to get the index(Rao & Rao,1989).

$$API = \frac{1}{3}\,[SPM / S_{SPM} + Sox / S_{SOx} + NOx / S_{NOx}] \times 100$$

[Where S_{SPM}, S_{SOx}, S_{NOx} represent the ambient air quality standards for SPM, SO_x, & NO_x.

Where [S_{SPM}=500, S_{SOx}=120, S_{NOx}=120 unit(μg/m^3)] in case of industrial area, and [S_{SPM}=200,S_{SOx}=80,S_{NOx}=80 unit(μg/m^3)] in case of residential area.

Biochemical Study: After 5 months of exposure different plant parts were analysed for different biochemical parameters estimation. Total chlorophyll was analysed following the standard methods of Arnon (1949), Ascorbic acid by Mukherjee & Choudhuri(1983), protein by Lowry et.al,(1951), total soluble sugar by Mc.Cready et.al,(1950). Different heavy metal detection from water, plant sample by APHA 1998.

Result :

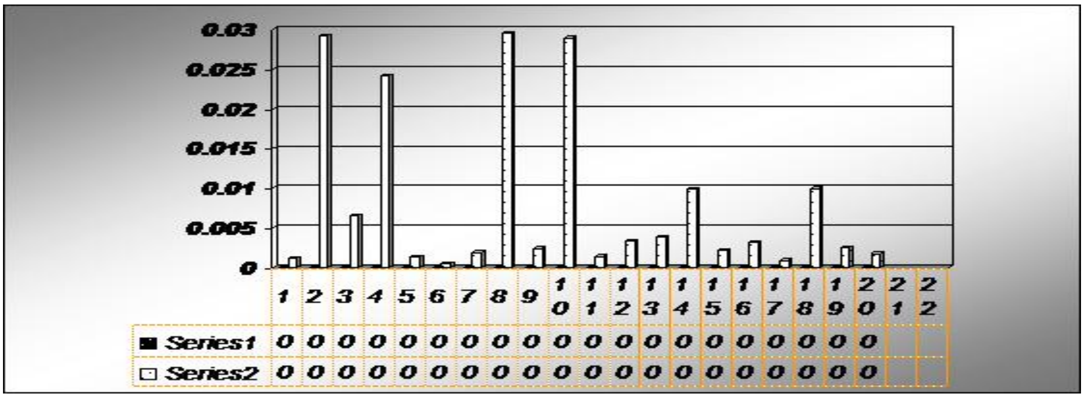
Table 4: Biomolecular concentration of different plant parts in paddy crop in (g/100g)

Plant parts		Sugar	Protein	Ascorbic acid	Chlorophyll
Leaf	Polluted area	0.0012±0.0002	0.0065±0.002	0.0013±0.0002	0.0019±0.0001
	Control area	0.0291±0.003	.0241±.001	0.0005±0.0002	0.0295±0.0007
Shoot	Polluted area	0.0024±.0001	0.0014±0.0002	0.0038±0.001	
	Control area	0.0289±0.0005	0.0033±0.0001	0.0098±0.0008	
Root	Polluted area	0.0021±0.0004	0.0009±0.0001	0.0025±0.0007	
	Control area	0.0032±0.0001	0.0099±0.001	0.0017±0.0001	

Table 5: Different heavy metal concentration (mg/l unit) in respective two sites.

	Cadmium	Lead	Chromium	Iron
Polluted areas water	0.0096±0.003	0.2153±0.02	0.2433±0.11	4.93±2.05
Control areas Water	0.0016±0.0006	0.0022±0.0006	Not detectable	0.28±0.02

Graph 1: Graphical representation of different biomolecular concentration in different plant parts in two different study sites.



X axis refers different biochemical parameters of different plant parts.

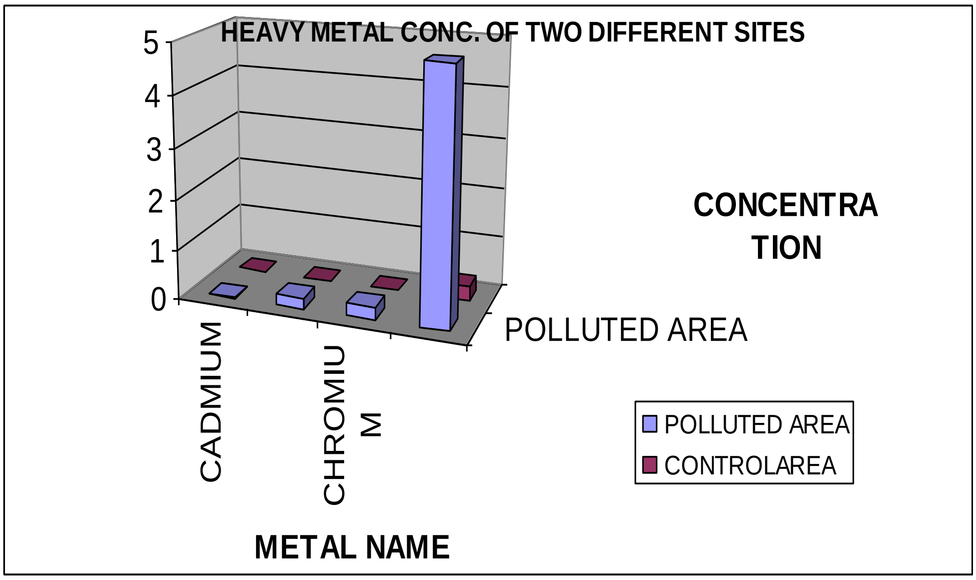
In X axis the even number denotes unpolluted areas plant sample and odd number denotes polluted areas plant sample.

1 and2 denotes leaf sugar, 3 and4 leaf protein,5-6 leaf ascorbic acid,7-8 total leaf chlorophyll,

9-10 shoot sugar,11-12 shoot protein,13-14 shoot ascorbic acid,

15-16 root sugar, 17-18 root protein, 19-20 root ascorbic acid.

Graph 2: Graphical representation of different heavy metal concentration in respective study sites



After 5 months of exposure, leaf & other plant parts sample of this species were analysed for chlorophyll, protein, soluble sugar, free ascorbic acid, activity. All the biochemical parameters exibited significant variation between two sites.

Leaves of *Oryza sativa* L. in the present investigation revealed 93.55% reduction of chlorophyll with respect to control area's plant. But ascorbic acid content of leaf in control plant also showed decreasing pattern in 61.53% when compared to polluted plant. Sugar content of leaf showed a declining trend at the polluted sites. Sugar content of leaf in this plant showed 95.87% reduction conditions when compared to control plant. Sugar content of shoot similarly showed decreasing pattern with 91.69% reduction when comparison to control. Reduction of leaf protein occured at 73.02 % in comparison to control. Reduction of shoot protein occured also at 57.57% respectively in comparison to control. Ascorbic acid content in shoot showed an decreasing rate 61.22%, in comparison to control during the present investigation. Ascorbic acid content in root showed an increasing attitude at a rate of 47.05% in comparison to control plant during the present investigation.

There was 34.37% reduction in root sugar content when comparison to control plant. Root protein content decreased significantly at a rate 90.90% when compared to control site plants.

Heavy metal estimation from collecting water samples of polluted site shows Lead and Iron was present at a greater ratio than permissible limit of water. Iron is present at very high quantity 4.93 miligram/liter , Lead 0.2153mg/l and Chromium 0.2433mg/l. The different heavy metal i.e., Cadmium, Lead, Chromium and Iron were present in very negligible amount in the control areas water sample.

Air quality assessment : For this experimental study different air parameters(SPM, NO_x, SO_x) value of two different sites were monitored. Polluted industrial region exibits 320.56 Air Pollution Index and Burdwan university farm shows clean air quality where Air Pollution Index is 24.84.

Discussions: The same species in two different sites showed significant variation in all the biochemical parameters in comparison to control . A considerable loss in total chlorophyll in the leaves of plant exposed in polluted stations. Air pollutants such as SPM, SO_x, NO_x entrance into the tissue through stomata cause pigment damage. Rao & Leblanc (1966) mentioned that high amount of gaseous SO_2 causes destruction of chlorophyll.

Reduction of sugar content in different plant parts in polluted stations can be attributed to increased respiration & decreased CO_2 fixation because of chlorophyll deterioration.

Davison & Barnes (1986) mentioned that pollutants like SO_2, NO_2, & H_2S under hardening conditions can cause more depletion of soluble sugars in the leaves of plant grown in polluted area. Reduction in protein content of three different plant parts in comparison to control site is found. Constantinidou & Kozlowski (1979) found enhanced protein denaturation & breakdown of existing protein to amino acid as the main causes of reduction in protein content. In polluted zone ascorbic acid content shows its increasing property in leaf and root region due to air pollution load and iron load respectively. Besides other biomolecules also showed decreasing property in polluted region due to heavy metals load in their growing environment. Sharma et al., (1986) mentioned that untreated industrial effluents is one of the most significant reasons for pollution of environmental ecosystem due to presence of significant amount of heavy metal. The free radicle production under SO_2 exposure would increase the free radicle scavengers, such as ascorbic acid (Pierre & Queirz,1981).

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