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Full Length Research Paper

The impact of dust emits by the steel complex of El Hadjar (ANNABA) on two biological models: Mousses and lichens

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The effect of the dust rejected by the steel complex of El Hadjar (SIDER) studies was by subjecting the mousses and lichens under a treatment by various concentrations of dust. Previously, the chemical composition of this dust was to analyze and show as well the quantitative and qualitative composition of dust and the dust is consisted of the pollutants with rates much higher than those authorized by WHO. All the measured morphophysiology parameters were strongly disturbed by dust in the case of the mousses and as well as that of the lichens. A clear disturbance of the energy respiratory metabolism was observed at the two species study; these disturbances are related to enzymatic dysfunctions likely to diagnose phototoxicity by certain heavy metals. It was concluded that, the dust rejected by SIDER disturbs the morphophysiology and biochemical parameters of the mousses and lichens and on the other hand, its dust strongly inhibits the two energy phenomena study with known breathing and photosynthesis.

Key words: Heavy metals, dust, mousses, lichens, breathing.

INTRODUCTION

The steel operations have tended to cause pollution of the atmosphere; pollution is often spectacular harmful. In recent years, due to the appearance in the manufacturing of iron and steel of new technologies, problems of pollution in this sector have become increasingly complex; the use of oxygen to steel provides significant emissions of red smoke, agglomeration of ores and various pollutants including dust composition and size varied (10 to100 µ) (Ramade, 1995). Dusts discharged by the mills are mostly formed by heavy metals, whose effects on plants are very harmful (Bouchelaghem, 2003). These dusts inhibit the growth of microorganism's freshwater (Douaouya et al., 2002).

MATERIALS AND METHODS

Origin of pollution

In this work, the main source of pollution was the steel complex of El Hadjar, located at 13 km from the city of Annaba (El Hadjar common).

The source unit of pollution is the electric steel work, particularly dye rejected dust. As a first step, this study searched the chemical composition of dust released by the two mills (ACE 1 and 2) through the placement of boxes on the roofs of sites, near the chimney.

Experimental materials

The experimental equipment used for this study was composed of lower plants (Mousses: *Rhizobium rigosium* and Lichens: *Ramalina farinacea*). Mousses and Lichens were from the region of Seraidi to 1200 m altitude over the city of Annaba.

Cultivation of mousses and lichens

Mousses and lichens were first carefully selected; they were weighed (5 g) for each sample and then, placed in beakers of 200 ml. They were then treated with different solutions of dust concentrations (0.25, 0.50, 0.75 and 1 g/L) (Bensoltane et al., 2005).

Determination of the chemical composition of dust

The analysis of the chemical composition of dust released by the

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Table 1. Chemical composition of dust released by the ACE 1 and 2 of the complex of El Hadjar steel during the year 2001/2002.

Sample	Content of element (ppm)						
	Cu	Zn	Pb	Cr	Ni	Mn	Fe
Dust ACE1	3.7	240	24	10	1.2	320	3000
Dust ACE2	7.0	480	62.4	12	1.3	540	3600
Average (ACE 1 and 2)	10.7	720	88.4	22	2.5	860	6600

Ppm, Part per million.

ACE1 and 2 was conducted at the DRA SIDER complex and determined by the technique of atomic absorption. This technique (Gaydon, 1968; Rubeska, 1968) was based on the absorption of a beam of radiation of a part of the atomic vapour emitted from the element to be determined.

The percentage of atomic absorption was detected by the weakening of the intensity of the line which is a function of the atomic vapour, (Philips, 1991).

Measurement of biochemical parameters

Determination of the average content of protein

Proteins were measured by the method of Bradford (1976). The principle of the method was based on setting an acid dye (Coomassie blue) of proteins at basic residues and aromatic, this setting causes a transfer of its colour from red to blue. This change in colour was measured at a wavelength of 595 nm by spectrophotometer (JENWAY 3600) using bovine serum albumin (BSA) as standard.

Determination of chlorophylls

The extraction of chlorophylls was carried out by the method of Holden (1975), which consists of a maceration of the plant in acetone. The processing of samples were as follows: 1 g of leaf vegetable was weighed, cut into small pieces and crushed in a mortar with 20 ml of acetone (to 80%) and approximately 100 mg of calcium bicarbonate ($CaCO_3$). After grinding, the solution was then filtered and put in black boxes in order to avoid oxidation of chlorophylls by light.

The reading was done at two different wavelengths of 645 and 663 nm, after calibrating the device with the solution of acetone to 80%. The values of the chlorophylls were calculated using the equation by Arnon (1949)

Chl.a = 12.70. DO (663) - 2.69. DO (645)

Chl.b = 22.90. DO (645) - 4.60. DO (663)

Measurement of respiratory activity

The oxygen uptake related to respiratory oxidation was measured by the polarography technique using oxygen electrode (HANSATECH) coupled to a computer. Cell volume adjustable from 1 to 2 ml is thermo stated at 25 + 0.02°C. The environment was highly turbulent and was composed of distilled water.

The concentration of oxygen in the measurement environment in equilibrium with the atmosphere was estimated to be equal to 240 µM (Djebar and Djebar, 2000).

RESULTS

Chemical composition of dust from ACE 1 and 2

The results of the chemical composition of dust released by the ACE 1 and 2 of the complex of El Hadjar steel are summarized in Table 1

Effects of dust on mousses and lichens

Effects on average levels of total protein on mousses and lichens

In this work, only the dust of ACE1 was used for the study experiences and results are summarized in Table 2.

Effects of the average content of chlorophylls a and b on mousses and lichens

The results of the assay of chlorophyll are shown in Figures 1 and 2. Thus, it can be seen that, the photosynthesis of mousses and lichens were strongly affected by the dust of ACE1 and from the low concentrations used.

Effects of average levels of total sugars on mousses and lichens

The total soluble sugars were assayed by the method of Sheilds and Burnett (1966). The assay was then carried out in a spectrophotometer (JENWAY 6300) at wave-length (λ) of = 585 nm.

The results are shown in Figure 3. It was observed that, the level of total sugars among registered mousses witnesses are higher than those obtained in lichens (about 9 times>).

Effects on the respiratory metabolism of mousses and lichens

The evolution of the respiratory metabolism of mousses

Table 2. Average content of total protein on mousses and lichens treated with dust from the ACE1.

Dust (g)	Mean total protein (µg/g fw)	
	Mousses	**Lichens**
0	39	47
0.25	37	45
0.50	35	42
0.75	22	32
1.00	12	27

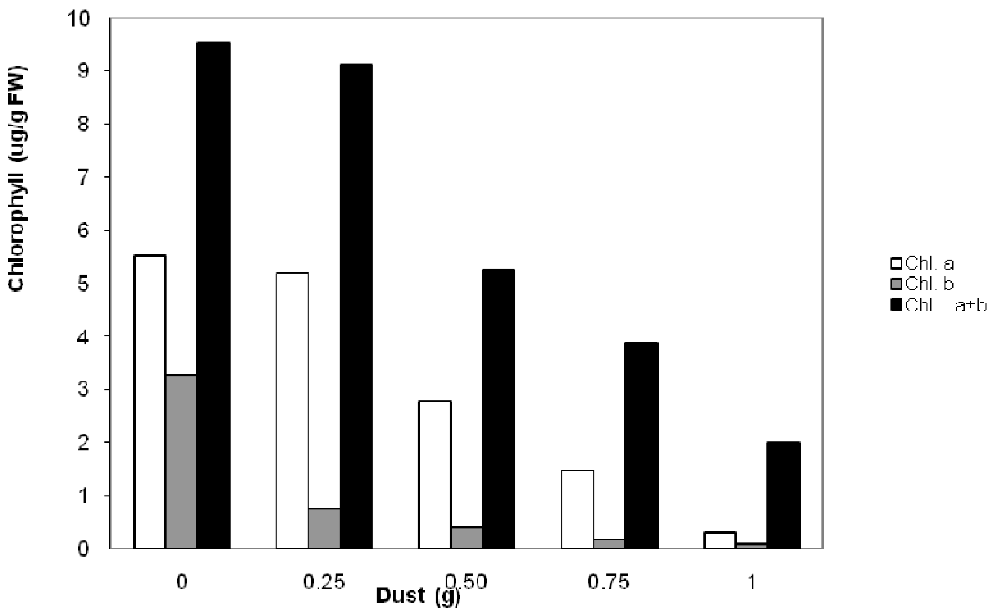

Figure 1. Effect of dust released by the Ace 1 on the average content of chlorophylls a, b and (a + b) of the mousses.

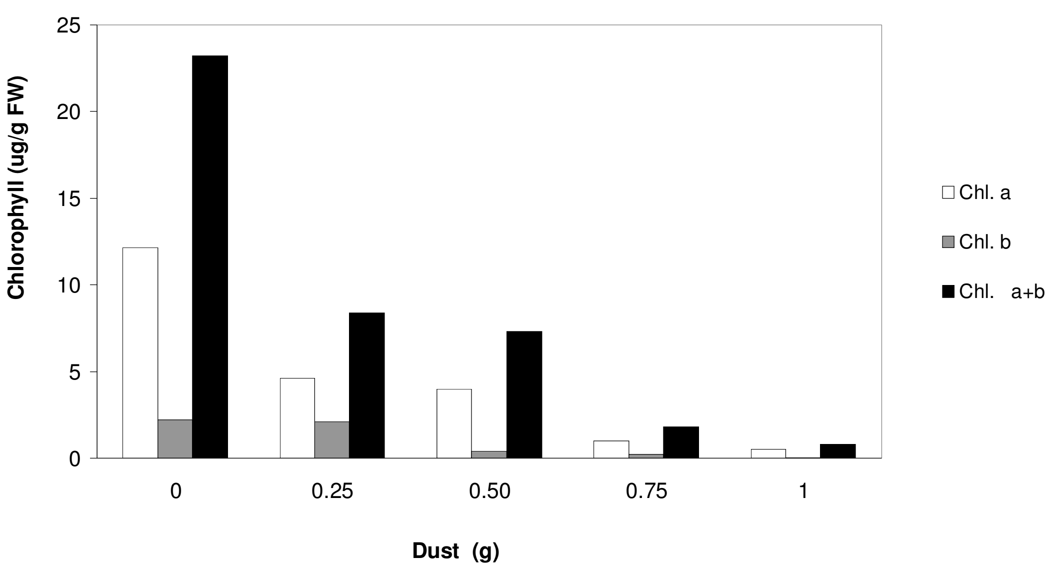

Figure 2. Effect of dust rejected by the ACE 1 on the average content of chlorophylls a, b and (a + b) of the lichens.

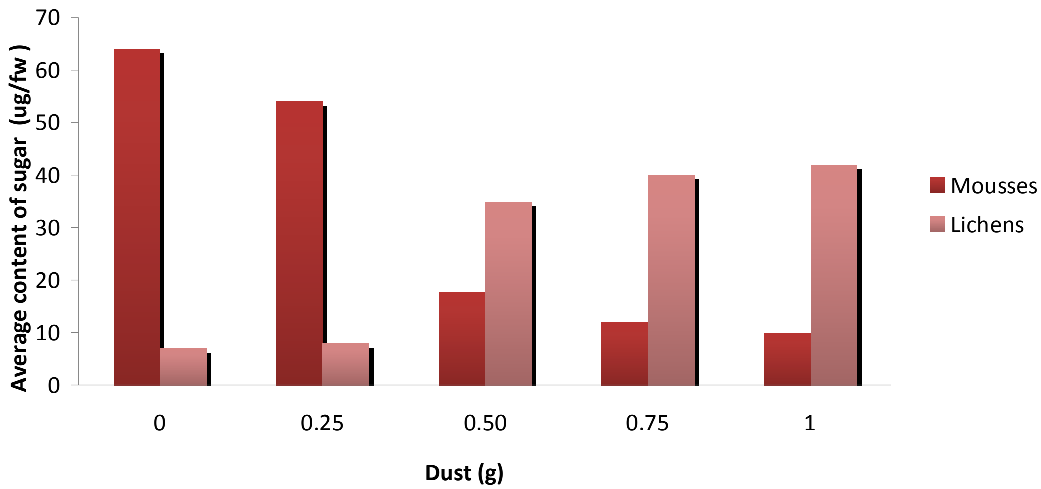

Figure 3. Effect of dust rejected by the ACE 1 on the average content of total sugar on mousses and lichens

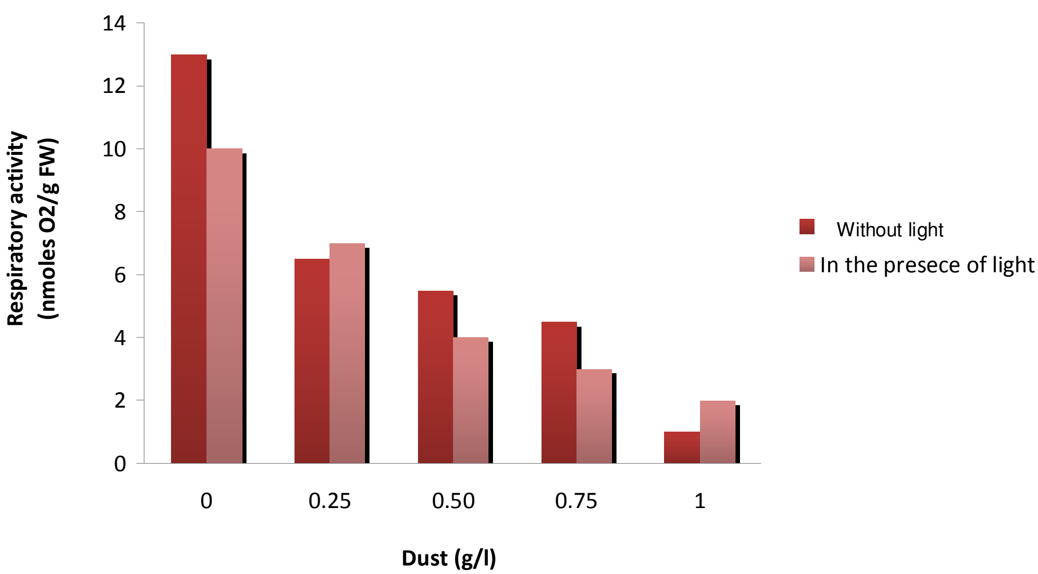

Figure 4. Changes in the respiration of mousses (j = 10) according to different concentrations of dust. The mid-position (middle electrode) consists of distilled water and the temperature was 22°C.

and lichens subjected to treatment with different concentrations of dust rejected by the ACE 1 was followed over an average duration of 10 days. The results obtained are shown in the Figures 4 and 5.

DISCUSSION

This part proposes to recall and discuss the results exposed in this work. Thus, in the first part, the chemical composition of the dust rejected by the ACE 1 and 2 of the iron and steel complex of El hadjar (Annaba) like polluting site, is given the comparison with the standards into force defined by the international organizations that will make it possible to give an idea on the degree of pollution of its units. The second part insisted on the impact caused by this dust on mousses and lichens. In the first step, this study showed a clear disturbance of protein metabolism which resulted to a decrease in average protein content, as well as the average contentof chlorophyll. In the case of the average contents of sugar, one parallel to note is a reduction in the rates of mousses which recorded an increase at the lichens. Thus, the lichens seem to behave differently; it is known

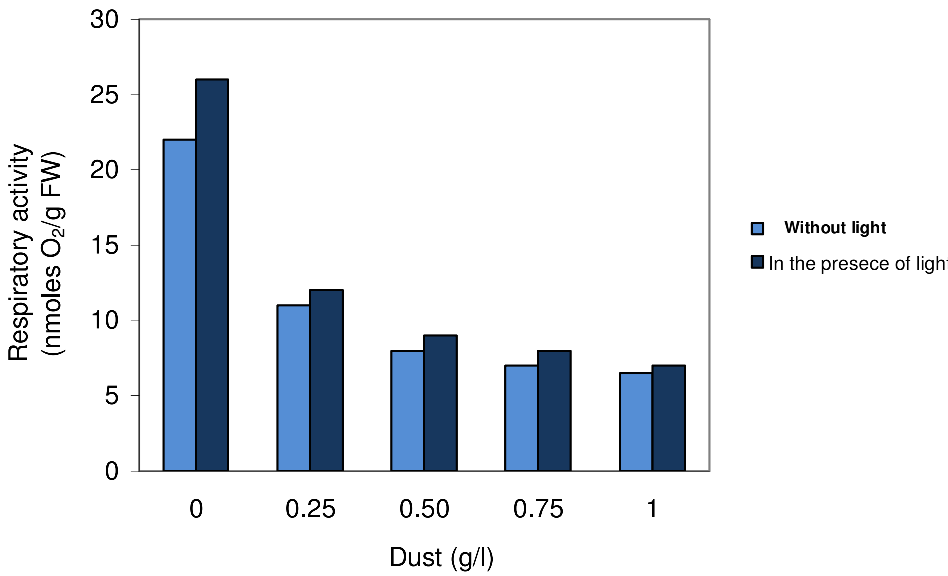

Figure 5. Changes in the respiration of lichen (j = 10) according to different concentrations of dust. The mid-position (middle electrode) consists of distilled water and the temperature was 22℃.

that the synthesis of total sugars is a response to various stresses (Belahcene, 2002). This clearly shows the role played by these micro-organisms in the bio detection of pollution in the air, comparatively, the mousses seem very sensitive to the pollution generated by the heavy metals contents in dust.

Concerning the results obtained as for the effects of dust on the respiratory metabolism of these organisms, it showed that breathing as well as photosynthesis is inhibited by dust and this is seen at the mousses and lichens. This effect would be due to the disturbance of the mitochondrial oxidative phosphorylation particularly at these organisms. This disturbance would be explained partly by the interference of certain heavy metals (example, Zn) in the respiratory enzymatic activities and consequently, in the phosphorylation mechanism of ADP in ATP by ATPase (Fluckiger et al., 1978).

Conclusions

From a chemical composition, it is clear that the dust released from the steel complex of El Hadjar pollutants is both qualitative and quantitative. These dusts contain heavy metals and hazardous rates far exceeding those permitted by WHO.

All parameters that measured morphophysiology have been seriously disturbed by heavy metals both in the case of mousses and lichens.

A distinct disturbance of respiratory energy metabolism is observed in both species studied. These disturbances are associated with dysfunctional enzyme likely to diagnose phototoxicity by some heavy metals.

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