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Effects of the Glyphosate Application on the Physio-Biochemical Parameters of *Xanthoria Parietina*

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ABSTRACT

The extended use of Glyphosate as herbicide in weed's control can lead to the damage of the ecosystem. Ecological indicators can be used as early warning signals to assess the environmental problems. In order to evaluate the performance of the lichen as an air pollution bio monitoring, we investigated if treatment of the lichen *Xanthoria parietina* with Glyphosate causes bio physiological alterations. In this respect, the effect of various herbicide doses on the lichen's bio physiology was tested in the laboratory during 7 days under controlled conditions. Samples of lichen, naturally grown, were collected from different forest's sites and were treated at the recommended doses as well as with double doses. The findings have shown a clear reduction in the photosynthetic pigments. Of particular importance in this respect, are the pigments chlorophyll (a), (b), (a+b) and carotenoid. However, an increase in the total protein, sugar and proline products levels was observed. Finally this study shows that *Xanthoria parietina* is an appropriate organism for the bio monitoring of undesirable effects of the Glyphosate .

Keywords: Biomonitoring, Lichen, Glyphosate, Herbicide, Air Pollution.

I. INTRODUCTION

Glyphosate is non-selective and systematic organ phosphorus herbicide which is used widely in order to control weeds [1]. Glyphosate targets a key enzyme (EPSPS) which is essential for the growth of most plants, inhibiting nucleic acid metabolism and protein synthesis [2]. Lichens are symbiotic bi- or tripartite organisms, it involves heterotrophic component mycobiont (ascomycetes) and autotrophic photobiont (green alga or a cyanobacterium) [3]. Lichens can be used as sentinels of air pollution because of the fact that they do not have real root and are strictly dependent on the atmosphere for their metabolism. Glyphosate is widely used by aerial spraying, so it may for sure reach a non-target species such as lichens, thus, the understanding of its possible impact is very important. It can be noticed that there is not enough studies on the effect of herbicide on lichens because they are considered as non-target organisms. However there are some few studies which indicate the possible negative effect of glyphosate treatment on the lichens. The aim of our study is to test the toxicity of glyphosate on the lichen *Xanthoria parietina* as well a physiological and chemical alterations consequences.

II. METHODS AND MATERIAL

Samples of the *X. parietina* were collected from their natural environment located at 48˚ 86' 67" latitude and 2˚ 33' 33" longitude in the East of Oran (USTO University). The choice of this species was based on their previous uses in biomonitoring studies as well as in laboratory experiments. After collection, lichens were left in the cytology laboratory where the marginal lobes were removed, cleaned from extraneous material and used for the experiment. Glyphosate was provided using Rophosate 480 (Rotam agrochemical), a common commercial glyphosate-based herbicide. Three treatment solutions of 0 (deionized water: control), treatment corresponding to the lowest usage dose recommended by the producer and a treatment with two times higher than the highest suggested usage dose. Samples were sprayed with the treatment solutions within seven days. The experiment was replicated three times.

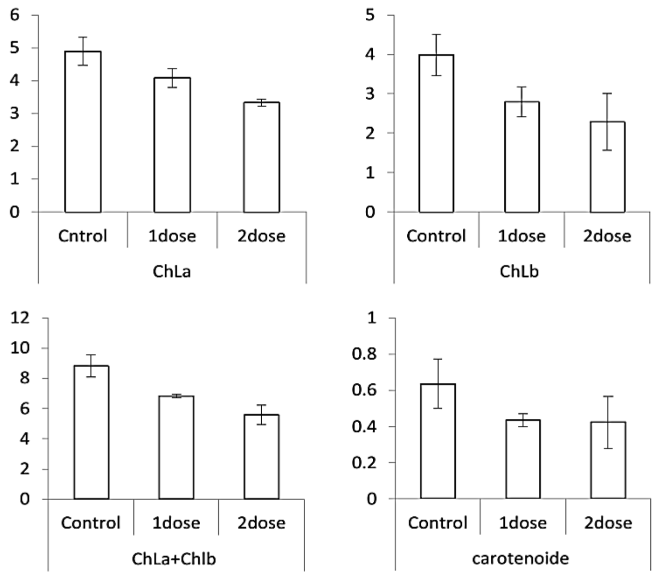

Figure 1 : Concentration of photosynthetic pigments (mg/g FM) in samples of *X. parietina.* Vertical bars indicate standard deviation.

The physiological effects were determined by quantifying chlorophyll a, b and a+b content as well as proline; total protein and soluble sugars concentration.

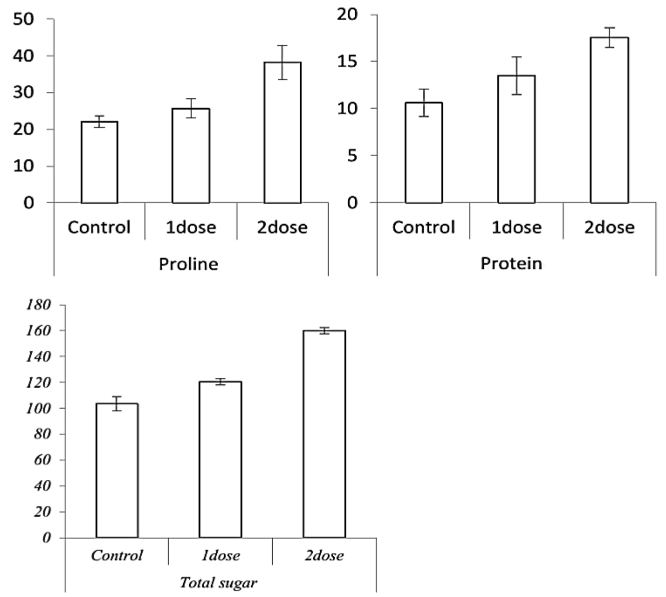

Figure 2 : Concentration of protein, proline and sugar (µg/100mg FM) in samples of *X. parietina*. Vertical bars indicate standard deviation.

Statistical analysis of resulted data is performed by the Student test (t test) by comparing the means of two populations using data from two independent samples.

III. RESULT AND DISCUSSION

The physio-biochemical parameters investigated resulted negatively for some parameters and positively for the others, irrespective of the treatment doses, for the photosynthetic pigment content were decreased at the lowest and the highest treatment dose after seven days period. For the other parameters: proline protein and sugar we observed an increase in the content of this parameters. Interaction between doses the results was significant for all parameters. Fig.1 and Fig.2 represent the Changes of chlorophyll a, b, carotenoids, protein, proline and sugars rates in function of the concentrations of Glyphosate used.

For the photosynthetic pigments their variations are minimal. The value of the rate of chlorophyll (a + b) in control sample is 8.83 mg / g FM, in the one of the sample treated with a single dose is 6.84 mg / g of FM and finally in the treated with a double dose is 5.58 mg / g of FM. In contrary, carotenoids have not substantially changed. The Measure of the average levels of chlorophylls (ab) and carotenoid obtained indicates the existence of a state of stress due to the presence of a pollutant. Chlorophyll is sensitive to oxidative processes initiated by stress, such as photochemical oxidation [4]. In a study carried out by Mascher et al. (2002), it is found that the decrease in chlorophyll's concentration and carotenoid is a signal of poisoning [5]. Silberstein et al. (1988) reported that the degradation of chlorophyll is one of the clearest indications of the damage caused by air pollutants [6]. The decrease in the concentration of chlorophyll "a" and chlorophyll'b' can be explained by the decrease in the photosynthetic activity of the treated samples. The significant increase of protein is a sign of a possible infringement of other basic metabolism and it can be explained by the fact that the pesticide inside tissue stimulates protein synthesis of many enzymes especially those involved in detoxification process.

For the protein, proline and sugars content, a small increase was observed, depending on the concentration. The average values of these rates are summarized in the Fig. 2. The dosage of the proline has allowed us to detect a phenomenon of stress under the effect of treatment with the pesticide. A metabolic disorder caused by the treatment was observed within the lichens. The increase in the rate of proline is due to the oxidation inhibition caused by the mitochondrial dysfunction. The results obtained allowed us to note that treatment with the pesticide, affect disorderly the proteins rates in both lichens and mousse. This disturbance is a sign of possible impairment of basic metabolism and reflects the toxicity of pesticides used. The dosage of the soluble proteins shows that treatment of the samples with a pesticide is behind an increase soluble proteins' concentration [7] which can be explained by the stimulation of protein synthesis of many enzymes known as an enzyme detoxifying. According to [8] the process of accumulation of soluble sugars and / or proline in leaf tissue of stressed plants is known as an adaptive characteristic. This confirms our results where we found increased levels of soluble sugars after treatment in both species. The ability of plants to respond to changes in the levels of soluble sugars can act as control mechanism incorporating the external environmental conditions such as biotic and abiotic stress [9].

IV. CONCLUSION

This work allowed us to verify that the lichen species *xanthoria parietina* is sensitive to the effects of the glyphosate because of physiological parameters damages found. The study proved that the negative effects of pesticide depend on its concentration, we have shown that *xanthoria parietina* can be used as bioindicator in agricultural ecosystems, in addition to its known qualities as urban bioindicator.

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