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SULPHUR IN FOLIAGE AND SOIL OF THE KORANGI INDUSTRIAL AREAS AND UNIVERSITY CAMPUS

M. ZAFAR IQBAL AND QAMAR-UZ-ZAMAN

Department of Botany, University of Karachi, Karachi-75270, Pakistan

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The concentration of total sulphur in leaves of some plant species, *Ficus religiosa, Tamarix indica* and *Prosopis juliflora* from different sites located in Korangi industrial area of Karachi and the University campus was determined. The level of total sulphur in the leaves of all the species was highest at Oil refinery and Muhammadi Foundary as compared to the University campus and Ittefaq Foundary. The soils of these sites also showed significant differences ($P<0.05$) in available sulphur. The highest value (11833 mg kg^{-1}) was found at Oil refinery followed by Muhammadi Foundary (6458 mg kg^{-1}) and Ittefaq Foundary (5833 mg kg^{-1}), while the lowest concentration (1667 mg kg^{-1}) was recorded at the University campus.

Key words: Industrial area, Plant foliage, Soil, Sulphur.

Introduction

Pollution produced from the diverse activities that occur in a city has become an emblem of urban life. Traffic and factories produce oxides of various toxic substances. Sulphur is an important pollutant of this type, released from a wide array of sources but the most important ones are those that are linked with fossil fuel combustion emanating large amount of SO_2 [1]. Sulphur dioxide, being a gas, is dispersed more readily and the rural concentration is probably about a 10th of the urban or industrial figure, though under unfavourable conditions much higher values may be obtained adjacent to some factories [2].

Sulphur is more injurious in the form of acid rain, which may cause environmental intoxication [3]. At the low concentration, plants can utilize atmospheric SO_2 as sulphur nutrient as reported by many workers [4,5]. But when its concentration reaches above a certain level, it becomes injurious for plants and reported to produce physiological and biochemical injuries in plants [6]. Nyborg [7] observed the effects of SO_2 emission on the precipitation and sulphur accumulation in soil. Miszalski and Mydlarz [8] had found a decrease in net photosynthetic rate in tomato plants after fumigating them with SO_2. Severe plant damage with SO_2 fumigation was also reported by many other workers [9- 11]. Iqbal [12] has investigated the amount of sulphur in foliage of roadside plantation and soil, whereas, Lawrey and Hale [13] have studied sulphur and lead accumulation in specimens of the lichen.

In this study, the concentration of total sulphur in leaves of some plants, *Ficus religiosal* L, *Tamarix indica* L. and *Prosopis juliflora* DC. and available sulphur in surface soil from different industrial areas was investigated.

Materials and Methods

The fresh leaves of *F. religiosa* L., *T. indica* L. and *P. juliflora* DC. were collected from the National Oil Refinery, Ittefaq Foundary and Muhammadi Foundary in Korangi industrial areas at the height of 2 m from the ground surface. Similar leaf samples were also collected from the University campus, about 18 km away from the industrial areas. Three replicates were taken from each site and the uniformity was observed throughout the sample collection. All the sample leaves were oven dried at 80° for 24 hrs, powdered, ashed at 450° in a muffle furnace for 5 hrs and the ash was dissolved in conc. HNO_3 and total sulphur was determined [14]. Surface soil samples from each site were collected and available sulphur was measured by a turbidimetric method [15].

Data from each experiment were assessed by analysis of variance technique [16]. Differences among sites were determined statistically significant at 5% ($p<0.05$).

Results and Discussion

Amounts of total sulphur in leaves of *F. religiosa, T.indica* and *P. juliflora* and available sulphur in surface soil at different sites are summarised in Table 1. Total sulphur was highest in leaves of all the species at Muhammadi Foundary and Oil Refinery. These values were significantly ($P<0.05$) higher in all the species at Ittefaq Foundary, Muhammadi Foundary and Oil Refinery as compared to University campus. The values were also significantly different in all the species between Ittefaq Foundary, Muhammadi Foundary and Oil Refinery except in *T. indica* between Muhammadi Foundary- and Oil Refinery. Highest concentration of sulphur was recorded in *F. religiosa* at all points as compared to the other species.

The soil analysis for available sulphur showed significant difference ($P<0.05$) between the sites (Table 1). The highest available sulphur was found in the soil of Oil Refinery (11833 mg kg^{-1}), followed by Muhammadi Foundary (6458 mg kg^{-1}), Ittefaq Foundary (5833 mg kg^{-1}) and the University campus (1667 mg kg^{-1}).

It has been found that sulphur in the leaves of all the plants investigated and soil was higher in the industrial areas of Korangi as compared to the campus area, which is far away from the industrial complex. Around the oil refinery, comparatively highest amount of sulphur was recorded in the plant leaves and soil as compared to Ittefaq and Muhammadi Foundaries. This has shown that the emission of oxides of sulphur due to the burning of fossil fuel was much more higher from the oil refinery than from the other two factories. The Ittefaq and Muhammadi Foundaries are comparatively a smaller units as compared to the National Oil Refinery. Sulphur present in the environment of the industries might has deposited on the soil by dry and wet deposition. Many of the chemicals found in rain water may come from industrial pollution [2]. Similarly, Possanizini and Buttini [17] have also found acid deposition due to the atmospheric gaseous pollutants. Some of the early studies [18,19] had shown that foliar sulphur levels were higher near the industrial centres than in remote areas.

Among the species studied, *F. religiosa* accumulated highest amount of sulphur in leaves than the other two species (*T. indica and P. juliflora*). It is established that vegetation play an important role in cleaning the atmosphere by absorbing certain toxic pollutants from the surrounding. Vegetation was known to exchange large quantities of CO_2, O_3 and water vapour with the atmosphere long before the scientific concept of gaseous pollutant was formalized. Hill [20] has demostrated an uptake of ordinary pollutants by alfalfa canopies. A comprehensive study of vegetation as a sink for atmospheric pollutants was given by Rasmussen and Kabel [21]. Johnsen and Sochting [22] demonstrated a high correlation between SO_2 of the air and bark of trees. The increase of sulphur content of the bark was evidently caused by dust emitted from the fertilizer factory. McCool and Johnson [19] had also found a correlation between SO_2 from smoke producing areas and the sulphur content in plants. Olsen [23] showed that healthy cotton plants obtained about 30% of their sulphur from the atmosphere. Over 50% of the sulphur in sulphur-deficient plants was absorbed directly from the atmosphere. Robert [24] grew white pine in area of high pollution for two months and found that the tolerant clone showed higher sulphur content than the corresponding pines in less SO_2 polluted area.

Highest accumulation of sulphur in *F. religiosa* could be related to the broader leaf size of the plant (Table 2). The size of the leaf in *F. religiosa* is much more greater (65.0 sq. cm) than the size of *T. indica* (7.5 sq. cm) and *P. juliflora* (2.3 sq. cm). Olsen [23] has demonstrated that SO_2 absorbed by the plants was roughly proportional to the size of plant, more presumably by large leaf surface.

A correlation was found between the concentration of total sulphur in tree species and the available sulphur in soil.

TABLE 1. CONCENTRATION OF TOTAL SULPHUR (mg kg^{-1}) IN PLANT LEAVES AND AVAILABLE SULPHUR (mg kg^{-1}) IN SURFACE SOILS.

Sites	*Ficus religiosa*	*Tamarix indica*	*Prosopis juliflora*	Surfac soils
University Campus	750 a (± 7.3)	400 a (± 5.2)	625 a (± 9.8)	1667 a (± 19.3)
Ittefaq Foundary	1063 b (± 5.2)	1063 b (±16.0)	1000 b (± 7.1)	5833 b (± 23.9)
Muhammadi Foundary	2375 c (± 6.6)	1750 c (± 16.3)	1063 c (±13.8)	6458 c (± 25.0)
Oil Refinery	2813 d (±12.5)	1750 c (± 8.7)	1875 d (± 13.8)	11833 d (± 9.2)

Statistical significance determined by analysis of variance. Numbers followed by the same letter in the same column are not significantly different ($P<0.05$) according to the student - Newman - Keuls multiple range test. ± Standard error.

TABLE 2. CHARACTERISTICS OF LEAVES OF TREE SPECIES.

Species	Average leaf length (cm)	Average leaf area (sq. cm)	Average leaf dry weight (g)
Prosopis juliflora	5.0 ± 0.2	2.3 ± 0.1	0.01 ± 0.02
Tamarix indica	6.4 ± 0.3	7.5 ± 0.3	0.04 ± 0.02
Ficus religiosa	13.0 ± 0.7	65.0 ± 1.4	0.62 ± 0.13

The amount of available sulphur in soil of the Korangi industrial complex was significantly higher ($P<0.05$) as compared with less polluted sites. This has shown that the industries are the main source of causing sulphur pollution of the environment.

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