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Sulphur Analysis in Soils of Peripheries of Power Plants of Turkey

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Within borders of Mugla district in Southwestern Turkey, there are three power plants operating called Yatagan, Yenikoy and Kemerkoy. These plants in which coal with low calorie and high sulphur content are used have been on the agenda of Turkey for long time, since they have been causing some environmental problems. Source of the claims are acid rains and these three power plans are indicated as major reason in distribution of natural plant cover and in product lost in agriculture. Within last 3 years, frequent but local forest deaths were recorded in forests of the region. These are Red pine (*Pinus brutia* Ten) forests. One of the major indicators of acid rain is increasing in amount of sulphur within soil. In our survey, lots of soil sample were taken form the region with priority of the sites where the deaths in trees were observed. Samples were analyzed in Department of Soil, Faculty of Agriculture Ege University. Findings of the study have revealed that sulphur levels are not high in the soils of the region and even it is under the normal level at some localities. For this reason, it has been concluded that the subject should be considered with different perspectives.

Key Words: Soil, Sulphur, Power Plant, Ecophysiology, Red pine, Southwestern Turkey.

INTRODUCTION

Coal based power plants play an important role in energy production of Turkey. These plants were established close to major coal basins. One of these basins are found in Southwestern Anatolia within borders of Mugla district. The coals found in basin are 2241 Kcal/kg with 18.54 % ash content, 3.15 % sulphur content and 37.75 % water content[1]. In order to use these coals, three power plants were established on the region. Yatagan, Yenikoy and Kemerkoy power plants were commenced to operate in 1982, 1986 and 1993, respectively. Total of 12 million tons of lignite is used in these three power plants. At each plant, there is a desulphurization system which have been using for only one years at all of them. While SO_2 ratios in stack gas were 5657 mg/NM^3 in Yatagan, 9196 mg/NM^3 in Yenikoy and 13103 mg/NM^3 in Kemerkoy before the usage of the desulphurization

system. These ratios decreased to 283 mg/NM^3, 460 mg/NM^3, 650 mg/NM^3, respectively with desulphurization system. Moreover, advanced electro filter systems are also present at these plants.

These plants have been on the agenda of Turkey for long time, since they have been causing some environmental problems. The tree deaths in forests of the region recorded within last 3 years caused to restarting of discussions on the subject seriously. In discussions, acid rains are mainly pointed out as a reason of tree deaths. Since the topography is undulated and meteorology stations are present only in major settlement areas, a proper modelling can not be held in the region. Stack gas measurements were not carried out directly in the regions where tree deaths were observed. For this reason, we have studied the subject comprehensively. Sulphur analysis in soil samples has an important share in present studies. Detailed sulphur analyses at periphery of the plants and the site where tree deaths were recorded were not carried out before. On the other hand, there are some sulphur analyses held in West Turkey soils. Sulphur contents in acidic brown forest soils of Izmir-Bozdag were studied[2]. This type of soil is also very common in power plants and their peripheries. Other common soil group around the plants is red mediterrenean soils. Sulphur contents of these soils were not sufficiently studied in West Turkey[3-6]. The present study cover both types of soil.

The study site is under the influence of typical Mediterranean climate. The data provided by Mugla, Milas, Yatagan and Bodrum meteorology stations, the nearest meteorology stations, were shortly evaluated. Total annual precipitation in Yatagan, Milas and Bodrum are 634.8, 704.7 and 683.7 mm, respectively. More than 50 % of the precipitations fall in winter season. Autumn and spring come after winter in order, while in summer there is too little or no precipitation. At all stations, annual average relative humidity is about 60 %. Annual average temperatures are 15.9 ºC in Yatagan, 17.5 ºC in Milas and 18.6 ºC in Bodrum. Therefore, these three stations are under influence of typical Mediterranean climate. The general characteristic of climate is dry and low humidity. Dominant wind direction is Northeast in Yatagan and Bodrum, southwest in Milas with low wind force.

EXPERIMENTAL

In the study area, 1 kg soil samples from each horizon of 13 profiles were taken at four different localities including the localities where tree deaths were seen. As A and B horizons were not differentiated due to excessive erosion, this two horizons were taken as A/B horizon. Ege University, Botanic Garden (Bornova-Izmir-Turkey) was used as a control sample. In sampling, grid system was applied and different rock and soil types were sampled. Samples were dried out under shade and passed through

2 mm fine sieve. Labeled samples were send to Soil Laboratory in Ege University, Faculty of Agriculture for sulphur analysis. In analysis of organic sulphur, samples were dried at 105 ºC. Then, samples agitated with 1 N HCl were washed with 1 N calcium acetate and dried again at 105 ºC. Soil sample passed through 20 mesh sieve was burned with $NaHCO_3$ (at 500 ºC for 3 h) in porcelain crucibles. It was extracted with 3 % $NaH_2PO_4 \cdot H_2O$. Sulphur content in filtrate was estimated by turbid metric method[7]. For total sulphur analysis; 1 g of soil sample was passed through a 149 µ sieve. It was melted at 900-1000 ºC in platinum crucible with anhydrous Na_2CO_3. By calorimetric method, sulphur content were measured on samples which were transformed into soluble form with 6 N and 12 N HCl.

All the results were evaluated by the reports of Kacar and Katkat[8] and Alpaslan *et al.*[9].

RESULTS AND DISCUSSION

The sulphur analyses were held for five different localities (Fig. 1). A sample from Ege University Botanic Garden (Bornova-Izmir) was taken as a control. Furthermore, while bedrock is calcareous and soil type is red Mediterranean soil at localities 1, 2 and 4, at locality 3, the bedrock is gneiss or micaschist with noncalcareous brown forest soil type. At locality 5, there is alluvial soil rich in lime.

Results are converted to graphics in Table-1 shows the analysis results and standard deviations.

TABLE-1
SULPHUR CONTENT IN SOIL SAMPLES (ppm)

Locality	Humus	Horizon A/B	Horizon C
1	36.41 ± 5.72	22.07 ± 6.09	15.49 ± 3.13
2	24.57 ± 2.72	07.05 ± 0.98	06.04 ± 1.40
3	34.96 ± 2.44	12.44 ± 3.07	05.85 ± 1.73
4	35.47 ± 6.66	07.48 ± 1.77	04.14 ± 2.64
5	24.34 ± 1.67	07.84 ± 0.84	03.39 ± 0.83

According to LSD test, the difference between humus layers of soil samples are insignificant. At A/B horizon, the difference between samples 1 and 2, samples 1 and 4, samples 2 and 5 and samples 4 and 5 is at the 0.05 level of significance.

According to Tukey's LSD test, the difference between humus and C horizons is insignificant. At A/B horizon, it is at the level of 0.05 significance between localities 1 and 2. Sulphur content is high at humus layer of all localities. While sulphur content is decreasing at A/B horizon, it reaches to the lowest level at C horizon. At humus layer, there is organic sulhur.

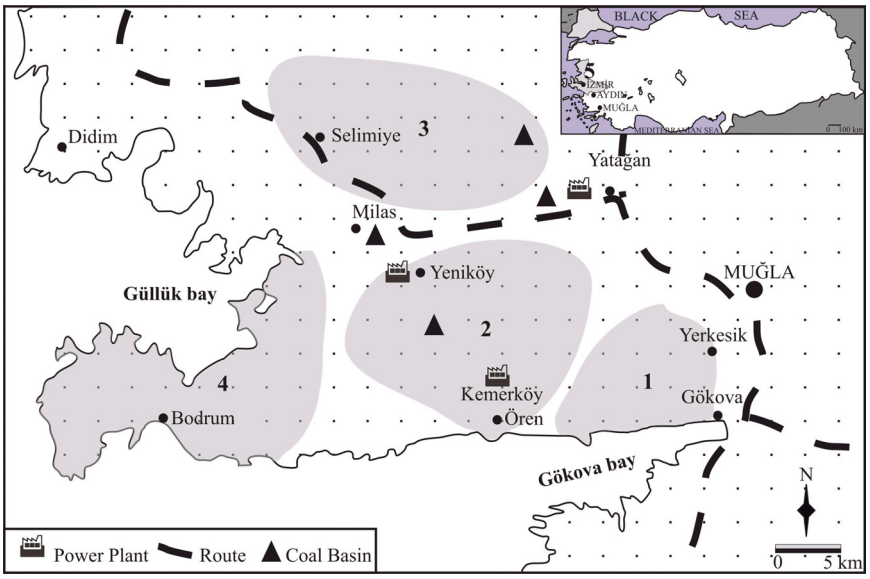

Fig. 1. Study area showing localities sampled 1, Locality 1; 2, Locality 2; 3, Locality 3; 4, Locality 4 ;5,Locality 5

Moreover, there is organic sulphur at an important ratio. On the other hand, total sulphur amount decreases sharply. Sulphur is present maximal in humus layer. It decreases in relation with soil depth. According to the highest values in the first locality, it is understood that this place is the most pollutant area. The second and third localities continue this. Because of the deaths of trees are seen mostly in this locality it can attribute to the acid rains.

The present study was carried out in a region where acid rains were thought to occur. In this region, tree deaths were observed locally. Thus, soil samples were taken from these sites. Preferential ways of determination of presence of acid rain are pH measurements in soil and water and sulphur content measurement in the soil. Both soil and water samples are basic or neutral based on pH measurements. It has been observed that it is basic on calcareous rocks, while being neutral on gneiss and mica schist.

Sulphur amount in soils can vary on soil type and ploughing of the soil[10]. In this regard, Nelson[11] found the sulphur content between 120 and 560 ppm in Mississippi soils. Melivelle *et al.*[12] determined that total sulphur is in between 135 and 1200 ppm and sulphur amount is higher in calcareous bedrocks than others. Tabatabai and Bremner[13] found that total sulphur is between 67 and 618 ppm in Iowa soils and decreases along the soil profile. Neptune *et al.*[14] in Brazil, total sulphur content was determined between 43 and 398 ppm.

Total amount of sulphur in noncalcareous brown soils formed on mica schists at West Turkey was determined[2] between 25 and 235 ppm. According to same study results, organic sulphur content is between 10 and 475 ppm and while it is high in surface horizons, it decreases sharply in lower horizons.

Sulphur content is similar to values above throughout Turkey. It is known that as sulphur content is low in Aegean region, sulphur is added to the soils in many sections of the region[8,9].

In present study, total amount of sulphur in soils changes between 3.1 and 43.43 ppm. These results are consistent with the literature given above.

It is known that sulphur amount of soils and plants depends on number of parameters[8,9]. In that context, it is difficult to make assessment about soil acidity and acid rains in forest ecosystems. The main purpose of this study is to determine that if there is any acid rain risk in study area. It was expecting that sulphur level would be high in these samples. On the other hand, it is remarkable that total sulphur contents were low. In this context, the association of tree deaths with acid rains is not seemed as a proper assessment. Furthermore, low precipitation levels in the region decrease the probability of this. In our opinion, the major cause on tree deaths is low precipitation levels in West Turkey as in all Mediterranean countries at recent years.

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