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Landscape Plants as Biomonitors for Magnesium Concentration in Some Species

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Abstract— There are various accumulable elements in the species that grow in urban centers as landscape planting. Especially Magnesium (Mg) is basic elements for all plants that can accumulation reach high concentrations in some cases. Some problems have been observed in the landscape species with direct or indirect factors in dense cities. The concentrations of various elements in their cell that these species can be a precursor to some environmental problems (abiotic and biotic). So using them as biomonitors is quite useful. The landscape plants show good biomonitoring properties by absorbing them easily. In this study, the Mg concentrations in leaves, branches, , wood, seeds and fruits of Prunus ceresifera, Tilia tomentosa, Prunus avium and Prunus cerasus species were compared as essential mineral element levels as biomonitors. The result of the study, it was determined that the variation of Mg concentration in all organs on the basis of species was compared to analysis of variance (ANOVA) and Duncan test. In general, the lowest values were obtained in Prunus cerasus or Prunus avium, and the highest values were obtained in Tilia tomentosa, while the lowest values in organs were obtained in seeds and the highest values in barks and branches.

Keywords—accumulation; biomonitor; landscape plants; magnesium; organ

I. Introduction

Magnesium (Mg) is more common elements that effect to physiological and biochemical processes in plants, and deficiency or excess of level caused by human activities disrupts the balance of the ecosystem [1]. Different reactions take place in the lack or abundance of this element, which is of vital importance for plants [2]. Mg subsidizes them in deficiencies of other nutrients essential to the plant [3]. The variation in the concentration level of such a useful element is different in each species [4]. Especially in plants under stress conditions resulting from exposure to environmental pollutants, the Mg level can either rise excessively or decrease to very low levels [5]. A common effect of some disease in plants is dietary alteration, and it is often difficult to clearly distinguish between biotic and abiotic factors such as element levels [6]. Also some plants grown in acid soils due to deficiency of essential elements (Ca, K, P and Mg etc.) at low pH [7]. They are not impaired absorption of these ions and are therefore more susceptible to common diseases (loaded with starch, amino acid and sugar) [8]. Emissions or discharged wastewaters caused by environmental pollutants primarily directly affect the air and soil (in terms of soil and pH) [9]. The Mg deficiency varies according to the nature of the soil structure (calcareous, acidic and saline) [10]. In particular, pollutants with high polluting potential such as heavy metals, toxic metals or pesticides infiltrate from the soil and threaten plants kilometers away [11]. Therefore, it is very important to reduce the emission of environmental pollutants at the source and then to monitor the pollutants.

Urban greening provides many advantages that is used as biomonitors for absorb various pollutants from atmospheric deposition (wet or dry), soil and noise pollution [12], [13]. The organ of landscape plants that are used leaf stoma, brunch, s and woods of evergreen species as passive biomonitoring in urban areas for a long-term [14]. The excessive use of these resources both disrupts the balance of the ecosystem, and the wastes formed as a result of the productions cause excessive pollution of air, water and soil

[15]. Global climate change and urbanization that occur as a result of this interconnected process are shown as the biggest irreversible problems of our age while environmental pollution is seen as the most important problem threatening living life and ecosystem [16]. Population growth and concentration of the population in urban areas, that is, urbanization, and other problems indirectly caused by these problems are shown as the most important problems of our age worldwide [17]. Increasing population and developments in technology increase both basic needs and comfort needs of people [18]. In addition to the increasing basic needs of shelter and nutrition, production to meet the need for comfort causes excessive use of underground resources such as mines as well as above-ground resources such as agricultural areas, forests and waters throughout the world [19]. The excessive use of these resources both disrupts the balance of the ecosystem, and the wastes formed as a result of the productions cause excessive pollution of air, water and soil. Global climate change and urbanization that occur as a result of this interconnected process are shown as the biggest irreversible problems of our age while environmental pollution is seen as the most important problem threatening living life and ecosystem [20]. Therefore, Mg concentration is great importance and costly to directly monitor in this site.

In this study, it was aimed to determine the most suitable biomonitors landscape plant and organ that can be used for monitoring Mg concentration in leaves, branches and woods of four different plant species depending on growing areas and factors. This study was aimed to potential biomonitors species that are commonly used in parks, streets and main roads in cities and provide information about some elements concentration levels.

II. Material And Method

The *Prunus ceresifera*, *Tilia tomentosa*, *Prunus avium* and *Prunus cerasus* was used which are grown intensively in Kastamonu city, Turkey. They were collected from several parks by cutting the branches with fruit on them at June of 2021. All samples were separated into organs as leaves, branches, wood, seeds and fruits. The obtained samples were kept for 15 days at room temperature. Afterwards, the samples were dried at 50 ºC for 48 h. The prepared samples were ground into powder and weighed 0.5 g and placed in tubes designed for microwave use. The samples, on which 10 mL of 65% HNO_3 was added, were burned in a microwave device at 280 PSI pressure and 180 ºC for 20 minutes. After the processes were completed, the tubes were removed from the microwave and allowed to cool, and deionized water was added to the cooled samples to make up to 50 ml. After the prepared samples were filtered through filter paper. Afterwards, they were read by ICP-OES device at appropriate wavelengths. The method in question is a method used in many studies for the determination of Mg concentration in plants. The Duncan test was applied for the factors with statistically significant differences at least 95% confidence level (p<0.05) by applying the analysis of variance with the help of the SPSS package program.

III. Findings And Discussion

The F value, error rate, mean values and Duncan test results obtained as a result of the analysis of variance regarding the variation of Mg concentrations in organs by species are given in Table 1.

TABLE I. VARIATION OF MG (PPM) CONCENTRATIONS BY SPECIES

Organ	**Landscape Species**				
	Prunus ceresifera	***Prunus cerasus***	***Prunus avium***	***Tilia tomentosa***	***F* value**
Leaf	3187.4bE	3274.2 cE	2966.2 aE	4627.5 dE	9448***
Branch	1041.0bC	1255.6 dD	1090.8 cC	555.9 aB	35264***
	1297.3cD	1040.4 aB	1106.2 bC	1455.5 dC	1807***

Organ	Landscape Species				
	Prunus ceresifera	***Prunus cerasus***	***Prunus avium***	***Tilia tomentosa***	***F* value**
Seed	485.7cA	285.6 aA	466.7 bB	2572.4 dD	264277***
Wood	495.6 cB	4696.2 dF	299.4 aA	341.3 bA	785202***
Fruit	1042.8 aC	1147.6 bC	2456.0 cD	-	218939***
F value	106597***	223396***	39566***	217208***	106597***

As seen that the variation of Mg concentrations in organs of landscape plants is statistically significant (***p<0.001). When the mean values and Duncan test results are examined, it is seen that the data are collected in two groups in leaf and fruits, and each species forms a separate group in other organs. While the lowest values were obtained in *Prunus avium* in leaf as 299.4 ppm, the lowest values were obtained in *Prunus cerasus* in seed as 285.6 ppm. The highest values in organs other than wood were generally obtained in *Tilia tomentosa*. The variation of Mg element in all organs on the basis of species was statistically significant that the concentrations of its vary significantly and it has even been emphasized that the most important factor affecting the element concentration on the basis of organs in plants is plant species.

The accumulation of elements in various organs within the plant is shaped under the mutual interaction of many factors. One of the most important of these factors is plant habitus and development [21]. Plant development is based on genetic structure and environmental conditions shaped by their interaction [22], [23]. Since the genetic structure of plants varies considerably on the basis of plant species, it is normal for the accumulation of some elements to be at different levels in the same organs of plants of different species grown in the same environment, and this has been expressed in many studies [24], [25], [26]. Another factor affecting some metal or toxic accumulation in plants is plant habitus [27]. The plant habitus is climatic such as temperature, precipitation, humidity as well as plant genetic structure and edaphic such as soil texture, structure, nutrient content and pH. Some studies reported that shaped under the influence of factors [28], [29]. Therefore, plant genetic structure and habitus are shaped depending on many mutual and interacting factors. The effect level of these factors depends, first of all, on the plant species. Therefore, it is normal for elemental accumulation to be at different levels in the same organs of different species of plants.

Nutrient element that Mg accumulation in various organs of plants is closely related to plant metabolism. For this reason, the stress level of the plant, which significantly affects plant metabolism, hormone applications, cultural processes such as pruning and shading also affect some elements accumulation in plants [30]. In addition, the changing environment and soil structure due to human influence in urban areas and micro-ecological factors affect the change of Mg concentration in plant organs.

As a result of this study, Mg concentration could be high in the fruits of some species grown in urban areas. Similar results were obtained in studies on the subject [31]. For example, in a study conducted with plums, the highest Mg concentration was obtained in fruits. In addition to the toxic effects of metals on plants, food safety has received a lot of attention around the world in recent years, and in the last 20-30 years, many studies have been carried out on the health risks associated with eating contaminated vegetables, and some metal contents in the edible parts of plants grown in polluted areas have exceeded the maximum allowable limits [32]. It has been reported that it may cause public health problems [33]. Therefore, the consumption of various organs of plants grown in areas with heavy traffic as food can lead to important health problems.

IV. Conclusion

As a result of the study, it was determined that the relationship of Mg concentration to organs was statistically significant in all species. The Mg^{+2} is found to be ample cations in plant cells that vital role on plants growth and development due to the different accumulation level in several organs. The organs are shaped by the interaction of many factors (physiological and biochemical). Mg enter the plant body from sources (soil or air). The contact time is an important factor, especially when entering the plant from the air or soil. As a result of the study, the seeds with the lowest concentrations are in the fruits and do not come into contact with the air. However, bark and wood are organs that are in constant contact with the air. In addition, in regions with high pollution levels, some elements in the air adhere to particulate matter and contaminate particulate matter with metals. Particulate matter contaminated with some pollutants is easy to adhere to on the bark due to the rough structure of the bark, thus these particulate substances increase the elemental concentrations in the barks. As a matter of fact, the Mg concentrations were compared each organ that the Mg concentrations in the leaf were at levels much higher than others.

Within the scope of the study, the changes in the organs of Mg, which is one of the macronutrient element that are extremely poisonous and can pose a serious threat to human health, despite being widely used, in the organs of four plant species that are frequently grown in urban centers. Some metals are extremely dangerous elements for human health, and some of them can have toxic effects even at low concentrations. Therefore, it is extremely important for human health to determine the concentrations of these elements, especially in the organs that are consumed as food and thus can be taken directly into the human body. Consumption of foods contaminated with some element is extremely dangerous for human health. Therefore, it is extremely risky for health to consume plants grown in areas with high pollution such as mine sites, industrial facilities, areas with high traffic, and the authorized institutions and citizens should be informed about the risks of consuming these plants as food. In this study, four plant species were evaluated. However, many vegetables and fruits are grown in polluted area and these can be consumed as landscape and edible plants. Also agricultural and industrial facilities adversely contribute to structure. It is extremely important to reveal possible dangers by subjecting these plants to similar studies. Therefore, it is recommended that similar studies be continued by diversifying.

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