Scientific Research Communications

Research Article

Sci. Res. Comm. (2023)
Volume 3, Issue 2
doi: 10.52460/src.2023.007

Determination of Boron for Indoor Architecture Plants Used in Indoor Architectural Designs

Adel Easa Saad Abo Aisha[1,*] Mehmet Çetin[2,3]

[1] Department of Materials Science and Engineering, Institute of Science, Kastamonu University, Kastamonu, Türkiye
[2] Department of Landscape Architecture, Institute of Science, Kastamonu University, Kastamonu, Türkiye
[3] Ondokuz Mayıs University, Faculty of Architecture, Department of City and Regional Planning, Department of Landscape Architecture, Ondokuz Mayıs University, Samsun, Türkiye

*Corresponding author: adelaboaishakastamonuuni@gmail.com

Received: 26.03.2023 Accepted: 27.04.2023

Abstract

Air pollution has become a global problem that affects the health of millions of people every year. Among the air pollutants, heavy metals are particularly infamous as they tend to bioaccumulate, can be toxic to human health even at low concentrations, and that even those that are necessary for living things as nutrients can be harmful at high concentrations. Boron (B), a microelement, is both extremely dangerous and important for human health, as it can cause toxic effects when used more or less. As with other heavy metals, the ingestion of B through the respiratory tract is extremely harmful to health. It is very important to monitor the change of B concentration in the air and reduce the pollution level. In order to contribute to the studies in this field, the change of B concentrations in some indoor plants grown in controlled, smoking and traffic environments was determined within the scope of this study. The results of the study showed that camel sole, diphenbahya, drasena, chiefera and yukka species are quite suitable for monitoring the change of B concentrations in the air. It has been determined that the most suitable species that can be used to reduce B pollution in the air are rubber and spatiphyllium.

Keywords: Bor; B; heavy metal; cigarette; traffic

1. Introduction

Today, environmental pollution has reached extents that threaten human health (Çetin et al. 2023; Savaş et al., 2021; Yücedağ et al., 2019). The gradual increase in populations living in urban centers, especially in developing countries, has brought along many problems in urban areas (Çetin et al., 2018a; Çetin et al., 2018b; Zeren Çetin and Şevik, 2020; Yücedağ et al., 2021). Studies conducted in urban areas include air (Çetin et al., 2019; Türkyılmaz et al., 2019; Türkyilmaz et al., 2020; Varol et al. 2022a; Varol et al. 2022b), water (Ucun Özel et al., 2019) and soil (Çetin et al., 2022a) show that the pollution is at higher levels.

The modern age has also significantly changed people's lifestyles, about 90% of people's lives are spent indoors (Çetin and Çobanoğlu, 2019; Çetin et al., 2017a; Çetin et al., 2017b; Çetin, 2019; Varol et al., 2021a, Varol et al., 2021b). According to the United States Environmental Protection Agency (EPA), indoor air is up to 100 times more polluted than outdoor air and, unlike atmospheric pollution, indoor pollutants are approximately 1000 times more likely to infect the lungs (Jo et al., 2020). Therefore, studies on indoor pollution sources and pollutants are of great importance.

Heavy metals are at the forefront of air pollution factors that pose the greatest threat to human health, both indoors and outdoors (Zeren Çetin 2022; Akarsu et al. 2019; Zeren et al 2017; Elsunousi et al., 2021). Boron, an infamous heavy metal, enters the human body through the respiratory and digestive tracts or mucous membranes and accumulates mostly in the bones. Nausea, severe vomiting, abdominal pain and diarrhea manifest the effect of boric acid and borax in humans. It can also cause osteoporosis, heart disease, stroke, diabetes and aging (Nielsen and Stoecher, 2009). B is fatal in the range of 5-6 g for children and 10-25 g for adults (Baykut et al., 1987). Therefore, since Boron, like other heavy metals, is very harmful to health, it is very important to monitor the change of B concentration in the air and reduce the pollution level. For this purpose, it is aimed to determine the change of B concentration in some indoor plants grown in different environments, based on the habitat and plant species.

2. Methodology

The types that are the subject of the study are selected from the regions designed in the interior. It is used to give direction to the design. The interior design proposal drawings of the types used are as shown in the Figure 1.

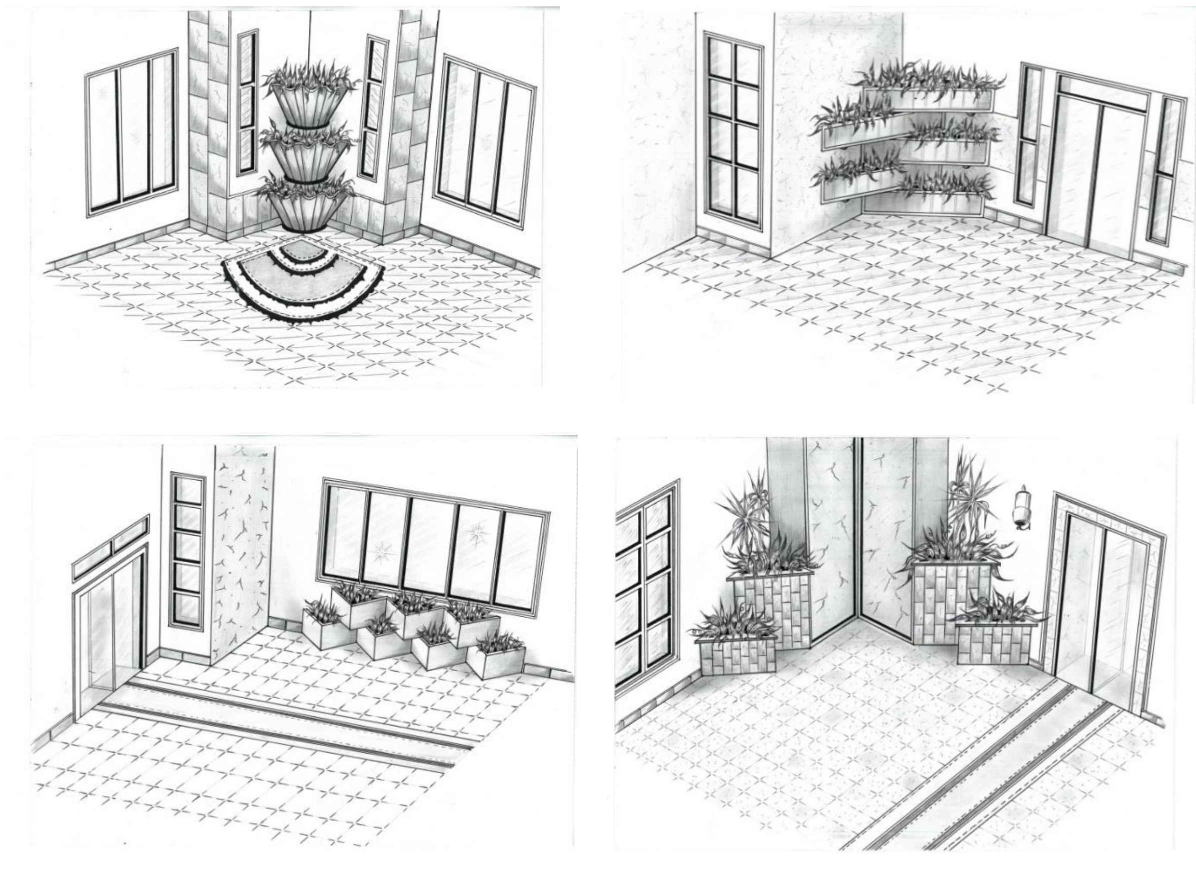

Figure 1. Showing of indoor plants used in architectural designs as materials

The collected samples were labeled, brought to the laboratory and separated into organs in the laboratory. Afterwards, the samples were labeled, laid out on cardboard plates and left to dry.

Branch and fruit samples were crushed and left to dry in glass petri dishes so that they could dry more easily. The samples, which were aerated by mixing at least once a week for about two months in the laboratory, were air-dried, then taken into cardboard cups and dried in an oven at 50 °C for one month. The dried samples were bagged and labeled in an airtight manner so that they would not be affected by air humidity and sent to the laboratory for analysis.

In the next step, the plant samples were ground into powder and 0.5 g was weighed and put into tubes designed for microwave. 10 mL of 65% HNO_3 was added to the samples. During these processes, it was worked in the fume hood.

The obtained data were evaluated with the help of the SPSS package program, variance analysis was applied to the data, and homogeneous groups were obtained by applying the Duncan test to the values with statistically differences at least 95% confidence level. The data obtained were simplified and interpreted by tabulating.

3. Results

The average concentration values, the F value obtained as a result of the analysis of variance, the error rate and the groups formed as a result of the Duncan test by determining the variation of the B concentration evaluated within the scope of the study on the basis of species in plants grown in different environments are given in Table 1.

Table 1. Variation of B concentration (ppm) by species

Species	Environment			Average
	Control	Cigarette	Traffic	
DT	13.93 b	23.79 b	29.66 b	22.46 a
DB	24.12 c	41.82 d	52.13 d	39.36 a
DC	10.38 a	35.90 c	44.75 c	30.34 a
KC	177.43 f	94.44 f	117.73 f	129.86 c
SF	10.14 a	35.53 c	44.30 c	29.99 a
SP	58.08 e	80.98 e	100.95 e	80.00 b
YK	55.87 d	15.37 a	19.16 a	30.13 a
F Value	444437.7***	20053.7***	11161.5***	35.3***

When the variation of B concentration on the basis of species is examined according to the results of analysis of variance, it is seen that the variation of B concentration on the basis of species in all environments is statistically significant at the 99.9% confidence level. When the groups formed as a result of the Duncan test are examined, it is noteworthy that each species is included in only one group in all environments.

In the controlled environment, the species formed six groups as a result of the Duncan test, DC (10.38 ppm) and SF (10.14 ppm) with the lowest values formed the first group, while each of the other species was in a separate group. After DC and SF, DT (13.93 ppm) with the lowest values formed the second group, DB (24.12 ppm) third group and YK (55.87 ppm) fourth group. KC (177.43 ppm) and SP (58.08 ppm), where the highest values were obtained, formed the last two groups.

When the mean values in smoking environments and the groups with Duncan's test are examined, it is seen that the lowest value was obtained in QC with 15.37 ppm, and the highest value was obtained in the liver with 94.44 ppm. WC (15.37 ppm) and DT (23.79 ppm) with the lowest values formed the first two groups, while DC (35.90 ppm) and SF (35.53 ppm) formed the third group. KC (94.44 ppm), SP (80.98 ppm) and DB (41.82 ppm), where the highest values were obtained, formed a separate group.

In the traffic environment, as in the controlled and smoking environments, six groups were formed as a result of the Duncan test. WC (19.16 ppm) and DT (29.66 ppm) with the lowest values formed the first two groups, while DC (44.75 ppm) and SF (44.30 ppm) formed the third group. KC (117.73 ppm), SP (100.95 ppm) and DB (52.13 ppm), where the three highest values were obtained, formed the last three groups.

As a result of Duncan test, only three groups were formed in terms of mean values. While KC (129.86 ppm) with the highest values formed the last group, SP (80.00 ppm) formed the second group, while all other species were in the first group. While the average B concentrations of the species in the first group varied between 22.46 ppm (DT) and 39.36 ppm (DB), the value obtained in the second group was twice the value obtained in the first group, and the value obtained in the third group was three times the values obtained in the first group. It is noteworthy that more than the changes in the concentrations of element B in Table 2.

Table 2. Change of B concentration (ppm) by medium

Species	Environment			F Value
	Control	Cigarette	Traffic	
DT	13.93 a	23.79 b	29.66 c	2104.2***
DB	24.12 a	41.82 b	52.13 c	3704.0***
DC	10.38 a	35.90 b	44.75 c	9901.3***
KC	177.4 c	94.44 a	117.73 b	10924.1***
SF	10.14 a	35.53 b	44.30 c	9185.2***
SP	58.08 a	80.98 b	100.95 c	6384.7***
YK	55.87 c	15.37 a	19.16 b	39890.9***
Average	49.99 a	46.83 a	58.38 a	0.43 ns

When the results of the table showing the change in the concentration of element B on the basis of the environment are examined, it is seen that the change of the B concentration on the basis of the environment is statistically significant ($p<0.001$) at the 99.9% confidence level. In terms of average values, the change of B concentration on the basis of environment is not statistically significant ($p>0.05$).

When the mean values and the groups formed as a result of Duncan's test are examined, it is seen that there are three groups in all species. The lowest B concentrations were obtained in the control medium in species other than KC and YK, and in cigarette medium in KC and YK. In KC and YK species, the highest B concentrations were obtained in the control environment, while the highest B concentrations in all other species were obtained in the traffic environment. It was determined that B concentration changed as control<cigarette<traffic in species other than KC and YK species. According to the mean values, there is no statistically significant difference between the environments.

4. Discussions

As a result of the study, it was determined that the variation of B concentration on the basis of species, both in different habitats and according to the average values, in all species subject to the study changed statistically significantly. In studies carried out to date, it has been frequently emphasized that the most important factor affecting the change in heavy metal concentration is the plant species

It was determined that the change of B concentration on the basis of environment in all species was statistically significant. Heavy metal accumulation in plants varies considerably depending on environmental conditions. Because heavy metals can accumulate in the plant body by being absorbed by the root, through the air through the leaves and by entering the stem parts directly (Chen et al., 2021). Therefore, heavy metals in the air can enter the plant body both through the leaves and directly into the stem parts (Çetin et al., 2022a; Çetin et al., 2022b; Özel et al., 2021a; Özel et al., 2021b; Özel et al., 2021c; Özel et al., 2021d). As a result of the study, it was determined that the B concentration changed as control<cigarette<traffic in species other than KC and YK species. This shows that traffic is a very important source of B, and cigarettes can be a source of B. In studies conducted to date, both traffic (Çetin and Jawed, 2021) have been shown to be among the important sources of heavy metal pollution.

Biomonitors are important tools that can be used to monitor heavy metal pollution in the air, as well as to reduce heavy metal pollution in the air (Çetin et al., 2020; Şevik and Çetin, 2016; Cesur et al., 2021; Cesur et al., 2022; Çetin and Jawed, 2022; Türkyılmaz et al., 2020; Şevik et al., 2019a; Şevik et al., 2019b; Şevik et al., 2020a, Şevik et al., 2020b). Within the scope of this study, it was determined that the highest B accumulation was in KC and SP species in all species. Therefore, these two types can be used effectively to reduce B pollution in the air.

5. Conclusions

It was determined that camel sole, diphenbahya, drasena, chiefera and yukka species are quite suitable for monitoring the change of B concentration in the air. It has been determined that the most suitable species that can be used to reduce B pollution in the air are rubber and spatiphyllium. The variation of B concentration on the basis of species, both in different habitats and according to the average values, in all species subject to the study changed statistically significantly. In studies carried out to date, it has been frequently emphasized that the most important factor affecting the change in heavy metal concentration is the plant species. Biomonitors are important tools that can be used to reduce heavy metal pollution in the air. It was determined that the highest B accumulation was in KC and SP species in all species. Therefore, these two types can be used effectively to reduce B pollution in the air. The use of nutrient contents of the in areas, where different tree species are grown, at different levels might cause specific nutrients to be remarkably depleted in the course of time. Thus, alternation is recommended for architecture activities, as in the indoor architecture activities. The results of Boron show that the design of indoor for plant species selected is important.

It is seen that the plant species used as indoor plants in architectural designs should be paid attention to. In the designs made, the use of different species in the change of Boron concentration in some indoor plants that can be used in architectural designs depending on the growing environment, healthy design of the indoor environment has been made both in the design and in the environmental aspect. The types to be used in the designs should be especially close to the windows and hung on the walls, and should be designed at least 30 cm above the ground.

Architecture design make choose rubber (KC), and spatiphyllium (SP) species of indoor plant as design material and environment as well as prevent the pollution indoor areas. The suggestions of drawing in material section for design that give how to make design indoor plant in architecture design.

Acknowledgments

This study was produced from a Doctoral study (Ph.D.) at Kastamonu University, Institute of Science Graduate Studies Research Projects of Doctoral study.

Author Statement

The authors confirm contribution to the paper as follows: study conception and design: Adel, Mehmet; data collection: Mehmet; analysis and interpretation of results: Adel and Mehmet; draft manuscript preparation: Adel. All authors reviewed the results and approved the final version of the manuscript.

Conflict of Interest

The authors declare no conflict of interest.

References

Akarsu, H., Zeren Çetin, İ., Jawed, A. A., Abo Aisha, A. E. S., Cesur, A., & Keskin, R. (2019). Changes of Some Heavy Metal Concentrations Based on Organic and Traffic Density in Fraxinus Excelsior L. *International Journal of Engineering, Design and Technology,* 1(1), 24-30.

Baykut, F., Aydın, A., & Baykut, S. (1987). Çevre Sorunları ve Korunma, *İstanbul Teknik Üniversitesi*, 3449, 419.

Cesur, A., Zeren Çetin, I., Abo Aisha, A. E. S., Alrabiti, O. B. M., Aljama, A. M. O., Jawed, A. A., Çetin, M., Şevik, H., Özel, & H. B. (2021). The Usability of Cupressus Arizonica Annual Rings in Monitoring the Changes in Heavy Metal Concentration in Air. *Environmental Science and Pollution Research*. DOI:10.1007/s11356-021-13166-4.

Cesur, A., Zeren Çetin, I., Çetin, M., Şevik, H., & Özel, H. B. (2022). The Use of Cupressus Arizonica as a Biomonitor of Li, Fe, and Cr Pollution in Kastamonu. *Water, Air, & Soil Pollution*, 233(6), 193. Doi: 10.1007/s11270-022-05667-w .

Chen, S., Yao, Q., Chen, X., Liu, J., Chen, D., Ou, T., ... & Fang, K. (2021). Tree-ring Recorded Variations of 10 Heavy Metal Elements over the Past 168 Years in Southeastern China. *Elem Sci Anth*, 9(1), 00075.

Çetin, M., Şevik, H., & Saat, A. (2017a). Indoor Air Quality: The Samples of Safranbolu Bulak Mencilis Cave. *Fresenius Environmental Bulletin*, 26(10), 5965-5970.

Çetin, M., Şevik, H., & Zeren, I. (2017b). Coastal Biocomfort Mapping for Doğanyurt. OMICS, E-Books International, *The Effects of Environmental Policies on Sustainability: Theory And Methods*. Eds: Nurcan Kilinc-Ata, 51, 55.

Çetin, M., Onaç, A. K., Şevik, H., Cantürk, U., & Akpınar, H. (2018a). Chronicles and Geoheritage of the Ancient Roman City of Pompeiopolis: A Landscape Plan. *Arabian Journal of Geosciences*, 11, 1-12. Doi: 10.1007/s12517-018-4170-6.

Çetin, M., Zeren, I., Şevik, H., Çakır, C., & Akpınar, H. (2018b). A Study on the Determination of the Natural Park's Sustainable Tourism Potential. *Environmental Monitoring and Assessment*, 190, 1-8. Doi: 10.1007/s10661-018-6534-5.

Çetin, M. (2019). The Effect of Urban Planning on Urban Formations Determining Bioclimatic Comfort Area's Effect Using Satellitia Imagines on Air Quality: A Case Study of Bursa

City. *Air Quality, Atmosphere & Health*, 12(10), 1237-1249. Doi: 10.1007/s11869-019-00742-4.

Çetin, M., & Çobanoğlu, O. (2019). The Possibilities of Using Blue Spruce (Picea Pungens Engelm) as a Biomonitor by Measuring the Recent Accumulation of Mn in Its Leaves. *Kastamonu University Journal of Engineering and Sciences*, 5(1), 43-50.

Çetin, M., Onaç, A. K., Şevik, H., & Şen, B. (2019). Temporal and Regional Change of Some Air Pollution Parameters in Bursa. *Air Quality, Atmosphere & Health*, 12, 311-316. Doi: 10.1007/s11869-018-00657-6.

Çetin, M., Şevik, H., & Çobanoğlu, O. (2020). Ca, Cu, and Li in Washed and Unwashed Specimens of Needles, Bark, And Branches of The Blue Spruce (Picea Pungens) in the City of Ankara. *Environmental Science and Pollution Research*, 27, 21816-21825. Doi: 10.1007/s11356-020-08687-3.

Çetin, M., & Jawed, A. A. (2021). The Chancing of Mg Concentrations in Some Plants Grown in Pakistan Depends on Plant Species and the Growing Environment. *Kastamonu University Journal of Engineering and Sciences*, 7(2), 167-174.

Çetin, M., & Jawed, A. A. (2022). Variation of Ba Concentrations in Some Plants Grown in Pakistan Depending on Traffic Density. *Biomass Conversion and Biorefinery*, 1-7. Doi: 10.1007/s13399-022-02334-2.

Çetin, M., Adıgüzel, F., & Zeren Çetin, I. (2023). Determination of the Effect of Urban Forests and Other Green Areas on Surface Temperature in Antalya. *In Concepts and Applications of Remote Sensing in Forestry,* 319-336. Singapore: Springer Nature Singapore.

Çetin, M., Aljama, A. M. O., Alrabiti, O. B. M., Adıgüzel, F., Şevik, H., & Zeren Çetin, I. (2022a). Determination and Mapping of Regional Change of Pb and Cr Pollution in Ankara City Center. *Water, Air, & Soil Pollution*, 233(5), 163.

Çetin, M., Aljama, A. M. O., Alrabiti, O. B. M., Adıgüzel, F., Şevik, H., & Zeren Çetin, I. (2022b). Using Topsoil Analysis to Determine and Map Changes in Ni Co Pollution. *Water, Air, & Soil Pollution*, 233(8), 293.

Elsunousi, A. A. M., Şevik H., Çetin M., Özel H. B., & Ucun Özel, H. (2021). Periodical and Regional Change of Particulate Matter and CO_2 Concentration in Misurata. *Environ Monit Assess,* 193-707. DOI: 10.1007/s10661-021-09478-0.

Jo, J., Jo, B., Kim, J., Kim, S., & Han, W. (2020). Development Of an Iot-based Indoor Air Quality Monitoring Platform. *Journal Of Sensors*.

Nielsen, F. H., & Stoecker B. J. (2009). Boron and Fish Oil Have Different Beneficial Effects on Strength and Trabecular Microarchitecture of Bone. *J Trace Elem Med Biol*, 23(3), 195-203.

Özel, H. B., Varol, H. N., & Şevik, H. (2021a). The Change of Mn Concentration by Organ and Species in Several Edible Plants. *International Journal of Progressive Sciences and Technologies (IJPSAT),* 29(2): 474-480.

Özel, H. B., Şen, M., & Şevik, H. (2021b) Change of Ba Concentration by Species and Organ in Several Fruits Grown in City Centers, *World Journal of Advanced Research and Reviews*, 12(3), 143–150, DOI: https://doi.org/10.30574/wjarr.2021.12.3.0681.

Özel, H. B., Çetin, M., Şevik, H., Varol, T., Işık, B., & Yaman, B. (2021c). The Effects of Base Station as an Electromagnetic Radiation Source on Flower and Cone Yield and

Germination Percentage in Pinus Brutia Ten. *Biologia Futura*. https://doi.org/10.1007/s42977-021-00085-1.

Özel, H. B., Abo Aisha, A. E. S., Çetin, M., Şevik, H., Zeren Çetin, I. (2021d). The Effects of Increased Exposure Time to UV-B Radiation on Germination and Seedling Development of Anatolian Black Pine Seeds. *Environ Monit Assess*, 193, 388. https://doi.org/10.1007/s10661-021-09178-9.

Savaş, D. S., Şevik, H., Işınkaralar, K., Türkyilmaz, A. & Çetin, M. (2021). The Potential of Using Cedrus Atlantica as a Biomonitor in the Concentrations of Cr and Mn. *Environ Sci Pollut Res*, https://doi.org/10.1007/s11356-021-14826-1.

Şevik, H., & Çetin, M. (2016). Effects of Some Hormone Applications on Germination and Morphological Characters of Endangered Plant Species Lilium Artvinense L. Onion Scales. *Bulgarian Chemical Communications*, 48(2), 256-260.

Şevik, H., Çetin, M., Özel, H. B., & Pınar, B. (2019a). Determining Toxic Metal Concentration Changes in Landscaping Plants Based on Some Factors. *Air Quality, Atmosphere & Health*, 12(8), 983-991.

Şevik, H., Çetin, M., Özturk, A., Özel, H. B., & Pınar, B. (2019b). Changes in Pb, Cr and Cu Concentrations in Some Bioindicators Depending on Traffic Density on the Basis of Species and Organs. *Applied Ecology and Environmental Research*, 17(6), 12843-12857.

Şevik, H., Çetin, M., Özel, H. B., Özel, S., & Çetin, I. Z. (2020a). Changes in Heavy Metal Accumulation in Some Edible Landscape Plants Depending on Traffic Density. *Environmental Monitoring and Assessment*, 192(2), 78.

Şevik, H., Çetin, M., Özel, H. U., Özel, H. B., Mossi, M. M. M., & Çetin, I. Z. (2020b). Determination of Pb and Mg Accumulation in Some of The Landscape Plants in Shrub Forms. *Environmental Science and Pollution Research*, 27(2), 2423-2431.

Türkyılmaz, A., Şevik, H., Işınkaralar, K., & Çetin, M. (2019). Use of Tree Rings as a Bioindicator to Observe Atmospheric Heavy Metal Deposition, *Environmental Science and Pollution Research*, 26(5), 5122-5130.

Türkyilmaz, A., Çetin, M., Şevik, H., Işınkaralar, K., & Saleh, E. A. A. (2020). Variation of Heavy Metal Accumulation in Certain Landscaping Plants Due to Traffic Density. Environment, *Development and Sustainability*, 22(3), 2385-2398.

Ucun Özel, H., Özel, H. B., Çetin, M., Şevik, H., Gemici, B. T., & Varol, T. (2019). Base Alteration of Some Heavy Metal Concentrations on Local and Seasonal in Bartın River. *Environmental Monitoring and Assessment*, 191(9), 594.

Varol, T., Özel, H. B., Ertuğrul, M., Emir, T., Tunay, M., Çetin, M., & Şevik, H. (2021a). Prediction of Soil-Bearing Capacity on Forest Roads by Statistical Approaches. *Environmental Monitoring and Assessment*, 193(8), 527.

Varol, T., Cantürk U., Çetin, M., Özel, H. B., Şevik, H. (2021b). Impacts of Climate Change Scenarios on European Ash Tree (Fraxinus excelsior L.) in Turkey. *Forest Ecology and Management*, 491, 119199. DOI: 10.1016/j.foreco.2021.119199.

Varol, T., Çetin, M., Özel, H. B., Şevik, H., & Zeren Çetin, I. (2022a). The Effects of Climate Change Scenarios on Carpinus Betulus and Carpinus Orientalis in Europe. *Water, Air, & Soil Pollution*, 233(2), 45. https://doi.org/10.1007/s11270-022-05516-w.

Varol, T., Cantürk, U., Çetin, M., Özel, H. B., Şevik, H., & Zeren Çetin, I. (2022b). Identifying the Suitable Habitats for Anatolian Boxwood (Buxus Sempervirens L.) for The Future

Regarding the Climate Change. *Theoretical and Applied Climatology*, 150(1-2), 637-647. https://doi.org/10.1007/s00704-022-04179-1.

Yücedağ, C., Özel, H. B., Çetin, M., & Şevik, H. (2019). Variability in Morphological Traits of Seedlings from Five Euonymus Japonicus Cultivars. Environmental Monitoring and Assessment, 191(5), 1-4.

Yücedağ, C., Çetin, M., Özel, H. B., Aisha, A. E. S. A., Alrabiti, O. B. M., & Jama, A. M. O. A. (2021). The Impacts of Altitude and Seed Pretreatments on Seedling Emergence of Syrian Juniper (Juniperus Drupacea (Labill.) Ant. Et Kotschy). *Ecological Processes*, 10(1), 1-6.

Zeren Çetin, İ. & Şevik, H. (2020). Investigation of the Relationship Between Bioclimatic Comfort and Land Use by Using GIS and RS Techniques in Trabzon. *Environmental Monitoring and Assessment*, 192(2), 71.

Zeren Çetin, İ. (2022) Change of B and Ag Concentrations Due to Traffic Density in Some Plants Growing in Samsun City Center. *Kastamonu University Journal of Engineering and Sciences*, 8(1), 18-27.

Zeren, İ., Cesur, A., Saleh, E. A. A., & Mossi, M. M. M. (2017). Variation of Chlorophyll Amount in Some Landscape Plants: A Case Study of Rize. *Journal of Chemical, Biological and Physical Sciences*, 7(3), 807-817.