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Determination of Plant Leaf Micro-Morphological Characters Depending on Traffic Density: Case Study of *Pyracantha coccinea*

Hakan Şevik[1,*], Mehmet Çetin[2], Nurcan Yiğit[3], Aydın Türkyılmaz[1], Savaş Canbulat[1], Nur Belkayalı[2], İnci Sevinç Kravkaz Kuşcu[3]

[1]*Kastamonu University, Faculty of Engineering and Architecture, Department of Environmental Engineering, Kastamonu, Turkey;* [2]*Kastamonu University, Faculty of Engineering and Architecture, Department of Landscape Architecture, Kastamonu, Turkey;* [3]*Kastamonu University, Faculty of Forestry, Department of Forest Engineering, Kastamonu, 37150, Turkey*

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Abstract: In urban area have many pollutants that lead to dirtiness urban roads because of vehicles, car wheels, and exhaust gases. These pollution resources effect to the improvement of living things in the urban environmental area they are in, the gathering of pollution reasons in the living people bodies, and some living things cause important deformations. These conglomerations and deformations that consist in the plants are used for the aim of determining the pollution deriving from the traffic density. The usage of plants as biomonitor is through designation of the amount of pollutants in the plant. Yet, pollutants lead to give some problems of plants, organs, tissues and cells. When these damages can sometimes see, and most of the damage is not visible to the bared eye. In this research, it purposed of to be detection for the variation of leaf micromorphological properties of *Pyracantha coccinea*, which used widely in landscape researches in many regions of Turkey depending on the traffic density. For this aim, stoma images of leaf samples took from the areas where the traffic density is at different levels were gotten data by electron microscopy. The measurements made on these images were measured Stoma Length (SL), Stoma Width (SW), Stomatal Density (SD), Pore Aperture (PA) and Pore Length (PL). The obtained data measured as statistics and it attempted to detect how these characters changed according to traffic density.

Keywords: Traffic, density, plants leaf, stoma, *Pyracantha coccinea*,

Introduction

One of the most important agenda topics of the present time is air pollution. It is predicted that in 2000, 47% of the world's population will be living in urban areas, and this rate will increase to 60% by 2030. Increasing population and industrialization, especially in city centers, has brought along air pollution, which has reached levels to threaten human health in some cities (Cetin et al., 2016a,b; Sevik et al., 2017a,b). It is reported that about 6.5 million people die in the world due to reasons associated with air pollution every year (URL1). Although air pollution is not considered as a serious problem in Turkey, it is reported that 29 thousand people died due to air pollution in 2016 (URL2).

One of the primary sources of air pollution in cities is vehicles. Many pollutants emerge due to vehicles (*e.g*. exhaust gas, car wheels, wear of vehicle parts) (Ugolini et al., 2013; Turkyilmaz et al., 2018a). These sources of pollution affect the growth of living beings in the environments they are in, accumulate pollutants in their bodies, and lead to significant levels of deformation in some living beings. Such accumulations and deformations are used for determining the pollution resulting from traffic (Ozturk & Bozdogan, 2015). Plants are used as a biomonitor mostly through determination of the amount of pollutants occurring in the plant body. However, pollutants harm the organs, tissues, and cells of plants. Such damage is sometimes visible, but it cannot be seen by naked eyes most of the time. Identification of such deformations and changes may be very useful for monitoring the level of air pollution effectively. In this regard, this study aims to identify the change in the leaf micromorphological characters of *Pyracantha coccinea*, which is intensely used especially in landscape works in many regions of Turkey, depending on traffic density.

**Corresponding: E-Mail: hsevik@kastamonu.edu.tr m; Tel:* +9 0366 280 2921*; Fax:* +9 0366 280 2900

Material and Method

The study was conducted on *Pyracantha coccinea* leaves. Within the scope of the study, leaf samples were taken from the *Pyracantha coccinea* individuals cultivated in the city centre where traffic is dense, from the Kuzeykent area, where traffic is less dense, and from the areas where no vehicle entry is allowed (i.e. the closest vehicle is at a 50-meter distance at minimum, that is, there is no traffic density). The collected leaf samples were pressed and dried. The stoma images were obtained via an electron microscope. The following characters were measured over such images: stoma length (SL), stoma width (SW), stomatal density (SD), pore aperture (PA), and pore length (PL). The obtained data were statistically evaluated, and an attempt was made to determine how such characters change depending on traffic density.

Findings

The data were subjected to analysis of variance and Duncan's test to determine how the micromorphological characters examined change depending on traffic density. Table 1 below presents the results of analysis of variance and Duncan's test.

Table 1. The change of micromorphological characters depending on traffic density

Traffic Density	**SL**	**SW**	**PA**	**PL**	**SD**
Without Traffic	28,16 b	27,12 b	4,99 b	9,89 a	70 b
Low	24,63 a	9,93 a	2,81 a	12,59 a	85 c
Heavy	48,11 c	30,12 c	5,44 c	19,78 b	56 a
F Value	166,816***	533,163***	9,098**	23,211***	338,036***

According to Table 1, the lowest values for all the characters except for SD were found in the areas with low traffic density, while the highest values were found in the areas with high traffic density. It is noteworthy that there is a difference of about 2 times between the values for SL and a difference of more than 3 times for SW. A difference of about 2 times is seen between the lowest and the highest values for PA and PL.

The highest value for SD, to the contrary of other characters, was detected in the areas with low traffic density, while the lowest value was in the areas with high traffic density. The number of stomas per unit area in the area with high traffic density is as approximately 1.5 times big as the number of stomas per unit area in the area with low traffic density. An overall examination of the values indicates that the number of stomas is fewer, but stoma size is higher in the areas with high traffic density. Figure 1 below presents a general view of the stomas measured.

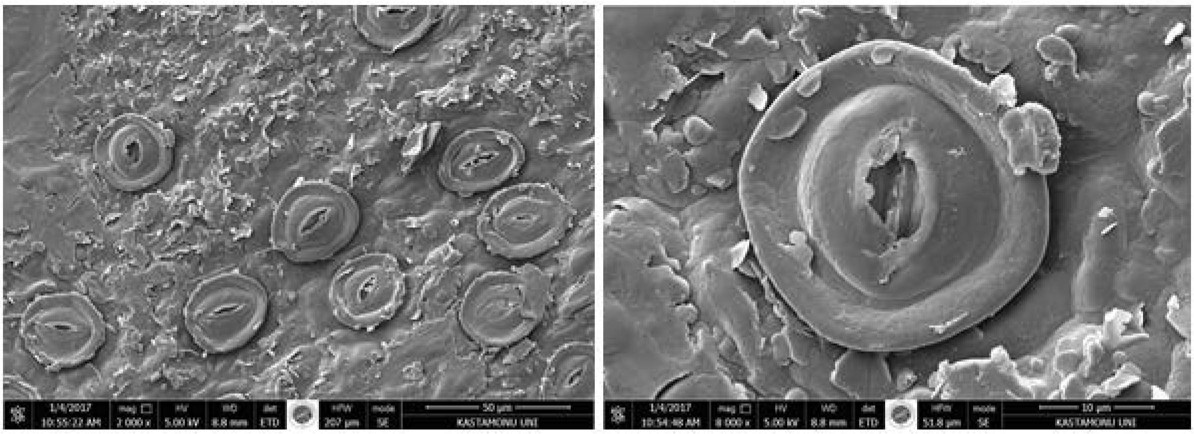

Figure 1. A general view of the stomas

Conclusion and Discussion

As the effects of air quality on human health have been revealed, an obvious increase has occurred in the research aimed at determining air quality (Cetin *et al*., 2017a,b). Heavy metals have a distinctive place among the components of air pollution. This is because they are not spoilt or destroyed in nature. Also, they are prone to bioaccumulation. Thus, determination of heavy metal concentration is very important to find out risky areas and risk levels. Previous research reports that traffic density is one of the important factors influential on heavy metal pollution (Ozel et al., 2015; Turkyilmaz et al., 2018b).

A lot of methods are used for determining the level of air pollution. The primary one is direct measure of air pollution (Sevik et al., 2015). However, direct measure of air pollution both requires expensive measuring devices and has more risk of contamination when compared to bioindicators. Another method for detecting air pollution is the use of bioindicators. It is cheap and convenient for sampling. In addition, heavy metal concentration is more than in the case of air and rain water. Hence, there are a lot of studies focusing on the use of plants as biomonitors (El-Hasan et al., 2002; Ozturk & Bozdogan, 2015; Ozel et al., 2015).

The present study aims to determine how stomatal characters change in the *Pyracantha coccinea* leaves collected from the areas with different levels of traffic density. Based on the findings of the study, it can generally be said that the number of stomas is fewer, but stoma size is larger in the areas with a high traffic density.

Stomas control CO_2 and water vapor entry into leaves and are considerably affected by environmental conditions (Xu and Zhou, 2008). Therefore, many studies have been conducted on environmental factors affecting stomatal density so far. It is reported that stomatal density or dimensions change depending on many factors such as water stress (Yang & Wang, 2001; Zhang et al., 2006; Liu et al., 2006), light (Sevik et al., 2016), plant density (Yang et al., 2007; Gazanchian et al., 2007), and salt stress (Zhao et al., 2001).

In the present study, the lowest values for all the characters except for SD were found in the areas with low traffic density, whereas the highest values were detected in the areas with high traffic density. The fact that the values obtained in the areas with no traffic density were neither the highest nor the lowest, but just in the middle implies that stomatal characters are affected by other environmental factors more. As a matter of fact, the samples examined in the study were not cultivated in a controlled environment, but were chosen considering traffic density. It is likely that other environmental factors in the areas where the samples were collected affected stomatal characters more than traffic density. There are many studies reporting that plants' morphological characters are shaped by many environmental factors (Guney et al., 2016; Ozel & Ertekin, 2011; Sevik & Cetin, 2015; Sevik & Cetin, 2016; Birişci et al., 2017a,b; Gülgün et al., 2014).

The results of the study show that stomatal characters have quite a high potential to be used for determining traffic density. However, research on this subject is not sufficient. It is known and reported that plants fulfill many economic, ecological, and aesthetical functions in nature (Kucuk et al., 2007; Saglam et al., 2006; Gulgun et al., 2016a,b; Kalaycı et al., 2017; Mansuroglu et al., 2016) and are effectively used for monitoring and reducing air pollution (Isinkaralar et al., 2017; Yigit et al., 2016a,b). Yet, there are few studies aimed at determining air pollution by using plant stomatal characters (Menghiu, et al., 2012; Ianovici et al., 2009). The present study indicates that plants have a high potential in this matter. However, detailed research is needed for an efficient use of plants for this purpose.

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References

Birişçi T, Mansuroğlu S, Söğüt, Z, Kalaycı ÖA, Dağ V, (2017) Doğa Dostu Peyzaj Uygulamaları. International *Conference on Agriculture, Forest, Food Sciences & Technologies*. 15-17 Mayıs, Kapadokya.

Birişçi T, Mansuroğlu S, Söğüt, Z, Kalaycı Önaç A, (2017) Ağaç, Çevre ve Toprak. Yaşamın Her Karesinde Toprak. İstanbul Aydın Ün. Yayınları.

Cetin M, Sevik H, (2016a) Change of air quality in Kastamonu city in terms of particulate matter and CO_2 amount. *Oxidation Commu.* **39** (4), 3394-3401

Cetin M, Sevik H, Isınkaralar, K. (2017a) Changes in the Particulate Matter and CO2 Concentrations Based on the Time and Weather Conditions: The Case of Kastamonu. *Oxidation Commu*., **40** (1-II), 477-485

Cetin M, Sevik H, Saat A. (2017b) Indoor air quality: The samples of Safranbolu Bulak Mencilis Cave. *Fresenius Environ. Bull*., **25**, (In Press).

Cetin M, Sevik H. (2016b) Measuring the Impact of Selected Plants on Indoor CO_2 Concentrations. *Pol. J. Environ. Stud*. **25**(3), 973-979

El-Hasan T, Al-Omari H, Jiries, A, Al-Nasir, F, (2002) Cypress tree (*Cupressus semervirens* L.) bark as an indicator for heavy metal pollution in the atmosphere of Amman City, Jordan. *Environ. Int.*, **28**(6), 513-519.

Gazanchian A, Hajheidari M, Sima NK, Salekdeh GH. (2007) Proteome response of Elymus elongatum to severe water stres and recovery. *J.Exper.l Bot.* **58**, 291–300.

Gulgun B, Balik, G, Yazici K, Dursun S, (2016b) Forest Plantation and Alternative Utilization of Some Cultivated Plants in Turkey. *15th International Multidisciplinary Scientific Geoconference, SGEM 2015*, Conference Proceedings Vol.1 Ecology & Environmental Protection, Albena, Bulgaria.

Gülgün, B, Güney, M, A, Aktaş, E, Yazici, K, 2014. Role of Landscape Architect in Interdıscıplinary Planing of Sustainable Cities. *J. Environ. Protec. & Eco*. **15**, No 4, 1877–1880 (2014).

Gulgun, B, Yazici, K, Dursun, S, Balik, G. 2016a. The Role of Phytoremediation in Reclamation Soil Pollution and Suitability of Certain Ornamental Plants to Phytoremediation. *Int. Sci. Index Conference Proceedings Book*, pg. 3805-3807, Eissn: 1307-6892, January 2016, Jeddah, Saudi Arabia.

Guney K, Cetin M, Sevik H, Guney KB. (2016) Influence of germination percentage and morphological properties of some hormones practice on Lilium martagon L. seeds. *Oxidation Commu*. **39** (1), 466-474

Ianovici N, Novac, ID, Vlădoiu, D, Bijan A, Ionaşcu A, Sălăşan B, Rămuş I, (2009) Biomonitoring of urban habitat quality by anatomical leaf parameters in Timişoara. *Ann. West Un. Timişoara, ser. Biol.*, **12**, 73-86.

Isinkaralar, O, Isinkaralar, K, Ekizler, A, Ilkdogan, C, 2017. Changes in the Amounts of CO2 and Particulate Matter in Kastamonu Province Depending on Weather Conditions and Locations, *J. Chem., Biol. & Phy. Sci.*, **7**(3); 643-650

Kalaycı Önaç, A, Birişçi T, (2017) Evaluating Ege Unıversity Campus Transportation Network Based On Human-Oriented Design Criteria, *Int. J. Soc. Sci*., **54**, 333-349

Kucuk, O, Saglam, B, & Bilgili, E. (2007) Canopy fuel characteristics and fuel load in young black pine trees. *Biotech. & Biotech. Equip.*, **21**(2), 235-240.

Liu S, Liu J, Cao J, Bai C, Shi R. (2006) Stomatal distribution and character analysis of leaf epidermis of jujube under drought stress. *J. Anhui Agricul. Sci*., **34**, 1315–1318.

Mansuroğlu, S, Birişçi, T, Söğüt, Z, Kalaycı ÖA, (2016) The Importance of Ecological Balance Protection of Roof Garden Applications in Mediterranean Climate, 1st International Mediterranean Science & Engineering Congress (IMSEC 2016), October 26-28, Adana/Turkey.

Menghiu, G, Iriza, E, Danciu, A, Zsombori, OT, Găman C, Muntean HE, (2012) Biomonitoring of urban area by anatomical leaf changes. *Ann. West University of Timişoara, Biology,* **15**, 125-130.

Ozel HB, Ertekin, M. (2011) Growth models in investigating oriental beech (Fagus orientalis Lipsky.) juvenilities growth performance in the Western Black Sea in Turkey (Devrek-Akçasu Case Study). *Romanian Biotechnological Letters*, **16**, 5850-5857.

Ozel HB, Ozel HU, Varol T, (2015) Using Leaves of Oriental Plane (Platanus orientalis L.) to Determine the Effects of Heavy Metal Pollution Caused by Vehicles. *Polish J. Environ. Studies*, **24**, 2569-2575.

Oztürk, S, Bozdogan, E, (2015) The Contribution of Urban Road Trees on Improving The Air Quality in an Urban Area, Fresenius Environmental Bulletin, 24(5): 1-9

Saglam B, Bilgili E, Kuçuk O, Durmaz BD, (2006) Determination of surface fuels moisture contents based on weather conditions. *Forest Ecology & Management*, **234**, S75.

Sevik H, Cetin M, Belkayali N, (2015) Effects of forests on amounts of CO_2: case study of Kastamonu and Ilgaz Mountain National Parks. *Polish J. Environ. Studies*. **24**, 253-256.

Sevik H, Cetin M, Guney K, Belkayali N. (2017a) The impact of Yucca (Yucca Elephantipes Regel) on the Amount of Indoor CO_2 Depending on Temperature. Journal of Chemical, Biological and Physical Sciences, Section D: Environmental Sciences, 7(2) 307-317.

Sevik H, Cetin M, Kapucu Ö. (2016) Effect of Light on Young Structures of Turkish Fir (*Abies nordmanniana* subsp. *bornmulleriana*) Oxidation Communications 39 (1–II): 485–492.

Sevik H, Cetin M. (2015) Effects of water stress on seed germination for select landscape plants. *Polish J. Environ. Studies* **24** , 689-693

Sevik H, Cetin 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

Sevik H, Cetin, M, Guney, K, Belkayali, N. (2017b) The Influence of House Plants on Indoor CO_2, Pol. J. Environ. Stud, 26(4): 1-9, DOI: 10.15244/pjoes/68875

Turkyilmaz A, Sevik H, Cetin M (2018a) The use of perennial needles as biomonitors for recently accumulated heavy metals. Landscape and Ecological Engineering, (in press) DOI: 10.1007/s11355-017-0335-9

Türkyılmaz A, Şevik H, Işınkaralar K, 2018b. Investigation of Heavy Metal Accumulation in the Black Pine Needles. Ecology Symposium 2017. p.196. 11-13 May, Kayseri Turkey

Ugolini F, Tognetti, R, Raschi, A, Bacci L, (2013) *Quercus ilex* L. as bioaccumulator for heavy metals in urban areas: Effectiveness of leaf washing with distilled water and considerations on the trees distance from traffic. Urban For-estry and Urban Greening, 12(4), 576-584

URL1. Retrieved from: http://www.cografyam.org/turkiyeiklimi.htm (access on 12.04.2016)

URL2. Retrieved from: http://turkiyede-gorulen-iklim-tipleri.nedir.org/ (access on 12.04.2016)

Xu Z, Zhou G, (2008) Responses of leaf stomatal density to water status and its relationship with photosynthesis in a grass. *Journal of experimental botany*, **59**, 3317-3325.

Yang HM, Wang GX, (2001) Leaf stomatal densities and distribution in Triticum aestivum under drought and CO2 enrichment. *Acta Phytoecologica Sinica* **25**, 312–316.

Yang L, Han M, Zhou G, Li J, (2007) The changes of water-use efficiency and stoma density of Leymus chinensis along Northeast China Transect. *Acta Ecologica Sinica* **27**, 16–24.

Yigit, N, Sevik, H, Cetin, M, Gul L, (2016a) Clonal variation in chemical wood characteristics in Hanönü (Kastamonu) Günlüburun black pine (Pinus nigra Arnold. subsp. Pallasiana (Lamb.) Holmboe) seed orchard. *J. Sustainable Forestry*, **35**(7), 515-526.

Yigit N, Sevik H, Cetin M, Kaya N, (2016b) Determination of the Effect of Drought Stress on the Seed Germination in Some Plant Species. Intech open. Water Stress in Plants, Eds: İsmail Mofizur Rahman, Zinnat Ara Begum, Chapter 3: Hiroshi Hasegawa, **126**, 43-62.

Zhang YP, Wang ZM, Wu YC, Zhang X, (2006) Stomatal characteristics of different green organs in wheat under different irrigation regimes. *Acta Agro. Sinica* **32**, 70–75.

Zhao RX, Zhang QB, Wu XY, Wang Y, (2001) The effects of drought on epidermal cells and stomatal density of wheat leaves. Inner Mongolia *Agri. Sci. & Tech.* **6**, 6–7.