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Original Research Article

Traffic-Based Heavy Metal Accumulation in *Prunus persica* (L.) Batsch Leaves: Is there any difference between washed and unwashed leaves caused by washing procedure?

Neslihan KARAVİN*[1], Cengiz YILDIRIM[2], Arzu CANSARAN[2],
[1]Amasya University, Faculty of Arts and Science, Department of Biology, 05100, Amasya-Turkey
[2]Amasya University, Faculty of Education, 05100, Amasya-Turkey

***Corresponding author**
Neslihan KARAVİN
Email: nnecli@gmail.com

Abstract: Traffic-based heavy metal pollution is one of the basic sources of foliar uptake of trace elements in high rates that cause damages in plants. This study aimed to determine the traffic-based accumulation of heavy metals in *Prunus persica* (L.) Batsch leaves by considering the impact of washing procedure. The freshly fallen senescent leaf samples under the trees were collected from five tree individuals in 0-100-200-300-400 m distance from the Amasya-Suluova highway, which links Middle East to the northern countries in Turkey, in November. Washing procedure was applied to half of the leaf samples in order to determine the amount of deposits on the leaf surface. The heavy metal analyses were carried out by using atomic absorption spectrophotometer (AAS). Results indicated that element concentrations in washed leaves tended to decrease. Except Mn and Ni, there isn't significant variation in other heavy metal concentrations among different distances for unwashed leaves. However, significant variations were determined for the washed leaves in all of the other measured elements among different distances except Pb and Ni. Significant correlations were determined between some of the elements in the unwashed leaves. However, there isn't any significant correlation between elements in the washed leaves. As a result, not only the pollution level but also the plant features and climatic and spatial features of the field have impacts on the deposited material on plant surface. Differences in element concentrations between washed and unwashed leaves reflect both amount of deposited elements on leaf surface and leached elements from the leaves.
Keywords: *Prunus persica* (L.) Batsch, metal analyses, trace elements.

INTRODUCTION

One of the basic problems in urban areas is the traffic pollution. Various materials such as heavy metals spread around due to exhaust gasses and mechanical parts of vehicles. These substances affect organisms by air and nutrition. The foliar uptake of trace elements may have a significant impact on plant contaminations, especially the elements such as Fe, Mn, Zn, and Cu [1]. Dalenberg and van Driel [2] examined the uptake and translocation of ^{210}Pb from atmospheric deposition and have indicated that 73 to 95% of the total Pb content in plants are taken up by leaves and transported to other plant organs [1]. Yield and crop quality of the fields near the roadsides are influenced negatively. Aerial substances deposit on plant surface and are accumulated in plant tissues. High concentrations of heavy metals lead to various symptoms in anatomic and metabolic processes. Heavy metals threat crops grown near the roadsides. Since plants don't move, leaves of plants are generally used for monitoring the heavy metal pollution in both plants and their environment [3, 4, 5]. Some of the plants accumulate huge amount of heavy metals in their tissues. However, some of them don't accumulate heavy metals. Accumulation of heavy metals in plants tissues not only threats plants but also threat organism that feed on them because heavy metals are transferred to other organisms by food chain.

Traffic-based heavy metal accumulation in *Prunus persica* (L.) Batsch leaves was aimed to be determined by considering the impact of washing procedure in this study. The study area is in Amasya, Central Black Sea Region, Turkey. Amasya is selected as a study area because fruit production such as apple, peach and cherry is very common in this region. Health of fruit trees affects the quality and amount of crops. Heavy metal contamination in fruit trees has an impact not only on organisms but also on economy. If the heavy metal concentrations in crops are above from the standard values, they mustn't be used as food. So, these crops should be destructed and this leads to economic loss. Therefore, determination of heavy metal concentrations in plant tissues is quite important.

In order to establish the amount of elements deposited on leaf surface, washing procedure is usually applied to leaves in heavy metal studies. It is approved as a suitable procedure for chemical foliar analyses by most of the scientists [3, 6, 7]. However, there is confusion about whether the washing procedure really reflects the amount of deposited material on leaf surface. Element concentrations between washed and unwashed leaves were also examined in order to test and determine the effect of washing procedure.

MATERIALS AND METHODS

The study area is near the Amasya-Suluova highway, which links Middle East to the northern countries in Central Black Sea Region, Turkey. In this area, traffic pollution is inevitable because of high traffic. There are various fruit, especially peach, growing in progress through the highway. The study materials are the senescent peach leaves. The freshly fallen senescent leaf samples under the trees were collected from five tree individuals in 0-100-200-300-400 m distance from the highway in November. The undamaged leaf samples were selected and omitted. Half of the leaf samples were washed first with tap water and then with distilled water, and others were not washed in order to determine the amount of deposits on the leaf surface. The leaf samples were air-dried and then put in to etuv at 70 °C until the constant weight. Dry leaf samples were milled. The heavy metal analyses were carried out by using atomic absorption spectrophotometer (AAS).

All the statistical analyses were done by using SPSS (Version 15). The Tukey post-hoc test was used to test for differences when the ANOVA was significant at the 0.05 level of probability. The effect of traffic pollution on heavy metal accumulation was tested by one way analysis of variance (ANOVA). Differences in heavy metal concentrations between washed and unwashed leaves were analyzed by independent sample T-test.

RESULTS AND DISCUSSION

Mean concentrations and standard deviations of heavy metals, and differences between means are given in Table 1. According to the results, element concentrations in washed leaves, tended to decrease. Except Mn and Ni, there isn't significant variation in other heavy metal concentrations among different distances for unwashed leaves. However, significant variations were determined for washed leaves in all of the other measured elements among different distances except Pb and Ni. In washed leaves Fe concentrations significantly and proportionately increased according to distance from the road. In contrast, Mn decreased. In unwashed leaves Cu, Zn and Ni concentrations significantly and proportionately increased according to the distance from the road.

Element concentrations usually decreased dramatically in washed leaves. Reduction percent in the element concentrations varied both according to the element and distance from the highway. However, a few of elements increased in washed leaves compared with those in unwashed leaves. If the deposited material was completely removed from the leaf surface by washing, element concentrations in washed leaves are expected to be lower than that in unwashed leaves. But, if it doesn't come true, it may be explained in two ways: (1) the washing procedure is insufficient or (2) the element which is measured penetrates into leaf tissues. The aerosol particles are intercepted by leaves and some of them are adsorbed on leaf surface and the others are absorbed into the tissues. Some of the deposited materials on leaf surface are washed off by rainfall but some of them are not. Not only the deposited material but also the ions are leached from the leaves [8]. So, does the difference in element concentrations between washed and unwashed leaves really reflect the deposited amount of elements? It is thought that there is confusion about it. In some of the previous studies, element concentrations proportionally decreased in washed leaves compared with unwashed leaves [3, 7, 9, 10]. However, no significant reduction was determined in element concentrations by washing leaves in the other studies [7, 11, 12, 13]. In the study of Ataabadi et al. [7], there were no significant differences between washed and unwashed leaves for Mn, Zn and Cu, except for Mn in *Pinus eldarica*, Zn and Cu in *Nerium oleander*. Because part of the Zn, which is present as water-soluble sulphate salts, penetrates quickly into the leaf tissues, it isn't removed easily by washing [7]. Since Mn doesn't have an adhesive feature, washing procedure doesn't lead to significant differences [7, 11].

Besides these, plant features also has an impact on deposited material on leaf surface. Availability and thickness of wax layer, hairiness and slickness of leaf surface, type of trichomes etc. are effective. Additionally, climatic conditions such as wind and rainfall and status of the field have influences on amount of deposited material on leaf surface.

Fe concentrations are at normal values in washed leaves and a bit higher than normal values in unwashed leaves. Cu, Mn, concentrations in both washed and unwashed leaves and Zn concentrations in unwashed leaves are higher than normal values in plant leaves reported by Kabata-Pendias and Mukherjee [14]. In addition, Mn concentrations are in toxic levels. Pb concentrations are in tolerable values in both washed and unwashed leaves. Cu is a quite toxic element for plants and causes damage in tissues and roots, darkening in plant colour, damage in photosynthesis and changes in permeability of the cell membrane [1, 15]. Mn toxicity leads to marginal chlorosis and necrosis of leaves, brown spots on leaves, leaf puckering, and an uneven distribution of chlorophyll in older leaves are also symptoms of Mn toxicity [1].

Depressed plant growth, and chlorosis, mainly in new leaves are the common symptoms of Zn toxicity [1]. These high concentrations of heavy metals are also transferred to other organisms by food chain.

These heavy metal concentrations were determined in senescent leaves. Resorption of some heavy metals such as Cu, Fe and Zn from senescent leaves was reported by Killingbeck and Costigan [16]. So, the element concentrations may be higher in green leaves than senescent leaves. Element concentrations in senescent leaves are a measure of resorption, which is called nutrient use proficiency. So, these determined values also reflect resorption proficiency of elements.

Table 1: Analysis of mean concentrations, standard deviations of heavy metals in washed and unwashed leaves of *Prunus persica*

		Washed	Unwashed
		Mean ± Std. Deviation	
Fe	0	657.543 ± 119.778 Aa	809.872 ± 474.869 Aa
	100	715.006 ± 93.158 Aa	1338.152 ± 502.795 Bab
	200	706.700 ± 141.306 Aa	1843.838 ± 598.116 Bb
	300	795.572 ± 182.595 Aa	1019.931 ± 326.186 Aab
	400	832.180 ± 379.886 Aa	674.102 ± 83.182 Aa
Cu	0	32.742 ± 2.572 Aa	31.435 ± 1.173 Aa
	100	36.493 ± 3.961 Aa	50.629 ± 29.397 Aa
	200	49.673 ± 26.653 Aa	34.129 ± 3.246 Aa
	300	34.726 ± 5.999 Aa	58.736 ± 22.608 Aa
	400	32.650 ± 10.447 Aa	150.053 ± 38.768 Bb
Zn	0	49.540 ± 7.922 Aa	47.380 ± 6.514 Aa
	100	41.504 ± 4.923 Aa	41.410 ± 2.823 Aa
	200	48.266 ± 20.732 Aa	150.872 ± 226.144 Aa
	300	57.595 ± 8.934 Aa	64.745 ± 7.637 Aa
	400	46.708 ± 10.173 Aa	412.320 ± 64.402 Bb
Mn	0	693.808 ± 67.145 Aa	586.511 ± 35.314 Bbc
	100	467.268 ± 47.078 Ab	409.747 ± 34.868 Aa
	200	528.599 ± 49.372 Ab	464.491 ± 37.481 Bab
	300	486.405 ± 60.669 Ab	486.710 ± 43.036 Aab
	400	212.997 ± 70.378 Ac	670.655 ± 139.386 Bc
Pb	0	0.053 ± 0.074 Aa	0.347 ± 0.147 Ba
	100	0.302 ± 0.211 Aa	0.334 ± 0.060 Aa
	200	0.000 ± 0.000 Aa	0.268 ± 0.018 Ba
	300	0.056 ± 0.077 Aa	0.307 ± 0.131 Ba
	400	0.131 ± 0.293 Aa	0.797 ± 0.916 Aa

Table 2: Study of correlations of the elements in Washed and unwashed leaves of *Prunus persica*

Washed					
	Fe	Cu	Zn	Mn	Pb
Fe	1	-0.113	-0.074	-0.309	-0.188
Cu	-0.113	1	-0.387	0.130	0.018
Zn	-0.074	-0.387	1	0.231	-0.018
Mn	-0.309	0.130	0.231	1	-0.038
Pb	-0.188	0.018	-0.018	-0.038	1
Unwashed					
Fe	1	-0.371	-0.393	-0.506**	-0.278
Cu	-0.371	1	0.723**	0.513**	0.595**
Zn	-0.393	0.723**	1	0.600**	0.457*
Mn	-0.506**	0.513**	0.600**	1	0.359
Pb	-0.278	0.595**	0.457*	0.359	1

Significant correlations were determined between some of the elements in unwashed leaves (Table 2). However, there isn't any significant correlation between the elements in washed leaves. The results of the current study nearly correspond to results of the previous studies [1, 15]. Having knowledge about element interactions provides opportunity to explain the element concentrations.

As a result, not only the pollution level but also the plant features, climatic and spatial features of the field have impacts on the deposited material on plant surface. Washing procedure provides an opportunity to guess the amount of deposited elements on leaf surface and the accumulated elements in plant tissues. But, element loss due to washing procedure and features of elements that inhibit deposition lead to confusion in determination of differences in element concentrations between washed and unwashed leaves. This may be solved by future detailed large scale experimental studies.

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REFERENCE

1. Kabata-Pendias A, Pendias H; Trace elements in soils and plants. 3rd edition, CRC Press, Boca Raton, Florida, 2001.
2. Dalenberg JW, van Driel W; Contribution of atmospheric deposition to heavy metal concentration in field crops. Netherlands J. Agric. Sci., 1990; 38: 369-379.
3. Aksoy A, Sahin U; *Elaeagnus angustifolia* L. as a biomonitor of heavy metal pollution. Tr. J. of Botany, 1999; 23: 83-87.
4. Figueiredo AMG, Nogueira CA, Saiki M, Milian FM, Domingos M; Assessment of atmospheric metallic pollution in the metropolitan region of Sao Paulo, Brazil, employing *Tillandsia usneoides* L. as biomonitor. Environmental Pollution, 2007; 145 (1): 279-292.
5. Karavin N, Cansaran A, Yıldırım C; Investigation on heavy metal accumulation of *Aesculus hippocastanum* L., *Platanus orientalis* L. and *Populus alba* L. and determining the pollution levels in Amasya, central black sea region of Turkey. Fresenius environmental bulletin, 2014; 23(4): 1080-1084.
6. Peryea FJ; Sample washing procedures influence mineral element concentrations in zinc-sprayed apple leaves. Communications in soil science and plant analysis, 2005; 36(19-20): 2923-2931.
7. Ataabadi M, Hoodaji M, Najafi P; Assessment of washing procedure for determination some of airborne metal concentrations. African Journal of Biotechnology, 2012; 11(19): 4391-4395.
8. Rossini Oliva S, Raitio H; Review of cleaning techniques and their effects on the chemical composition of foliar samples. Boreal Environ. Res., 2003; 8(3): 263-272.
9. Sharma RK, Agrawal M, Marshall FM; Heavy metal (Cu, Zn, Cd and Pb) contamination of vegetables in urban India: A case study in Varanasi. Environmental Pollution, 2008; 154(2): 254-263.
10. De Nicola F, Maisto G, Prati MV, Alfani A; Leaf accumulation of trace elements and polycyclic aromatic hydrocarbons (PAHs) in *Quercus ilex* L.. Environmental Pollution, 2008; 153(2): 376-383.
11. Wyttenbach A, Bajo S, Tobler L; Major and trace element concentrations in needles of *Picea abies*: levels, distribution functions, correlations and environmental influences. Plant Soil, 1985; 85(3): 313-325.
12. Alfani A, Baldantoni D, Maisto G, Bartoli G, Virzo De Santo A; Temporal and spatial variation in C, N, S and trace element contents in the leaves of *Quercus ilex* within the urban area of Naples. Environ. Pollut. 2000; 109(1): 119-129.
13. Rossini Oliva S, Valdes B; Influence of washing on metal concentrations in leaf tissue. Commun. Soil Sci. Plant Anal., 2004; 35(11-12): 1543-1552.
14. Kabata-Pendias A, Mukherjee AB; Trace elements from soil to human. Springer Science & Business Media, Berlin, 2007.
15. Okcu M, Tozlu E, Kumlay AM, Pehluvan M; The effects of heavy metals on plants. Alinteri Zirai Bilimler Dergisi, 2009; 17: 14-26.
16. Killingbeck KT, Costigan SA; Element resorption in a guild of understory shrub species: niche differentiation and resorption thresholds. Oikos, 1988; 366-374.