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THE ANALYSIS OF THE ACCUMULATION OF FOUR KINDS OF ATMOSPHERIC POLLUTION ELEMENTS IN FIFTEEN KINDS OF LANDSCAPE PLANT LEAVES

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ABSTRACT

This paper aims to reveal the difference of foliage sulfur content in common road green trees in Nanjing. Fifteen afforestation trees were selected from four sampling sites, and the sulfur content of the leaves was analyzed. The results indicate that there is a significant difference in the amount of foliage sulfur content for different species of trees at different sites. The foliage sulfur content near Chemical Works and Door of Taiping-Beijing East Road is higher than those near NanjingForestryUniversity and ZhongshanBotanical Garden. The seasonal variation of sulfur content for some trees is also evident. The sulfur content of the majority of trees, with the exception of LigustumLucidum and Viburnum awabuki, increases according to the season. Tree species have been sorted using three classifications on the basis of year-round foliage sulfur content. *Populus Canadensis*, *Ligustrunquihoui,* and *Platanushispanica* are classified into the first category, where the sulfur content was high. The second category includes *Osmanthusfragrans*, *Lorpetalumchinense,* and*LigustumLucidum*, and those varieties displayed a moderate sulfur content. *Viburnum awabuki*are,*Cinnamomumcamphora*,*Buxussinica* and *Aucubajaponica.Var. variegate* are classified into the third category, which means that their sulfur content was low.

Key words: Landscape plant, Foliage, Pollution elements, Accumulation.

INTRODUCTION

Recently, one of the principle causes of urban environmental pollution is the emission of lead, copper, chlorine, and sulfur waste products (Lachapelle*et al*., 2012; Parolin*et al*., 2002; Pyankov*et al*., 1999). Plant leaves are more sensitive to changes in the environment as plants evolve; the physical appearance of the leaves reflect the influence of environmental factors that force the plants to adapt accordingly (Zeng*et al*., 2013; Anand*et al*., 2003;Wang *et al*., 2005). Therefore, the contaminants found in landscape plant leaves can be used as an indicator of urban environmental pollution (Figure 1).

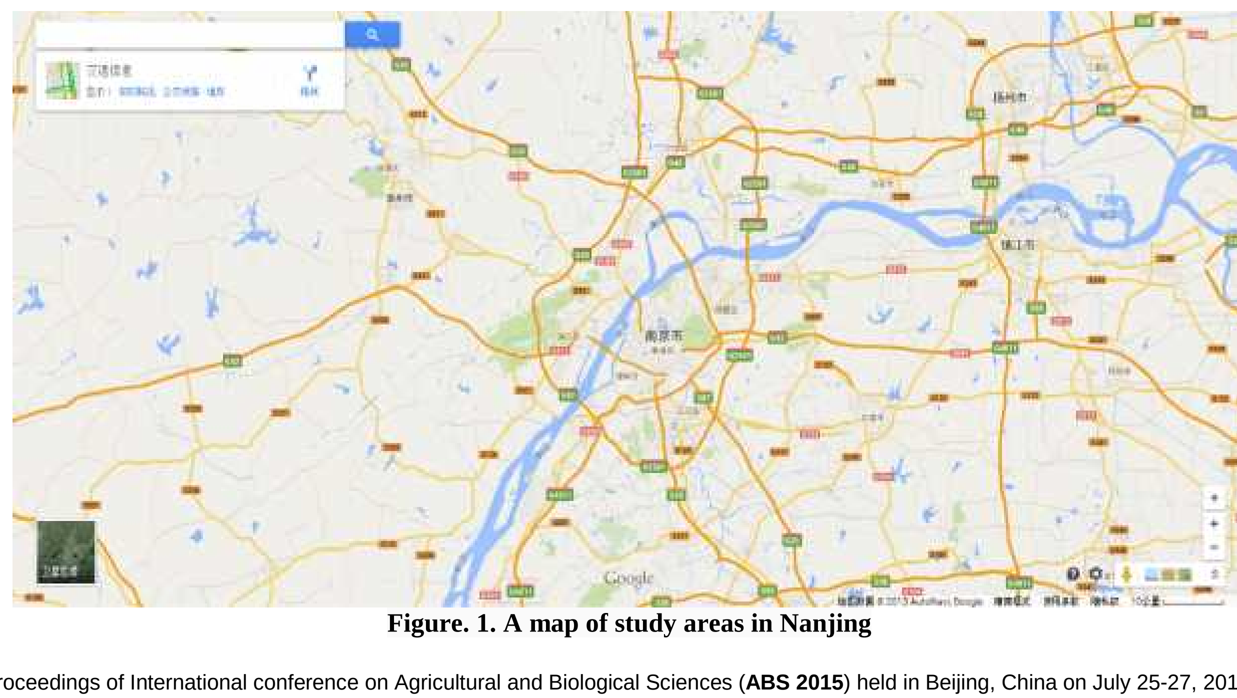

Figure. 1. A map of study areas in Nanjing

In recent years, scholars have strived to evaluate the atmospheric environmental benefits of urban greening plants. They want to accumulate garden plants that can absorb atmospheric pollutants, including sulfur and lead, and to screen out typical pollutants (Du *et al*., 2007a; Du *et al*., 2007b).

Currently, the Nanjing green plant leaves are able to absorb lead. Information regarding their interaction with sulfur and chlorine has not been reported. In view of this, our study chose 15 kinds of common green plants (*Magnolia grandiflora*, *Sophora Japonica*, *Populus*, *Broussonetiapapyrifera*, *Pterocaryastenoptera*, *Koelreuteriabipinnata*, *Prunuscerasifera*, *Acer palmatum*Thunb, *Platanus*, *Pittosporum tobira*, *Buxussinica*, *Aucuba japonica*, *Cinnamomumcamphora*, *Viburnum awabuk,* and *Ligustrumquihoui*). The polluted area and control area were tree leaf pollution elements that would help us determine the pollutant content. This study aims to compare the abilities of different species of trees to absorb and accumulate pollution elements, in order to provide a theoretical basis for the enrichment of air by garden plants.

MATERIALS AND METHODS

Design Sampling Time and Location: According to the difference in the degree of atmospheric pollution in Nanjing, we chose 2 different functional areas. The Nanjing chemical plant served as our pollution area, and the Nanjing forestry university campus was our clean area. Garden plants of different seasons were checked for lead, copper, chlorine, and sulfur content in May, July, and September of 2012. 1.2 The sample collection and preparation

We examined plants during spring, summer, and autumn of 2012 in different functional areas in order to choose the species with the healthiest leaves. For each species of tree, we measured the height, diameter at breast height (DBH), and the growth situation. Each sample point was taken randomly from 3 to 4 strains. The sampling location was the choice canopy outside out the area in all four directions. The height distance control was approximately 2.5 meters. From every branch, we chose 3 to 5 pieces of old leaves as a sample. We collected 10 to 12 leaves from large leaf trees, and 20 to 25 leaves from lobular species. We placed the collected blades in a self-sealing plastic bag and transported them back to the lab for processing. The specific steps are as follows: the blade is washed with water, then immersed in distilled water for six hours before being placed in the oven filming for 1 h under 105 ℃. The samples are dried at 72 ℃ to constant weight, and the samples are crushed using 60 mesh. The powder samples are set aside for later analysis.

Sample Measuring and Data Processing: The airy card reagent digestion samples include barium sulfate turbidimetry for the determination of sulfur content (Huang*et al*., 1990;Pang *et al*., 2008).Calcium oxide dry ashing - silver nitrate titration for the determination of chlorine content (Li*et al*., 1982;Zhang*et al*., 2014), and flame atomic absorption spectrophotometry for the determination of copper and lead content (Wang *et al*., 2009; Zhang *et al*., 1984). In this paper, we use Microsoft Excel and Spss 17.0 and Word 2003 software for statistics and analysis.

RESULTS AND DISCUSSION

Garden Plant Leaves Of Seasonal Change Of Lead, Copper, Chlorine and Sulfur Point: The physiological activities of the plants often changes seasonally. This affects the ability of the plants to absorb pollutants and to mutate, so the presence of pollutants presents some changes. Table 1 shows the trees from the pollution area and their leaf lead, copper, chlorine, and sulfur content. The progression of spring, summer, and autumn showed increasing trends as time went on. This situation allows us to divide the trees into three categories. The first category is an apparent variation in pollutant content. For example, the copper contentof the *Koelreuteriapaniculata* leaf in autumn is 4.92 times that of it in the spring. The chlorine content of a *Populusdeltoides* leaf in autumn is 4.58 times that of it in the spring. The second category is an evident change of pollutant content as time goes on, but this change is not as evident as it is in those species of the first category. The *Pterocaryahupeheasis* and *Prunuscerasifera* leaves have lead content in the fall that is 3.81 and 3.16 times, respectively, that of their lead content in the spring. The copper content of *Platanushispanica* leaf in autumn is 3.70 times that of the spring. *Pittosporum tobira*, *Populusdeltoides*, *Cinnamomumcamphora,*and*Prunuscerasifera* leaves showed sulfur contents in autumn that were respectively 3.38, 3.12, 3.06 and 3.00 times that of the spring. The third category shows a very slight change in pollution content. *Magnolia grandiflora*, *Sophora japonica*, *Broussonetiapapyrifera*, *Acer palmatum*, *Buxussinica*, *Aucuba japonica*, *Viburnum odoratissimum* and *Ligustumlucidum* leaves show very little change in pollutant elements as time goes on. As a result, it can be determined that some of the species are subject to seasonal variations of pollutant content. Spring is the period of germination, which means that pollutant elements disperse, resulting in a relatively low content during that time. In summer, the Rush Dilute Effect is present, wherein the element accumulation speed cannot keep up with the growth of the blades. In autumn, the plant enters the slow-growth phase, so the accumulation of pollutants is more outstanding. This is consistent with the results of Mei *et al*. (2005) and Li *et al*. (2014), who found that heavy metal content in plant leaves changes with the seasons, first falling between spring and summer, and rising during fall.

Inconsistent results stem from differences between the selected species, the geographical locations, and the climates in which the plants are found

Garden Plant Leaf Lead, Copper, Chlorine and Sulfur Content of Function Change: Table 1 presents 15 kinds of garden plant leaves and their respective lead, copper, chlorine, and sulfur content in two functional areas. The leaves collected in autumn reach the maximum pollutant content, so we sample from both the highly polluted area and the clean area during that time. All garden plant leaf contaminants have similar variations. Those found in the Nanjing chemical plant have higher pollutant content than those from the Nanjing forestry university campus. Among the samples, the difference in lead content between the two locations has been especially visible in *Pterocaryahupeheasis*, *Sophora japonica*, *Magnolia grandiflora*, *Koelreuteriapaniculata*, *Viburnum odoratissimum*, *Aucuba japonica*, *Platanushispanica*, *Buxussinica*, and *Populus deltoids*. The rest of the trees showed a significant difference, as well. The difference in copper content between the two areas was most prevalent in *Cinnamomumcamphora*. With the exception of *Pittosporum tobira* and *Ligustrumlucidum*, the rest of the trees showed significant differences. For *Magnolia grandiflora*, there was no significant difference between the two areas in terms of chlorine content, but the rest of the trees exhibited extremely significant differences. Only *Sophora japonica* and *Broussonetiapapyrifera* showed a significant difference in sulfur content, while *Ligustrumlucidum* and *Buxussinica* showed no significant difference and the rest of the trees showed a moderate difference. These differences can be explained by the variation in pollutants in each area. Around the Nanjing forestry university campus far away from downtown, there are not industrial enterprises, while near the chemical plant, industry is prevalent. The Nanjing forestry university campus thus has a lower concentration of atmospheric pollution than urban and industrial zones. Therefore, the garden plants found there have relatively low contents of pollutants in the leaves.

Table1. 15 kinds of garden plants in different seasons each function leaf lead, copper, chlorine and sulfur content more ($p < 0.05$ and $p < 0.05$)

Element	Tree species	Contaminated Zone			Clean Zone
		May	July	September	September
Pb	FY	1.180±0.135a	3.690±0.047b	4.490±0.060c	2.630±0.089**
	GH	2.040±0.241a	4.220±0.123b	5.380±0.065c	3.100±0.147**
	GS	2.070±0.176a	3.150±0.155b	4.920±0.038c	3.450±0.506*
	GY	3.220±0.124a	3.860±0.047b	4.060±0.150b	1.260±0.159**
	HT	2.050±0.151a	2.120±0.119a	3.140±0.105b	1.940±0.541*
	JZ	1.870±0.080a	2.540±0.078b	2.650±0.086b	2.060±0.168*
	LS	2.340±0.077a	3.660±0.114b	5.770±0.083c	3.810±0.111**
	NZ	2.450±0.070a	2.780±0.065b	4.150±0.070c	3.040±0.426*
	SH	1.210±0.130a	1.460±0.045ab	1.550±0.088b	0.740±0.005**
	SJ	1.580±0.068a	2.880±0.118b	3.250±0.102c	2.590±0.069**
	XL	2.240±0.080a	3.470±0.109b	3.530±0.081b	2.160±0.149**
	XY	2.150±0.107a	2.060±0.133a	2.780±0.077b	1.890±0.0053**
	XZ	1.440±0.074a	2.540±0.041b	3.010±0.076c	2.540±0.164*
	YS	2.360±0.031a	3.650±0.074b	4.060±0.097c	1.960±0.039**
	ZY	1.890±0.096a	3.730±0.107b	5.970±0.123c	4.660±0.546*
Cu	FY	4.150±0.053a	8.470±0.053b	10.250±0.024c	6.380±0.047**
	GH	3.780±0.046a	8.450±0.049b	9.630±0.053c	5.710±0.049**
	GS	4.090±0.056a	9.260±0.053b	10.360±0.065c	7.140±0.389**
	GY	7.550±0.083a	8.140±0.064b	8.150±0.067b	5.280±0.029**
	HT	3.770±0.048a	4.500±0.106b	4.880±0.037c	4.030±0.619-
	JZ	2.280±0.053a	4.160±0.030b	5.380±0.030c	2.650±0.048**
	LS	1.580±0.065a	5.670±0.120b	7.780±0.041c	4.460±0.078**
	NZ	3.950±0.069a	4.560±0.078b	5.260±0.050c	4.770±0.380-
	SH	2.330±0.045a	4.430±0.044b	6.230±0.044c	5.750±0.049**
	SJ	2.600±0.063a	5.480±0.050b	6.740±0.053c	4.620±0.086**
	XL	1.940±0.047a	5.220±0.074b	7.170±0.026c	5.210±0.048**
	XY	3.360±0.089a	4.780±0.047b	5.220±0.038c	2.890±0.073**

	XZ	2.710±0.057a	4.300±0.077b	4.390±0.057b	3.980±0.241*
	YS	5.670±0.074a	8.560±0.046b	11.310±0.049c	10.410±0.083**
	ZY	4.730±0.046a	8.950±0.060b	10.050±0.091c	7.550±0.471**
	FY	0.883±0.018a	0.974±0.008b	1.291±0.005c	0.953±0.008**
	GH	0.432±0.003a	0.601±0.008b	0.654±0.011c	0.523±0.003**
	GS	0.612±0.007a	0.854±0.004b	0.973±0.011c	0.742±0.004**
	GY	0.980±0.167a	2.200±0.571b	2.780±0.245b	2.062±0.016-
	HT	0.282±0.005a	0.352±0.004b	0.412±0.004c	0.309±0.004**
	JZ	1.053±0.012a	1.311±0.005b	1.364±0.008c	1.063±0.007**
	LS	0.443±0.004a	0.483±0.005b	0.593±0.006c	0.401±0.006**
Cl	NZ	0.223±0.007a	0.261±0.006b	0.383±0.004c	0.253±0.009**
	SH	0.302±0.015a	0.362±0.005b	0.472±0.006c	0.321±0.004**
	SJ	0.362±0.005a	0.412±0.004b	0.623±0.007c	0.491±0.004**
	XL	0.422±0.004a	0.693±0.012b	0.843±0.008c	0.573±0.009**
	XY	0.332±0.007a	0.732±0.007b	0.752±0.016b	0.453±0.012**
	XZ	0.132±0.006a	0.201±0.005b	0.264±0.009c	0.184±0.004**
	YS	0.550±0.041a	1.253±0.008b	2.520±0.087c	1.203±0.444**
	ZY	0.762±0.013a	1.054±0.011b	1.223±0.007c	0.944±0.016**
	FY	0.230±0.043a	0.350±0.047ab	0.474±0.045b	0.290±0.022*
	GH	0.240±0.041a	0.550±0.025b	0.690±0.047c	0.410±0.027**
	GS	0.380±0.030a	0.620±0.062b	0.770±0.074b	0.400±0.029**
	G	0.210±0.052a	0.320±0.056a	0.551±0.040b	0.370±0.002*
	HT	0.190±0.037a	0.420±0.050b	0.643±0.054c	0.380±0.036*
	JZ	0.500±0.054a	0.560±0.047a	0.860±0.043b	0.610±0.062*
	LS	0.240±0.044a	0.420±0.014b	0.470±0.033b	0.280±0.041*
S	NZ	0.230±0.038a	0.280±0.039a	0.340±0.041a	0.250±0.036-
	SH	0.190±0.026a	0.350±0.043b	0.360±0.035b	0.233±0.040*
	SJ	0.150±0.040a	0.200±0.057a	0.410±0.048b	0.240±0.055*
	XL	0.340±0.044a	0.510±0.060b	0.650±0.046b	0.440±0.053*
	XY	0.250±0.043a	0.370±0.029ab	0.430±0.046b	0.314±0.053-
	XZ	0.170±0.039a	0.340±0.044b	0.520±0.039c	0.280±0.029*
	YS	0.330±0.042a	0.870±0.040b	1.030±0.042c	0.760±0.078*
	ZY	0.210±0.028a	0.460±0.035b	0.630±0.065c	0.340±0.044*

Note: the pollution area between different letters within the same column mean significant at the 5% level difference; ** says pollution area and clean area extremely significant difference ($p < 0.01$), * showed significant difference ($p < 0.05$), - said there was no significant difference ($p \geq 0.05$). Abbreviations: FY, Chinese beech; GH, pagoda tree; GS, broussonetiapapyrifera; GY, magnolia. HT, pittosporum; JZ, chicken claw maple; LS, goldenrain tree; NZ, privet; SH, coral tree; SJ, coral and gold; XL, sycamores; X, y, lobular boxwood; XZ, camphor; YS, poplar; ZY, *Prunuscerasifera*(the same below).

Garden Plant Leaf Lead, Copper, Chlorine and Sulfur Content of The Comprehensive Analysis: The membership function method is widely used for mathematical evaluation and adopts the method of membership in mathematics to the subordinate function value of the accumulation of pollutants in garden plant leaves. It calculates the average to assess the richness of the leaves based on the amount of pollutants. The specific calculation method is as follows:

Calculatethe subordinate function value of each index by Formula: T = (T - Tmin)/(Tmax - Tmin), type: T determination value as an index; Tmin as an index determination of the minimum value; Tmax determination value as an index of the maximum (Zhang *et al*., 2014).sum up the indicators of membership function values. The accumulative value reflect the size of the blade what contaminants.

The size of the accumulative value (X) is divided into the following three range (Table 2): X 2, 1 << X or 2 X 1 or less. Accordingly, garden plants can be divided into three categories. The first category has plants with high lead, copper, chlorine, and sulfur content, as seen in *Magnolia grandiflora*, *Sophora japonica*, *Populusdeltoides*, *Broussonetiapapyrifera* and *Pterocaryahupeheasis*. The second category, which includes *Koelreuteriapaniculata*, *Prunuscerasifera*, *Acer palmatum*, *Platanushispanica*, and *Pittosporum tobira*, has a moderate amount of pollution elements. Plants such as *Buxussinica*, *Aucuba japonica*, *Cinnamomumcamphora*, *Viburnum odoratissimum*, which display low pollutant content, make up the third category.

Garden Plant Leaf Lead, Copper, Chlorine and Sulfur Content of Multiple Comparison: Table 3 shows 15 kinds of garden plant leaves with multiple comparison results of lead and copper content. The majority of the garden plants show a significant or extremely significant correlation between lead and copper content. As for lead content, none of the species showed significant differences. In terms of copper content, there was also no significant difference any of the species.

Table 2. 15 kinds of garden plant leaf lead, copper, comprehensive analysis of chlorine and sulfur

Tree species	Element accumulation				The membership function value				
	Pb/ mg.kg^{-1}	Cu/ mg.kg^{-1}	Cl/%	S/%	Pb	Cu	Cl	S	Summation
FY	1.860	3.870	0.338	0.184	0.597	0.986	0.209	0.336	2.127
GH	2.280	3.920	0.131	0.280	0.777	1.000	0.041	0.679	2.497
GS	1.470	3.220	0.231	0.370	0.429	0.801	0.122	1.000	2.352
GY	2.800	2.870	0.718	0.181	1.000	0.701	0.516	0.325	2.542
HT	1.200	0.850	0.103	0.263	0.313	0.125	0.019	0.618	1.075
JZ	0.590	2.730	0.301	0.250	0.052	0.661	0.179	0.571	1.463
LS	1.960	3.320	0.192	0.190	0.639	0.829	0.091	0.357	1.916
NZ	1.110	0.490	0.130	0.090	0.275	0.023	0.040	0.000	0.338
SH	0.810	0.480	0.151	0.127	0.146	0.020	0.057	0.132	0.355
SJ	0.660	2.120	0.132	0.170	0.082	0.487	0.042	0.286	0.896
XL	1.370	1.960	0.270	0.210	0.386	0.442	0.154	0.429	1.410
XY	0.890	2.330	0.299	0.116	0.180	0.547	0.177	0.093	0.997
XZ	0.470	0.410	0.080	0.240	0.000	0.000	0.000	0.536	0.536
YS	2.100	0.900	1.317	0.270	0.700	0.140	1.000	0.643	2.482
ZY	1.310	2.500	0.279	0.290	0.361	0.595	0.161	0.714	1.831

Table 3. 15 kinds of garden plant leaves multiple comparison of lead and copper content

Pb \ Cu	FY	GH	GS	GY	HT	JZ	LS	NZ	SH	SJ	XL	XY	XZ	YS	ZY
FY	1	N	N	**	*	**	N	*	**	**	N	**	**	N	N
GH	N	1	**	N	**	**	N	**	**	**	**	**	**	N	**
GS	#	##	1	**	N	**	*	N	*	**	N	*	**	*	N
GY	##	##	N	1	**	**	**	**	**	**	**	**	**	*	**
HT	##	##	##	##	1	*	*	N	N	N	N	N	*	**	N
JZ	##	##	N	n	##	1	**	N	N	N	**	N	N	**	*
LS	#	#	N	n	##	#	1	**	**	**	*	**	**	N	*
NZ	##	##	##	##	n	##	##	1	N	N	N	N	*	**	N
SH	##	##	##	##	n	##	##	n	1	N	N	N	N	**	N
SJ	##	##	##	##	##	#	##	##	##	1	*	N	N	**	*
XL	##	##	##	##	##	##	##	##	##	n	1	*	**	*	N
XY	##	##	##	#	##	n	##	##	##	n	n	1	N	**	N
XZ	##	##	##	##	n	##	##	n	n	##	##	##	1	**	**
YS	##	##	##	##	n	##	##	n	n	##	##	##	n	1	**
ZY	##	##	##	n	##	n	##	##	##	n	#	n	##	##	1

Note: under the diagonal, said copper content on the diagonal respectively lead; * / # : $p < 0.05$; ** / # # : $p < 0.01$; N/n: $p \geq 0.05$.

Table 4 shows the 15 kinds of garden plant leaves and their chlorine and sulfur content. For most of the plants, the difference in chlorine and sulfur content was not significant, but a few of the plants had a significant or extremely significant difference. The plants with an significant and extremely significant differences are *Pterocaryahupeheasis* and *Sophora japonica*, *Magnolia grandiflora*, *Pittosporum tobira*, *Ligustrumlucidum*, *Viburnum odoratissimum*, *Aucubajaponica*, *Cinnamomumcamphora*, *Populusdeltoides*; *Sophorajaponica*and *Pterocaryahupeheasis*, *Magnolia grandiflora*, *Acer palmatum* Thunb, *Buxussinica*Rehd, *Populusdeltoides*; *Broussonetiapapyrifera* and *Magnolia grandiflora*, *Cinnamomumcamphora*, *Populusdeltoides*; *Magnolia grandiflora* and all plants; *Pittosporum tobira* and *Pterocaryahupeheasis*, *Magnolia grandiflora*, *Acer palmatum*Thunb, *Platanushispanica*, *Buxussinica*Rehd, *Populusdeltoides*, *Prunuscerasifera*; *Acer palmatum*Thunb and *Sophora japonica*, *Magnolia grandiflora*, *Pittosporum tobira*, *Aucuba japonica* Thunb, *Cinnamomumcamphora*, *Populusdeltoides*; *Koelreuteriapaniculata* and *Magnolia grandiflora*, *Populusdeltoides*; *Ligustrumlucidum* and *Pterocaryahupeheasis*, *Magnolia grandiflora*, *Acer palmatum* Thunb, *Buxussinica* Rehd, *Populusdeltoides*; *Viburnum odoratissimum* and*Pterocaryahupeheasis*, *Magnolia grandiflora*, *Acer palmatum*Thunb, *Populusdeltoides*; *Aucuba japonica* Thunb and *Pterocaryahupeheasis*, *Magnolia grandiflora*, *Acer* *palmatum*Thunb, *Buxussinica*Rehd, *Populusdeltoides*; *Platanushispanica*and *Magnolia grandiflora*, *Pittosporum tobira*, *Cinnamomumcamphora*, *Populus deltoids*; *Buxussinica*Rehd, and *Sophora japonica*, *Magnolia grandiflora*, *Pittosporum tobira*, *Ligustrumlucidum*, *Aucuba japonica* Thunb, *Cinnamomumcamphora*, *Populus deltoids*; *Cinnamomumcamphora*and*Pterocaryahupeheasis*, *Broussonetiapapyrifera*, *Magnolia grandiflora*, *Acer palmatum*Thunb, *Platanushispanica*, *Buxussinica*Rehd, *Populusdeltoides*, *Prunuscerasifera*; *Populusdeltoides* and all plants; *Prunuscerasifera* and *Magnolia grandiflora*, *Pittosporum tobira*, *Cinnamomumcamphora*, *Populus deltoids*.

In terms of sulfur content, 15 kinds of garden plant respectively with the rest of the plants had significant or extremely significant difference is:*Pterocaryahupeheasis* and *Broussonetiapapyrifera*, *Prunuscerasifera*; *Sophora japonica* and *Ligustumlucidum*, *Viburnum odoratissimum*, *Aucuba japonica* Thunb, *Buxussinica* Rehd; *Broussonetiapapyrifera* and *Pterocaryahupeheasis*, *Magnolia grandiflora*, *Pittosporum tobira*, *Acer palmatum* Thunb, *Koelreuteriapaniculata*, *Ligustumlucidum*, *Viburnum odoratissimum*, *Aucuba japonica* Thunb, *Platanushispanica*, *Buxussinic*a Rehd, *Cinnamomumcamphora*; *Magnolia grandiflora* and*Broussonetiapapyrifera*, *Prunuscerasifera*; *Pittosporum tobira* And *Broussonetiapapyrifera*, *Ligustumlucidum*, *Viburnum odoratissimum*, *Buxussinica*Rehd; *Acer palmatum*Thunb and *Broussonetiapapyrifera*, *Ligustumlucidum*, *Viburnum odoratissimum*, *Buxussinica* Rehd; *Koelreuteriapaniculata* and *Broussonetiapapyrifera*; *Ligustrumlucidum* and *Sophora japonica*, *Broussonetiapapyrifera*, *Pittosporum tobira*, *Acer palmatum* Thunb, *Platanushispanica*, *Cinnamomumcamphora*, *Populus deltoids*, *Prunuscerasifera*; *Viburnum odoratissimum* and *Sophora japonica*,*Broussonetiapapyrifera*, *Pittosporum tobira*, *Acer palmatum*Thunb, *Cinnamomumcamphora*, *Populus deltoids*, *Prunus.cerasifera*; *Aucuba japonica* Thunb and *Sophora japonica*, *Broussonetiapapyrifer*, *Prunuscerasifer*; *Platanushispanica* and *Broussonetiapapyrifera*, *Ligustrumlucidum*; *Buxussinica*Rehd, and *Sophora japonica*, *Koelreuteriapaniculata*, *Pittosporum tobira*, *Acer palmatum*Thunb, *Cinnamomumcamphora*, *Populus deltoids*, *Prunuscerasifera*; *Cinnamomumcamphora* and *Broussonetiapapyrifera*; *Ligustrumlucidum*, *Viburnum odoratissimum*, *Buxussinica*Rehd; *Populusdeltoides* and *Ligustrumlucidum*, *Viburnum odoratissimum*, *Buxussinica*Rehd; *Populusdeltoides* and *Ligustrumlucidum*, *Viburnum odoratissimum*, *Buxussinica*Rehd; *Prunuscerasifera* and *Pterocaryahupeheasis*, *Magnolia grandiflora*, *Ligustrumlucidum*, *Viburnum odoratissimum*, *Aucuba japonica* Thunb, *Buxussinica* Rehd.

Table 4. 15 kinds of garden plant leaves multiple comparison of chlorine and sulfur content

Cl \ S	FY	GH	GS	GY	HT	JZ	LS	NZ	SH	SJ	XL	XY	XZ	YS	ZY
FY	1	**	N	**	**	N	N	**	*	**	N	N	**	**	N
GH	N	1	N	**	N	*	N	N	N	N	N	*	N	**	N
GS	##	n	1	**	N	N	N	N	N	N	N	N	*	**	N
GY	N	n	##	1	**	**	**	**	**	**	**	**	**	**	**
HT	N	n	#	n	1	*	N	N	N	N	*	*	N	**	*
JZ	N	n	#	n	n	1	N	*	*	*	N	N	**	**	N
LS	N	n	##	n	n	n	1	N	N	N	N	N	N	**	N
NZ	N	##	##	n	##	##	n	1	N	N	N	*	N	**	N
SH	N	##	##	n	#	#	n	n	1	N	N	N	N	**	N
SJ	N	#	##	n	n	n	n	n	n	1	N	*	N	**	N
XL	N	n	##	n	n	n	n	#	n	n	1	N	*	**	N
XY	N	##	##	n	##	#	n	n	n	n	n	1	**	**	N
XZ	N	n	#	n	n	n	n	##	#	n	n	#	1	**	*
YS	N	n	N	n	n	n	n	##	##	n	n	##	n	1	**
ZY	#	n	N	#	n	n	n	##	##	#	n	##	n	n	1

Note: under the diagonal said sulfur content, chlorine content on the diagonal said; * / # : $p < 0.05$; ** / # # : $p < 0.01$; N/n: $p \geq 0.05$.

Conclusion: The greening trees' pollution elements can be characterized by chlorine > copper > lead > sulfur. The four pollution elements also show significant differences among the species of trees: *Sophora japonica*L., *Magnolia grandiflora* and *Populusdeltoids*. High copper content was visible in *Pterocaryahupeheasis*, *Sophora japonica*, *Broussonetiapapyrifera*, *Magnolia grandiflora*, *Acer palmatum*, *Koelreuteriapaniculata*,*Aucuba japonica*, *Buxussinica*, and *Prunus cerasifera*. We saw chlorine and a relatively high sulfur content in *Populusdeltoides* and *Broussonetiapapyrifera*. The reasons for this difference may be related to the nature of the pollutant, the structure of the plant, the height of the leaf, or the soil and climate conditions.

Fifteen kinds of garden plant leaves containing lead, copper, chlorine, and sulfur due to seasonal changes in pollution are examined. We have taken plants form two different functional areas—one polluted area and one clean area. We have collected samples at different times throughout the year, are able to see that pollution content increases as time goes on.

If we were to classify the plants based on their cumulative pollutant content, it would be done as follows: *Magnolia grandiflora*, *Sophora japonica* L., *Populusdeltoides*, *Broussonetiapapyrifera*, and *Pterocaryahupeheasis* are first class; *Koelreuteriapaniculata*, *Prunuscerasifera*, *Acer palmatum*, *Platanushispanica*, and *Pittosporum tobira* are second; and *Buxussinica*, *Aucubajaponica*,*Cinnamomum camphora*, *Viburnum odoratissimum* and *Ligustrumlucidum* are third. Therefore, in order to both reduce air pollution and beautify the environment, *Magnolia grandiflora*, *Sophora japonica*, *Populusdeltoides*, *Broussonetiapapyrifera*, and *Pterocaryahupeheasis* should be given preference. Growing plants may be influenced by both human and natural factors, and are often affected by a variety of pollution elements t [19]. This paper has analyzed the factors of the season and the location of the plant. Our next step is to investigate other factors, including leaf structure, specific leaf weight, direction of the wind, and soil.

REFERENCES

Anand, M., K. M. Ma, A. Okonski, (2003).Characterising biocomplexity and soil microbial dynamics along a smelter-damaged landscape gradient. The Science of the Total Environment. 311(1):247-259.

Du Z. Y., S. J. Xing, Y. M. Song, J. F. Zhang and Q. H. Wang (2007a). Analysis of S and Pb concentrations in leaves of main green treesalongside expressways in Shandong province.Chinese J. EcolEnv. 16(6):1608-1611

Du Z. Y., S. J. Xing, Y. M. Song, J. F. Zhang and Q. H. Wang (2007b). Lead pollution along expressways and its attenuation by green belts in shandong province. Chinese J. Soil and Water Con.21(5):175-179.

Huang Y. X., S. H. Lin, R. Z. Hanand Y. Q. Yao (1990). The characteristics of accumulation of sulphur from the air by the main plants and soils in Beijing and their indicative and purgative abilities. Chinese J. Acta Botanica Sinica, 32(5):380-389.

Lachapelle, P. P. and B. Shipley (2012). Interspecific prediction of photosynthetic light response curves using specific leaf mass and leaf nitrogen content: effects of differences in soil fertility and growth irradiance. Ann Bot. 109(6):1149-1157.

Li D. Y. and K. X.Wang (1982).Air pollution on plant leaves sulfur, chlorine, fluorine content effect. Chinese J. Env Sci. (5):50-55.

Li S. N., L. W. Kong, S. W. Lu (2014). Beijiang common green tree leaves accumulation capacity for heavy metals. Chinese J. EnvSci. 35(5): 1891-1900.

Mei Z. H., D. Fang, Y. Z. Song and L. Ren (2005).Contents of nitrogen, sulfur, lead in leaves of plants and air pollution evaluation in Nanjing district. Chinese J. Pol Con Technology. 18(4):40-41.

Pang X. Y., P. Lv, Y. Q. Feng (2008). Detection of sulfur in expanded graphite combined digestion under eschka reagents with turbidimetry of barium sulfate. Chinese J. Hebei University (Natural Science Edition).28(1):52-56,112.

Parolin, P (2002). Seasonal changes of specific leaf mass and leaf size in trees of Amazonian floodplains. Phyton-Annales Rei Botanicae. 42(1):169-185.

Pyankov V. I and A.V. Kondratchuk (1999). Shipley B. Leaf structure and specific leaf mass: the alpine desert plants of the Eastern Pamirs, Tadjikistan. New Phytologist, 143(1):131-142.

Wang A. X., M. Zhang, L. B. Huang, Y. M. Fang and C. Y. Gao (2009). Accumulation capacity of Nanjing 14 virescence tree species to heavy metal pollutants of the atmosphere. Chinese J. Bulletin of Botanical Res.29(3):368-374.

Wang L. J. and X. F. Liao (2005). Analysis and comprehensive evaluation of Baoji air quality. Chinese J. Southwest China Normal University (Natural Science).30(1):154-157.

Zeng J. R., G. L. Zhang and L. M. Bao (2013). Sulfur speciation and bioaccumulation in camphor tree leaves as atmospheric sulfur indicator analyzed by synchrotron radiation XRF and XANES. Chinese J. Env. Sci. 25(3): 605-612.

Zhang C. X., Y. B. Zhang, H. Y. Huang (1984).Lead content in leaves of woody plants as an index of air lead-pollution status. Chinese J. Ecology.(4):5-10.

Zhang J. Y., L. L. Chen, M. Ren (2014).Comparison of the foliage chlorine contents in 26 affore station trees. Chinese J. Southwest China Normal University (Natural Science Edition).39(8):62-66.