Determination and Analysis of Leaf P and K Concentrations of Several Plant Species in Jinan City

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Abstract. The effect of phosphorus(P) and potassium(K) on plant growth and development was irreplaceable. Based on random sampling of several plant species in the west campus of University of Jinan, the concentration of leaf P and K were measured by the total nitrogen total phosphorus total potassium analyzer. The results showed that Armeniaca vulgaris Lam. has the highest concentration of P and K, reaching 395.08 mg/kg and 227.45 mg/kg, followed by locust Robinia pseudoacacia Linn.. Ailanthus altissima (Mill.) Swingle and Ligustrum quihoui Carr. has the lowest concentration of leaf P. The leaf P concentration of all plant species was higher than leaf K concentration except for skunk. Based on the soil nutrients status of study area, it was found that Armeniaca vulgaris Lam.and Robinia pseudoacacia Linn. could be appropriately expanded in the end.

1 Introduction

Sufficient sunlight and moisture are playing an important role in the process of growth and development of plants, while nutrient is also indispensable. Nutrients of the maximum demand and the most important impact in the growth and development stages of plants are P and K. Phosphorus deficiency in plants caused the plants to be short, the roots to be underdeveloped, the leave tip and leave margin to be chlorotic and red, the grains to be not full, and the old leaves are yellowed first. Potassium deficiency in plants also caused the plants to be short, and the old leaves to be yellowed first along the leaf margins and become brown and burnt. The concentrations of phosphorus and potassium affect the growth and development of plant lateral roots[1], Phosphorus and potassium concentration fertilization also had significant effects on plant community coverage and species diversity[2]. The determination of P and K concentration of plants is of great reference value for understanding plant health, scientific fertilization and ecological adaptation.

2 Materials and methods

2.1 Research Area

The study area was located in the west campus of University of Jinan in Jinan city, Shandong province. Situated in the central and western part of Shandong Province, Jinan City was located at the junction of the low hills of central and south of Shandong Province and the alluvial plains of northwestern Shandong province, of which the terrain was high in the south and low in the north. It was a warm temperate continental monsoon climate, with dry and less rain in spring, warm and rainy in summer, cool and uninteresting in autumn, cold and snow in winter, concentrated rainfall and full sunshine. The annual average temperature of Jinan was 14.7 °C, the annual average precipitation was 671.1 mm, the annual sunshine hours were 2616.8 hours, and the annual frost-free period was 235 days.

2.2 Materials

Seven kinds of green plants on the campus of Jinan University were randomly selected, belonging to 7 families and 6 genera, which respectively were false acacia (Robinia pseudoacacia Linn.), apricot trees (Armeniaca vulgaris Lam.), populus (Populus tomentosa Carrière), skunk (Ailanthus altissima (Mill.) Swingle), mulberry (Morus alba L.), french plane (Platanus orientalis Linn.) and purpus priver (Ligustrum quihoui Carr.) (Table 1).

2.3 Research methods

Methods for determining plant nutrients included conventional chemical analysis methods and modern instrumental analysis methods. The traditional method to determine the leaf P and K concentrations used dry ashing or wet ashing (HNO_3-$HCLO_4$-H_2SO_4 triacid method, or HNO_3-$HCLO_4$ diacid method), but this method would interfere with the measurement results due to the presence of Cu^{2+}, Na^+ and Se. Thomas et al.

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increased the recovery of P and K elements in 1967 by using H₂SO₄-H₂O₂ heating digestion method to determine the concentration of leaf P and K in plants[3], and in 1979, Smith used the modified $H_2SO_4-H_2O_2-LiSO_4-Se$ heating digestion method to determine the leaf P and K concentrations and further controlled the recovery rate to about 99%[4]. Combining the advantages and disadvantages of the above methods, this experiment used a total nitrogen total phosphorus total potassium analyzer to measure the leaf P and K element concentration, which the advantages were that the pretreatment process was simplified, the measurement speed was accelerated, time was saved, and work efficiency was improved. The important organs that plants produced nutrients for the growth and development of trees were Leaves, which are most sensitive to nutrient reactions. The dynamic changes of nutrients can directly reflect the abundance of plant and soil nutrients.

Table 1. Plant species participating in the assay.

Plant	Latin name	Life form
False acacia	Robinia pseudoacacia Linn.	Deciduous tree
Apricot trees	Armeniaca vulgaris Lam.	Deciduous tree
Populus	Populus tomentosa Carrière	Deciduous tree
Skunk	Ailanthus altissima (Mill.) Swingle	Deciduous tree
Mulberry	Morus alba L.	Deciduous tree
French plane	Platanus orientalis Linn.	Deciduous tree
Purpus priver	Ligustrum quihoui Carr.	Small bush

**Table 1.** Continuation. Plant species participating in the assay.

Plant	Order	Family	Genus
False acacia	Fabales	Leguminosae	genus robinia
Apricot trees	Rosales	Rosaceae	Armeniaca
Populus	Salicales	Salicaceae	Populus
Skunk	Sapindales	Simaroubaceae	Ailanthus Desf
Mulberry	Urticales	Moraceae	Morus Linn.
French plane	Rosales	Platanaceae	Platanus
Purpus priver	Contortae	Oleaceae	Ligustrum L.

This experiment randomly selected leaf samples from 7 tree species in the west campus of Jinan University in July 2018, extracted the tissue fluid of fresh plant leaves, and configured standard solution and blank solution, each took 2ml, and measured leaf P and K concentration of plant samples with a total nitrogen total phosphorus

total potassium analyzer(The data is shown in Table 2 and Figure 1.).

Table 2. P and K concentrations of plant leaves.

Plant	Leaf P concentration（mg/kg）	Leaf K concentration（mg/kg）
False acacia	383.88	181.02
Apricot trees	395.08	227.45
Populus	267.01	46.78
Skunk	26.78	61.59
Mulberry	170.86	51.76
French plane	157.08	60.92
Purpus priver	30.95	18.63
average value	204.52	92.59
standard deviation,	140.15	72.91
coefficient of variation	68.53%	78.74%
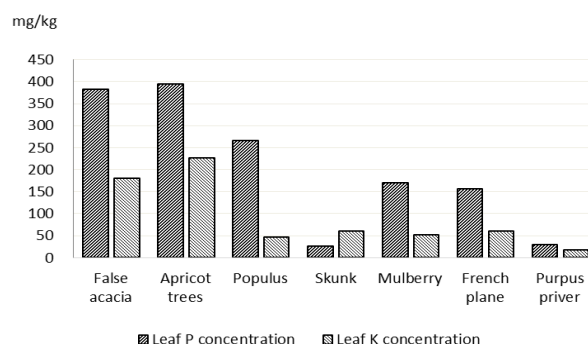
Fig. 1. P and K concentrations in different plant leaves.

2.4 Data processing

Data analysis and charting applied statistical software such as Excel 2010.

3 Discussion and results

3.1 Leaf P concentration

P was an essential nutrient for plant growth, was the main component and provider of energy carriers in plants, was closely related to protein synthesis, cell division and cell growth, and participated in the metabolism and transportation of carbohydrates. Phosphorus stress has a great influence on plants, especially roots, and under low phosphorus stress, plants often increase the absorption capacity of soil phosphorus by changing the morphology of roots, thereby increasing the availability of phosphorus in soil. It could be seen from Table 2 and Fig. 1 that the average leaf P

concentration of common green plants in the campus was 204.52 mg/kg, the standard deviation was 140.15 mg/kg, the coefficient of variation was 68.53%, and the plant population with higher leaf P concentrations were apricot trees and false acacia, 395.08 mg/kg and 383.88 mg/kg, lower in content for skunks and lobes, 26.78 mg/kg and 30.95 mg/kg, respectively. There was a significant difference in leaf P concentration among various trees,which the highest one was apricot, and the lowest was skunk and the difference between the two was 368.30 mg/kg.

3.2 Leaf K concentration

K was one of the abundant nutrients necessary for plant growth and development, and also the only monovalent cation in all living organisms. Potassium stress has the greatest impact on plant growth and metabolism, mainly due to potassium deficiency affecting plant leaf photosynthesis and reducing leaf stomatal conductance, reducing photosynthetic phosphorylation activity and electron transport activity, thereby restricting the net photosynthetic rate and biological yield of plants[5]. From Table 2 and Fig. 1, it could be seen that the average K concentration of the leaves of the campus tree was 92.59 mg/kg, the standard deviation was 72.91mg/kg, and the coefficient of variation was 78.74%. The K concentration of the leaves was expressed in order of height as apricot tree (227.45 mg/kg)> false acacia(181.02 mg/kg)> skunk(61.59 mg/kg)> french plan (60.92 mg/kg)> mulberry(51.76 mg/kg)> populus(46.78 mg/kg)> purpus priver(18.63 mg/kg), and the K concentration of each tree was more uniform and higher than the shrub.

3.3 Differences in the utilization value of N and P among different plant groups

The concentration of nutrients in plants had been widely used to estimate the utilization value of plants for nutrients[6-8], and which was quite different in different plants. For example, the concentration of nutrients in evergreen woody plants was generally lower than that of deciduous plants or herbaceous plants[9], and in herbaceous plants, dicotyledons have higher nutrient concentrations than monocotyledons[10]. The west campus of Jinan University covered an area of 2.43 million square meters, and the soil type was cinnamon soil. After determination, the soil salt was 471.5 μs, the ammonium nitrogen was 120.1 mg/kg, the available potassium was 20.1 mg/kg, and the available phosphorus was 123.8 mg/ Kg, that rainwater leaching made the available potassium concentration much lower than ammonium nitrogen and available phosphorus. The results of this study showed that the leaf N and P concentrations in the leaves were inconsistent with the environment. For example, the K concentration in the leaves of the arbor plants was significantly higher than that in the shrubs, but the P concentration in the leaves was not significantly different, and the P concentration in the leaves was significantly different among the arbor

plants, but the K concentration were more uniform. This indicated that the factors affecting the concentration of N and P in plant leaves were very complex, relying on the concentration of nutrients with higher value on the one hand, and on the other hand, the response process different between species and in areas with nutrient deficiency[11]. According to the comparison of P and K contents in soil and P and K contents in plant leaves, it was found that false acacia and apricot trees with higher P and K concentrations in the body have stronger adaptability to the environment of the study area and can be expanded.

4 Conclusion

After calculation, the correlation coefficient between leaf p concentration and K concentration is 0.837785, which is a strong correlation, indicating a significant positive correlation between P and K content in different plant leaves. The leaf nutrient concentration of the same tree species in the study area was roughly satisfied: P>K (except skunk), in which the differences between the leaf P and K concentrations of populus were the largest, and the purpus priver were the smallest, while the highest concentrations of leaf P and K were False acacia and Apricot trees, and the lowest were skunks and purpus priver. The coefficient of variation of leaf P concentration between different plants was less than K concentration. The difference of leaf P concentration among each tree was obvious, for example, the highest tree was apricot tree (395.08 mg/kg), and the lowest was skunk (26.78 mg/kg). The difference between the K concentrations was small and relatively uniform, and the K concentration of the arbor leaves was higher than that of the shrub leaves.

False acacia and apricot trees have the best adaptability in the study area and are suitable as greening trees. For other tree species, the efficient absorption potential of P and K elements of plants should be excavated, the P and K nutritional traits of plants should be improved, the utilization ratio of P and K should be improved, and the environment of the study area and other habitats should be better adapted. indicated that the factors affecting the concentration of N and P in plant.

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