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

Ye Liu1, Xinyu Wang1, Fang Luo1,2*, Liuqing Wu1, Yating Zhang1 and Tianjun Lan1

1School of Water Conservancy and Environment, University of Jinan, 250022 Jinan, China
2Shandong Provincial Engineering Technology Research Center for Ecological Carbon Sink and Capture Utilization, 250022 Jinan, China

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 (HNO3-HCLO4-H2SO4 triacid method, or HNO3-HCLO4 diacid method), but this method would interfere with the measurement results due to the presence of Cu²⁺, Na⁺ and Se. Thomas et al.

* Corresponding author: stu_luof@ujn.edu.cn
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 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 of plants that 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 | Deciduous tree  |
| Apricot trees  | Armeniaca vulgaris   | Deciduous tree  |
| Populus        | Populus tomentosa    | Deciduous tree  |
| Skunk          | Ailanthus altissima  | Deciduous tree  |
| Mulberry       | Morus alba L.        | Deciduous tree  |
| French plane   | Platanus orientalis  | Deciduous tree  |
| Purpus priver  | Ligustrum quihoui    | 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        | Salicaceae| Salicaceae     | Populus      |
| Skunk          | Sapindales| Simaroubaceae  | Ailanthus    |
| Mulberry       | Urticales | Moraceae       | Morus Linn.  |
| French plane   | Rosales  | Platanaceae    | Platanus     |
| Purpus priver  | Contortae| Oleaceae       | Ligustrum    |

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 72.91 mg/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 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 72.91 mg/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.

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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