



AgEcon SEARCH
RESEARCH IN AGRICULTURAL & APPLIED ECONOMICS

The World's Largest Open Access Agricultural & Applied Economics Digital Library

This document is discoverable and free to researchers across the globe due to the work of AgEcon Search.

Help ensure our sustainability.

Give to AgEcon Search

AgEcon Search
<http://ageconsearch.umn.edu>
aesearch@umn.edu

*Papers downloaded from **AgEcon Search** may be used for non-commercial purposes and personal study only. No other use, including posting to another Internet site, is permitted without permission from the copyright owner (not AgEcon Search), or as allowed under the provisions of Fair Use, U.S. Copyright Act, Title 17 U.S.C.*

Construction of Plant Landscape Spaces in Colleges and Universities: Taking Jiangxi Normal University as an example

Xiaogang CHEN*, Ziyuan SHU, Hui LIN

College of City Construction, Jiangxi Normal University, Nanchang 330022, China

Abstract Landscape in colleges and universities is mainly composed of plant landscape. Plant space landscape has a profound impact on the campus landscape construction. This paper investigates and analyzes four plant landscape space plots in the Yaohu Campus of Jiangxi Normal University to understand their characteristics, in order to provide reference for the construction of plant landscape space in southern colleges and universities.

Key words Garden plants, Landscape space, Jiangxi Normal University

1 Introduction

University campuses have many functions such as education, scientific research, life, and leisure. Their audiences are mostly teachers and students. The environmental comfort of campuses affects the physical and mental health of teachers and students in many ways^[1]. The status of the environment and plant landscapes in campuses is getting more and more attention, because that campus plants, as part of the urban greening system, play the role of beautifying the environment and maintaining ecological balance, and they are not only conducive to cultivating sentiment and optimizing the learning and living environment of teachers and students and can also provide a place for teachers and students to rest, abuse, communicate and learn^[2]. Plant landscape space creation is the core content of plant landscape design in university and college campuses. Different time and space changes can be revealed through rich layers, colors and forms. This paper analyzes and studies the plant landscape spaces in Yaohu Campus of Jiangxi Normal University to provide reference and improvement suggestions for the construction of plant landscape spaces in university and college campuses.

2 Overview of research area

Nanchang (115°27′–116°35′ E, 28°10′–29°11′ N) is located in the north of central Jiangxi Province, in the middle and lower reaches of the Yangtze River, near Poyang Lake. Nanchang is located in the subtropical humid monsoon climate zone with abundant precipitation. In summer, the precipitation is more and intensive; and in winter, the precipitation is less, and the sunshine is sufficient. Throughout the year, summer and winter are long, and spring and autumn are short. The annual average temperature is about 17°C. It is in the plain-hill area, and the terrain is relatively flat. The Yaohu Campus of Jiangxi Normal University is located in the eastern part of Nan-

chang City, adjacent to Yaohu Lake. The campus covers an area of about 2 km² and was built around 2003, with a total construction area of approximately 770 000 km². It can accommodate more than 40 000 students.

3 Research method and plot selection

3.1 Research method Through measuring and recording, the data about the plant factor and space factor of the four plant space plots were obtained. The data measurement of plant factor is closely related to plant life form and plant allocation. The species of plants, the quantity and ratio of arbors and shrubs and the quantity and ratio of evergreen and deciduous plants were quantified using the shape factor (S), and used to describe the spatial pattern of plants. The spatial complexity of a plant is expressed by the ratio of the actual length (L) of its boundary to the circumference of the same area (A), that is, $S = L / (2 \sqrt{\pi A})$. The higher the S value, the more complex the spatial shape. The plant landscape spaces were investigated and analyzed using plant community life form analysis method. According to the height of the plants, the plant community hierarchy was divided as follows: upper plants: plant height ≥ 3.0 m; middle plants: plant height between 0.5–3.0 m. The spatial factor data included perimeter coverage area (referring to the area of plants above 0.5 m), open space area (referring to the area of lawn and other herbaceous plants), total space area and length of forest edge^[3].

3.2 Plot selection Based on the experience of the majority of teachers and students learning and living, four plant landscape spaces of Yaohu Campus of Jiangxi Normal University were selected for actual measurement and analysis. The plots 1 and 2 are located between the teaching buildings of Xiansu and Fangyin, and the plots 3 and 3 are located in the Youth Cultural Square in front of the fourth dining hall. The teaching buildings require being quieter, so the plant landscapes are mostly used to separate the noise of the roadway, thus creating a quiet environment. The cultural square is more lively, providing venues for students to organize activities and entertainment. Plants must

not only create an environment that is suitable for students to learn and live, but also demonstrate campus culture. As the nature and geographical location of the sites to which the plant landscape spaces belong vary, the four plant landscape spaces have their own characteristics.

Table 1 Characteristics of the four plant landscape space plots

Plot code	Space area//m ²	Circumference//m	Coverage//m ²	Open area//m ²	Length of forest edge//m	Shape factor
1	1 215.6	139.0	447.8	767.8	172.3	1.12
2	1 858.2	179.6	422.3	1 435.9	169.8	1.17
3	1 192.1	149.1	473.2	718.9	198.0	1.22
4	1 034.6	137.7	345.5	689.1	197.7	1.21

Table 2 Plant community coverage in the four plant landscape space plots

Plot code	Coverage of each layer of plant communities//%					Total
	Community code	Upper evergreen layer	Upper deciduous layer	Middle evergreen layer	Middle deciduous layer	
1		22.6	2.4	5.1	5.1	35.2
2		19.6	6.4	3.3	1.4	30.7
3	1	5.4		1.5	1.1	8.0
	2	17.5	7.1	2.8	2.8	30.2
4	1	6.5	6.0	2.0		14.5
	2	9.1	2.1	6.5	2.9	20.6

Table 3 Ratios of deciduous plants to evergreen plants, and shrubs to arbors in the four plant landscape space plots

Plot code	Deciduous plants/evergreen plants	Shrubs/arbors
1	1:4.4	1:2.0
2	1:1.8	1:1.5
3	1:2.5	1:1.4
4	1:2.4	1:1.1

Table 4 Statistics of the four plant landscape space plots from the viewing angle

Plot code	Value		
	D/m	H/m	D/H
1	6.7	3.9	1.7
2	8.7	3.8	2.3
3	6.5	3.9	1.7
4	6.8	3.1	2.2

4.1 Plot 1 Plot 1 is located in the south of the Xiansu Building, with an area of about 1 215.6 m². The terrain is low around and high in the center. The planting forms of plants are mostly natural. The plot is enclosed by two roadways and one garden road (Fig. 1). The plant varieties in Plot 1 are relatively simple, but the spatial structure of the plants is variable. The upper plants include camphor, evergreen magnolia, plum, *etc.*; and the middle plants include michelia, camellia, plum, *etc.* Among the plants, camphor, evergreen magnolia, plum, michelia, camellia and pomegranate account for 36%, 27%, 4%, 13%, 6% and 14%, respectively. Camphor has the largest proportion. The open space is relatively large and relatively empty. The color of the entire plot is relatively uniform. The proportions of upper plants (66.7%) and evergreen plants (81.5%) are relatively large. On one side of the two main roads on the west and north sides, camphor trees are planted. Through the east and south sides enclosed by the garden

4 Results and analysis

Through the investigation and measurement, the data about the spatial characteristics, plant allocation, plant community coverage and viewing angle of the four plots were obtained to reflect the current status of the plant landscape spaces (Table 1 – Table 4).

road, the internal landscape of the plot can be viewed directly. The camphor trees in the plot create a semi-enclosed space, thus creating a relatively quiet environment. Arbors and shrubs are scattered in the center of the plot space. Arbors, dominated by evergreen magnolia, are mostly planted on higher slopes. Small arbors, dominated by pomegranate and michelia, and shrubs are planted on the flat land around the slopes. This high and low drop enhances the spatial layering of the green space. This plot is mainly an evergreen plant landscape. However, the leaves, flowers and fruit of each evergreen plant are rich in color, conducive to the creation of unique seasonal landscapes. There are relatively few plant types in the plot. Most of the selected plants are native plants suitable for growth, such as camphor and evergreen magnolia. They are mostly flower trees, enriching the color of the entire plot.

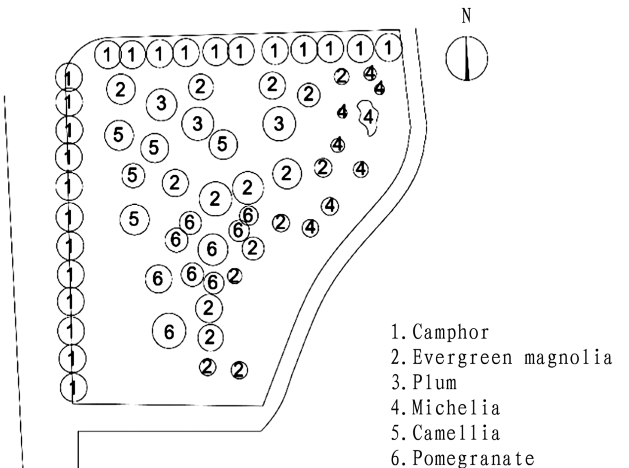


Fig. 1 Floor plan of plot 1

The semi-enclosed space and natural planting mode create a tranquil environment. However, plot 1 has the smallest shape factor,

with a simple spatial shape and short forest edge. The plants do not form distinct communities (Fig. 2).



Fig. 2 Real map of plot 1

4.2 Plot 2 Plot 2 is located in the southeast of the Xiansu Building, relatively remote, with an area of about 1 858.2 m². The terrain is high in the south and low in the north, forming a natural slope. The planting forms of plants are mainly natural. The plot is enclosed by two roadways and two garden roads (Fig. 3). The upper plants include camphor, tulip poplar, chinaberry, etc.; and the middle plants include *Lindera megaphylla*, horned holly, purple-leaf plum, etc. Among them, camphor, purple-leaf plum, *L. megaphylla*, tulip poplar, *Bambusa multiplex*, chinaberry and horned holly account for 25%, 9%, 17%, 11%, 31%, 5% and 2%, respectively. Camphor has the largest proportion. The space coverage of plot 2 is the smallest. The entire plot is relatively empty. The distribution of upper and middle plants is sparse. In this plot, the proportion of upper plants is about 72.2%, and the proportion of evergreen plants is about 74.4%. The northern roadway has a lower grade, and the camphor trees along the roadway are smaller in canopy, shorter, and large in quantity. The eastern roadway has a higher grade, and the camphor trees along the roadway are larger in canopy, taller and small in quantity. The volume and quantity of camphor trees of the two rows are different. However, the two rows of camphor trees intersect with each other and partially enclose the plot, forming a relatively closed space. Tall trees such as tulip poplar and chinaberry are mainly located in the north of the plot, close to garden roads. They are located on a higher terrain, and can act as a barrier. Shrubs, dominated by purple-leaf plum, and *L. megaphylla* seedlings are located in the flat terrain of the northern part, contrasting with the tall arbor trees, and enhancing the sense of space. The central part of the plot is densely distributed with *B. multiplex*, which has a large coverage and quantity. The *B. multiplex* communities divide the plot into two parts. The middle and upper plants in the western part are dense, and those in the eastern part are sparse. The vegetation is dominated by grassland and other ground cover plants. Due to the remote location and small population, the plot has relatively few plant species and flowers trees, with a single color. However, the proportion of deciduous forests in this plot is rela-

tively large, which increases the seasonal variation of the landscape to some extent. In plot 2, the shape factor is small, the shape of the space is simple, the length of the forest edge is the shortest, and the plants do not form distinct communities with low planting densities (Fig. 4).

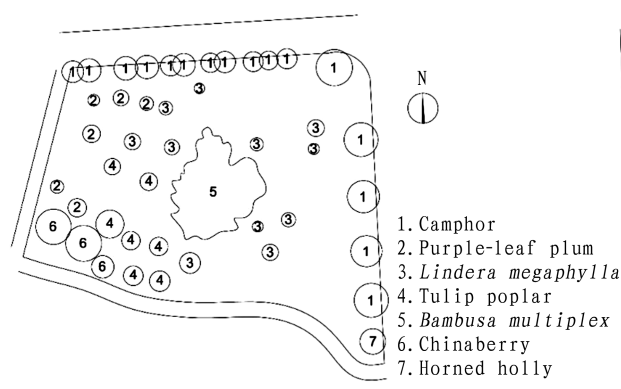


Fig. 3 Floor plan of plot 2



Fig. 4 Real map of plot 2

4.3 Plot 3 Plot 3 is located on the east side of the second dining hall, on the west side of Youth Cultural Square, and in the south of the school library, with large flow rate. The area is about

1 192.1 m². The terrain is relatively flat. It is enclosed by two roadways, one waking path, and a garden road. The plot consists of two plant communities. Community 1 is located in the northeast of the plot, and community 2 is located in the southwest of the plot with a larger area (Fig. 5). In community 1, the upper plants include camphor, cherry bay, *B. multiplex*, *etc.*; and the middle plants include firethorn and pomegranate. The plants are mainly composed of arbors and evergreen plants, with more flower trees and rich colors. In community 2, the upper plants include camphor, apricot, plum, sakura, cherry bay, evergreen magnolia, *etc.*; and the middle plants include purple-leaf plum, firethorn, pomegranate, *etc.* The plants are dominated by arbors and evergreen plants. However, there are more plant species, especially deciduous plant species in community 2, with rich colors and ignificant seasonal change. There is no obvious boundary between community 1 and community 2. The plant species of the two communities are similar, and they are mainly dominated by arbors and shrubs. There are large numbers of stones in the two communities, which create a more natural environment combined with the groves. There are also landscape lights in the communities, and they can create a different community landscape at night. The area of plot 3 is smaller, but it has the largest shape factor, greater changes in the spatial shape, the lon-

gest forest edge, larger coverage and larger planting density, forming tow more distinct plant communities. The three species of the plot 3 are the most abundant, which is conducive to the formation of distinct seasonal changes. This plot is only enclosed by the camphor trees along the southern roadway, separating the green space and the road, and leaving enough viewing space. The formation of a relatively open green space is compatible with the surrounding environment (Fig. 6).

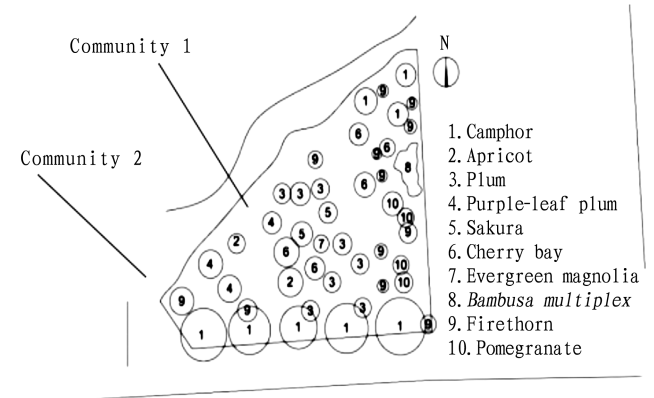


Fig. 5 Floor plan of plot 3



Fig. 6 Real map of plot 3

4.4 Plot 4 Plot 4 is located on the south side of the fourth dining hall, the east side of the second dining hall, and the west side of the Youth Cultural Square, with an area of about 1 034.6 m². The flow rate is large. The terrain is relatively flat. The plot is enclosed by two roadways, one walking path and one garden road. It consists of two communities. Community 1 is located in the east, with a small area; and community 2 is located in the west, with a large area (Fig. 7). In community 1, the upper plants include camphor, plum, cherry bay, pomelo, ginkgo, *etc.*; and the middle plants include camellia and firethorn. The plants are dominated by arbors. The number of evergreen and deciduous plants is similar, with more flower trees and rich colors. In community 2, the upper plants include camphor, apricot, plum, pear, pomelo, ginkgo, *etc.*; and the middle plants include firethorn and camellia. The plants are dominated by evergreen plants. The quantity

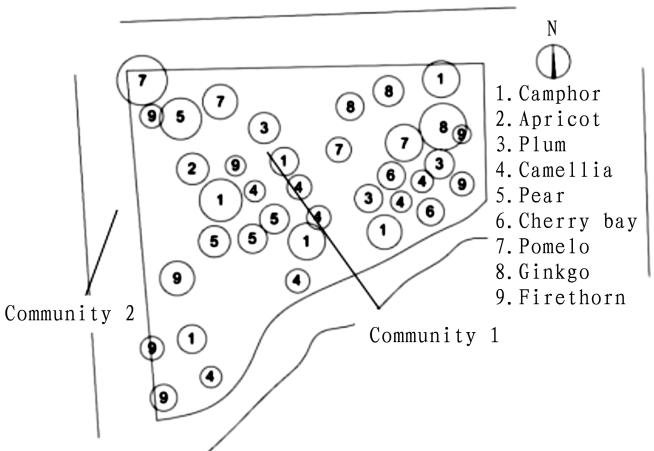


Fig. 7 Floor map of plot 4

of arbors and shrubs is similar. There are more plant species in community 2, and the colors vary. The community 1 and the community 2 are separated by a garden road, and the two communities have similar plant species, both dominated by arbors and shrubs. In the communities, there are garden roads, seats, landscape lights, *etc.*, facilitating sightseeing and viewing (Fig. 8). The area of plot 4 is the smallest, and it has larger shape factor, greater changes in spatial shape, longer forest edge, larger coverage and larger planting density. Two distinct plant communities are formed in plot 4. The species of trees in plot 4 are rich, which is conducive to the creation of seasonal landscapes. There are no major roads around the plot, and there are no obvious enclosed plants at

the edge of the plot. The interior landscape can be viewed directly. There are garden roads passing through the plot. The space is more open, and it can meet the needs of the surrounding people for sightseeing and leisure.

Through the investigation and analysis of the four plots, it can be found that the proportion of upper plants and evergreens is more than half. Camphor is widely used in the construction of plant landscape spaces in the Yaohu Campus of Jiangxi Normal University. In the four plots, the proportion of camphor is relatively large, and flower trees occupy a certain proportion; the coverage area is smaller than the open space; and the plants are mostly planted in the natural form.



Fig.8 Real map of plot 4

5 Conclusions

5.1 Sense of enclosure in the campus plant space The sense of enclosure of plant communities has an important impact on the construction of plant space landscapes. Plant open space refers to a certain open plant space where surrounding plant landscape is lower than the human line of sight^[4]. The relationship between the coverage of upper and middle plants, and evergreen and deciduous plants, as well as the open and closed space can reflect the enclosure of plant spaces. The higher the coverage of the plant community, the larger the horizontal area of the community, and the stronger the sense of enclosure in the vertical space. The lower the coverage of the plant community, the smaller the horizontal area of the community, and the weaker the sense of enclosure of the vertical space. The open spaces (Table 1) and plant community coverages (Table 2) of the four plots show that the coverage of the middle plants is low, while the coverage of the upper plants is high, which play a major role in space limitation and enclosure. However, the total coverage of the middle and upper plants is lower, and the enclosure sense of the four plots is weak. They all adopt the allocation pattern of upper plants + middle plants. The upper plants are often selected from evergreen trees such as camphor and evergreen magnolia, and the middle plants are mostly selected from evergreen shrubs such as camellia and firethorn. As shown in the tables, plot 3 has the highest degree of enclosure, with a total coverage of 38.2%; and plot 2 has the lowest degree of enclosure, with a total coverage of 30.7%. The distance between the locations of plots 2 and 3 is far, and the surrounding environment is quite different. Different coverage and degree of en-

closure reflect the diversity of campus plant community spaces, ensure that the plant communities serve the buildings which they belong to and meet the needs of teachers and students.

5.2 Plant allocation in campus plant space The diversity of plant species is an important factor in maintaining biodiversity and ecological stability^[5]. In southern China, the greening is mainly based on evergreen plants, and deciduous plants are used to reflect seasonal changes in the landscapes. Therefore, the ratio of evergreen plants to deciduous plants plays an important role in the construction of campus plant space landscapes. Through the study of the ratio of deciduous plants to evergreen plants in the four plots of the Yaohu Campus of Jiangxi Normal University, it is found that the campus plant landscape spaces are mainly composed of evergreen plants, with a large proportion. Among them, the proportion is largest in plot 1, in which the ratio of deciduous plants to evergreen plants reaches 1:4.4; and the proportion is smallest in plot 2, in which the ratio of deciduous plants to evergreen plants is 1:1.8 (Table 3). Although the difference in the quantity of evergreen plants and deciduous plants is very great, the proportion of flower trees in the four plots is large, so that the influence on the seasonal changes and color richness of plant space landscapes is small. Native plants such as evergreen plants, especially camphor are often used. Through the combination of plants with campus culture, a campus environment with a distinctive cultural atmosphere is created^[6], conducive to the exhibition of school culture and Nanchang city characteristics. Plants can adapt to the environment, and the incidence of pests and diseases is low, facilitating management.

5.3 Arbor/shrub ratio in plant space In the construction of campus plant spaces, plant height affects the spatial vertical structure, and further affects the vertical perception of the entire plant space. The ratio of arbors to shrubs needs to be properly arranged considering the environmental conditions of the area and the type and function of green space. Chen Zixin, from the Beijing Institute of Landscape Agriculture, proposed that the appropriate ratio of arbors to shrubs should be 1:6:29 (*i. e.*, one arbor and six shrubs in 29 m² of green space)^[7]. In the four plots of Jiangxi Normal University, upper plants are used more frequently than the middle plants. Even in the plot 4 in which the proportion of arbors is lowest, the ratio of shrubs to arbors reaches 1:1.1. Such a configuration method enhances the sense of enclosure of the space, but weakens the transparency of the space. It does not match the appropriate ratio (Table 3). What's more, the ratio of upper plants to middle plants does not match the area of green space, and the density of upper and middle plants is low. In addition to the ratio of arbors to shrubs, the creation of plant space landscapes should also consider the micro-topography. Plots 1 and 2 have slopes. Some arbors are arranged on the top of the slopes, and shrubs are arranged around the slopes, increasing the difference in coverage of arbors and shrubs and enhancing the space gap.

5.4 Shape index of campus plant space The shape index reflects the relationship between spatial morphology and function. The larger the value is, the richer the spatial form and hierarchy is. Plot 2 has the largest area, but its forest edge is the shortest, and shape factor is also smaller, indicating that the spatial shape changes less, and the level is relatively simple. Considering that the location of plot 2 is remote with small people flow, the relatively weak layering has little effect on its function. The areas of plots 1, 3 and 4 are similar, but the forest edges and shape factors of plots 3 and 4 are much greater than those of plot 1. Plot 1 is adjacent to the teaching building, and the landscape between the green spaces should create a quiet environment. The more peaceful spatial form and level is conducive to a quiet learning atmosphere. Plots 3 and 4 are located next to the Youth Cultural Square, which is often used for students' social activities and events. The varied spatial forms and rich layers are conducive to creating an active environment. Through the investigation and analysis of the plant landscape spaces of Jiangxi Normal University, it can be known that the biggest highlight of its space creation is to combine the surrounding environment of the green spaces, consider the function of the green spaces, and allocate plants according to local conditions. The landscape created by the difference in plant space is also different.

5.5 Closure of campus plant space Plant growth keeps the

plant space constantly changing. The length, width and height of plants have an important influence on the viewing angle and sensory of plants. The ratio of the distance from the viewpoint to the plant landscape (D in Table 4) to the height of the plant landscape (H in Table 4) can reflect the spatial perception of the plant landscape. The larger the value of D/H is, the more open the space is, and the weaker the closure is. The smaller the value of D/H is, the narrower the space is, and the stronger the closure is^[8]. As shown in Table 5, the values of D/H of the four plots are all about 2. Among them, the values of plots 1 and 3 are less than 2, and those of plots 2 and 4 are greater than 2. Combining the analysis results of open space and covering space in the four plots in Table 1, in plot 1, the proportion of covering space is small, the ratio of D/H is small, the interior of the space is relatively empty, but the space is more closed; in plot 2, the proportion of covering space is the smallest, the ratio of D/H is large, and the overall space is relatively empty; in plot 3, the proportion of covering space is large, the D/H ratio is small, the interior of the space is crowded, but it has a weak closure; and in plot 4, the proportion of covering space is large, the D/H ratio is large, the interior of the space is crowded, and the space is more closed.

References

- [1] ZHAO K, PAN JQ. Analysis of configuration of woody plants within campus green spaces in Tsinghua University[J]. Journal of Southwest Forestry University(Social Sciences), 2018, 2(1): 87–91. (in Chinese).
- [2] CHENG YH. The investigation and analysis of landscape plants on campus of Southwest University of Science and Technology[J]. Journal of Fujian Forestry Science and Technology, 2018, 45(1): 95–99. (in Chinese).
- [3] XU NW, SHI Y, BAO ZY. Space construction of the plant landscape of Olympic Park in Beidaihe[J]. Hua Zhong Architecture, 2017, 35(9): 76–83. (in Chinese).
- [4] SHI Y. Investigation and evaluation of plant landscape in Park Greenland of Nanchang City[D]. Nanning: Guangxi University, 2017. (in Chinese).
- [5] BAI YS. Study on plant landscape evaluation of Aixi Lake Wetland Park in Nanchang City[D]. Nanchang: Jiangxi University of Finance and Economics, 2018. (in Chinese).
- [6] ZHANG YQ. Study on campus plant landscape of Jiangxi University of Finance and Economics[D]. Nanchang: Jiangxi University of Finance and Economics, 2018. (in Chinese).
- [7] SU XF. Selection and allocation of urban greening tree species in North China[J]. Inner Mongolia Forestry Investigation and Design, 2009, 32(3): 81–84. (in Chinese).
- [8] LIU XH. Literary mind and artistic conception: Analysis of constituent elements of Chinese classical garden landscape[M]. Beijing: China Architecture & Building Press, 2002. (in Chinese).