

SEASONAL ANALYSIS AND LANDSCAPE APPLICATION OF COLORFUL PLANTS IN BAYI, CHINA

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Abstract

To explore the seasonal change and color match of colorful plants in Fujian park and wetland park of Bayi District, Nyingchi City were selected as research zone, and colorful plants in the two parks were taken as research object. By photographing the leaves of colorful plants in each season, and extracting CMYK value of leaf color seasonal changes and color characteristics of colorful plants were analyzed. Research results showed that (1) the main color of colorful plants in spring was light green, and light green > dark green and scarlet, purple, brown and pink > yellow; (2) the main color of colorful plants in summer was dark green, and dark green > light green > purple > scarlet and yellow, scarlet and yellow > pink and brown; (3) the main color of colorful plants in autumn was yellow, and yellow > dark green > purple and scarlet, purple and scarlet > pink > brown and light green (4) the main color of colorful plants in winter was dark green, and dark green > brown and pink > purple, light green, scarlet and yellow. Finally, some suggestions on plant configuration were proposed.

Introduction

Colorful plant is an indispensable part of garden plants, and the research on its seasonal change could better provide reference and opinion for plant configuration of garden landscape (Geng 2017). Meanwhile, colorful plants have very good aesthetic effect, which could add more artistic conception to garden landscape architecture (Jiang and Zhang 2017). In garden landscape design by colorful plants, it needs not only noticing living habits of colorful plants but also the matching with other garden elements, and it is necessary to embody beauty as well as environmental awareness (Zhao and Chen 2018). As the city's card, the rational and good ecological garden project have greater influence on the city's image, in which colorful plants with rich color changes play a crucial role (Jia *et al.* 2016). Rational and orderly collocation between colorful plants and garden greening could not only guarantee the healthy development of the city but also improve the city's environment and provide healthy living environment for citizens (Kang 2017, Tian 2016, Li 2016). Seasonal color changes of colorful plants its application in garden landscape are analyzed, which could provide the reference for the research and use of colorful plants in plateau city.

Materials and Methods

Bayi district is the capital of Nyingchi city, Tibet Autonomous Region, and political, economic and cultural center, with the altitude of 2900 m. It is located on the bank of the Niyang river, more than 30 km from the intersection of the Yarlung Zangbo river and Niyang river, and more than 400 km from Lhasa city. The investigation was done in Fujian park and Wetland park in Bayi district. The species of colorful plants were surveyed, and its seasonal changes were analyzed. The species, their living habits and seasonal changes of colorful plants of Fujian park and Wetland park of Bayi district, were surveyed, thereby obtaining more optimized configuration mode.

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Using natural A-6NCS1950 color card which is compatible with CAD, photoshop and other common graphics software, CMYK data of leaf color of plants from Fujian park and Wetland park were collected. Combining the seasonal changes of colorful plants in the two parks, plant configuration and color characteristics in the two parks were analyzed.

Seventeen types of colorful plants were collected in the present investigation (Table 1), in which 10 of arbors, 4 of shrubs, and 3 of vines. Among them, arbor was widely applied, followed by shrub, and vine application was the least, *Prunus cerasifera* Ehrhar f. L., *Ligustrum quihoui* Carr f *atropurea* L. and *Salix alba* L. were widely applied (Cai 1999, Max 2016, Pei *et al* 2010, Xu 1987).

The time of investigation in spring was from April 25 to May 1, 2018; in summer during June 8-15, 2017; in autumn during September 10 - 20, 2017; in winter during December 10 - 20, 2017. The color of colorful plants in the same season changed somewhat, represented the most significant color of the colorful plant in one season. Leaf color of 17 types of colorful plants in each season was extracted, and CMYK value of leaf in each season was obtained (Fig.1), thereby obtaining chromatic aberration chart. In 17 types of colorful plants, there were 10 types of spring colorful plants, 8 kinds of summer colorful plants, 14 types of autumn colorful plants and 2 types of winter colorful plants. Additionally, there were 5 types of colorful plants in three seasons and 4 types of colorful plants in two seasons.

Fig.1 shows that, CMYK values of the plants surveyed: In the spring, there are 7 types of C value 50 or more, 5 types of M value 50 or more, and 16 types of Y value 50 or more. In summer, there are 13 types of C values of 50 or more, 9 types of M values of 50 or more, and 15 types of Y values of 50 or more. In autumn, there are 4 kinds of C value 50 or more, 8 types of M value 50 or more, and 14 types of Y value 50 or more. In winter, there are 3 types of C value 50 or more, 3 types of M value 50 or more, and 3 types of Y value 50 or more.

Fig. 2 shows that the main color of colorful plants in spring was light green, light green > dark green and scarlet, purple, brown and pink > yellow; the main color of colorful plants in summer was dark green, and dark green > light green > purple > scarlet and yellow, scarlet and yellow > pink and brown; the main color of colorful plants in autumn was yellow, and yellow > dark green > purple and scarlet, purple and scarlet > pink > brown and light green; the main color of colorful plants in winter was dark green, and dark green > brown and pink > purple, light green, scarlet and yellow. From Figs 1 and 2, it was revealed that, the species of colorful plants were fewer in Bayi district, color composition was single, and colorful plants were less applied in the garden.

The application of colorful plants in urban district of Nyingchi city is dominated by arbor and shrub, and common configuration methods are as below: shrub has cluster planting, patch planting, color fence or parterre and strip planting, while arbor has cluster planting, isolated planting, column planting and scattered planting. The application of colorful herbs and lianas is less, and they are mostly used as ground cover and ornamental plants. In general, the configuration of colorful plants is simple, single kind of colorful plant is often used in one garden landscape, and the configuration of many kinds of colorful plants is relatively less. In the surveyed 17 types of colorful plants, only 8 types of colorful plants are widely applied in various types of green space. Other types are occasionally seen in a green space, and the application amount and area are relatively small.

Sufficient sunshine of Nyingchi city is very suitable for color exhibition of colorful plants. In the investigation, it is found that color exhibition effect of many colorful plants is not good; especially vines and herbaceous colorful plants are rare. Colorful plants are mainly red, purple and yellow, and other color is less. Therefore, one should select and apply colorful plants suitable for Nyingchi city, and the colorful plants which need full illumination should not be planted in the shade. Additionally, the color of colorful plants is very rich and aesthetic principles in plant configuration, not only meet the unity of ecological adaptability of plants and environment but also deploy rationally and embody formal beauty of individual plant and groups resulting artistic

Table 1. List of plants with colorful leaf of Fujian garden and Wetland park in Bayi district.

No.	Name	Family	Color attributes
1	<i>Prunus cerasifera</i> Ehrhar f. L.	Rosaceae	<i>P. cerasifera</i> is small deciduous arbor, branchlets are reddish brown, and branches and leaves are perennial fuchsia
2	<i>Platanus occidentalis</i> L.	Platanaceae T. Lestib.	Bark is gray green or gray white, with irregular exfoliation. It shows pink greenish after exfoliation, which is smooth
3	<i>Acer palmatum</i> 'Atropurpureum' L.	Aceraceae	Bark is smooth and grayish brown
4	<i>Ligustrum vicaryi</i> L.	Oleaceae	<i>Ligustrum vicaryi's</i> leaf is golden, especially in spring and autumn, the color is brighter
5	<i>Populus</i> sp. L.	Salicaceae Mirb.	Bark is smooth or has longitudinal crack, and is often grey and white
6	<i>Ginkgo biloba</i> L.	Ginkgoaceae	Bark of young tree is near smooth and light grey. Bark of big tree is gray brown, and changes into yellow before autumn defoliation
7	<i>Ligustrum quihoui</i> <i>Carr.f.atropurea</i> L.	Oleaceae	Leaf is green in summer and red in other seasons. Moreover, the lower the temperature, the better the color. Especially encountering the frost, the color will be more intense
8	<i>Parthenocissus tricuspidata</i> Planoch.	Vitaceae Juss.	Large deciduous woody lianas. Its leaves are green and hairless, and the back has white powder. There is pubescence at vein of leaf back, and it changes into cardinal in autumn
9	<i>Berberis thunbergii</i> <i>var.atropurpurea</i> Chenault L.	Berberidaceae	Young branch is magenta or dark red, while old branch is beige or purple brown. Leaf is small, rhomboid or oval, and has margin. It is purplish red to bright red, and the back color of leaf is slightly light
10	<i>cv. Aurea nana</i>	Cupressaceae	Leaf is yellowish green, and it is especially light on the top. After entering into winter, it slightly turns into green
11	<i>Cerasus serrulata</i> (Lindl.) G. Don ex London var. lan	Aceraceae	Small branch is purple or light purple green, and old branch is lilac. After entering into autumn, it turns into scarlet, which is bright, colorful, and brilliant. It is excellent leaf-viewing tree species
12	<i>Liriodendron tulipifera</i> 'Aureomarginatum'	Magnoliaceae Juss.	Bark is grey and has longitudinal stripe. There is golden broadband on the edge of leaf.
13	<i>Hedera canariensis</i> L.	Araliaceae	There are dark green and light green in the middle of the leaf, and leaf's margin shows white or cream yellow. After entering into autumn, the outer edge of the leaf turns into pink, and then restores to the status quo in next spring
14	<i>Metasequoia glyptostroboides</i> Hu et Cheng	Taxodiaceae	The shape of leaf is line, and color is light green
15	<i>Spiraea japonica</i> Gold Mound	Rosaceae	Newborn leaflets are golden, summer leaves are light green, and autumn leaves are golden; flower is light pink
16	<i>Cerasus serrulata</i> (Lindl.) G. Don ex London var. <i>lannesiana</i> (Carri.) Makino	Rosaceae	Bark is gray-brown or gray-black, and has lip-shape lenticel
17	<i>Salix alba</i> L.	Salicaceae Mirb.	Bark is dark grey and has deep longitudinal crack

beauty (Tian 2003). Growth habits and viewing characteristics of various colorful plants should be deeply understood, and systemic research on physiological characteristics and leaf color change of each kind of colorful plant is needed (Yu *et al.* 2013).
























































Species name	Leafcolor value(spring)	Leafcolor value(summmer)	Leafcolor value(autumn)	Leafcolor value(winter)
Prunus cerasifera Ehrhar f.L.	 C-47 M-90 Y-100 K-18	 C-51 M-79 Y-51 K-3	 C-61 M-86 Y-67 K-32	
Platanus occidentalis L.	 C-24 M-0 Y-72 K-0	 C-76 M-50 Y-100 K-13	 C-6 M-20 Y-88 K-0	
Acer palmatum 'Atropurpureum' L.	 C-0 M-78 Y-70 K-0	 C-0 M-85 Y-90 K-0	 C-46 M-92 Y-78 K-12	
Ligustrum vicaryi L.	 C-33 M-0 Y-80 K-0	 C-56 M-12 Y-77 K-0	 C-39 M-17 Y-98 K-0	
Populus sp. L.	 C-71 M-14 Y-100 K-0	 C-79 M-55 Y-100 K-22	 C-4 M-18 Y-65 K-0	
Ginkgo biloba L.	 C-52 M-21 Y-100 K-0	 C-84 M-51 Y-100 K-19	 C-9 M-39 Y-89 K-0	
Ligustrum quihoui Carr.f.atropurea L.	 C-0 M-81 Y-55 K-0	 C-70 M-43 Y-100 K-3	 C-75 M-60 Y-100 K-32	 C-79 M-63 Y-100 K-41
Parthenocissus tricuspidata	 C-49 M-11 Y-96 K-0	 C-78 M-52 Y-100 K-16	 C-37 M-100 Y-92 K-3	
Berberis thunbergii var.atropurpurea Chenault L.	 C-18 M-36 Y-14 K-0	 C-30 M-60 Y-31 K-0	 C-48 M-65 Y-19 K-0	
cv.Aurea Nana	 C-0 M-1 Y-96 K-0	 C-18 M-78 Y-88 K-0	 C-57 M-44 Y-99 K-1	 C-90 M-57 Y-100 K-33
Cerasus serrulata (Lindl.) G. Don ex London var. lan	 C-8 M-47 Y-64 K-0	 C-61 M-39 Y-95 K-0	 C-32 M-97 Y-95 K-1	
Liriodendron tulipifera 'Aureomarginatum'	 C-57 M-11 Y-100 K-0	 C-74 M-47 Y-99 K-7	 C-37 M-30 Y-99 K-0	
Hedera canariensis	 C-70 M-34 Y-100 K-0	 C-35 M-20 Y-35 K-0	 C-11 M-16 Y-36 K-0	 C-11 M-18 Y-46 K-0
Metasequoia glyptostroboides Hu et Cheng	 C-55 M-1 Y-97 K-0	 C-77 M-49 Y-100 K-11	 C-77 M-57 Y-95 K-25	 C-51 M-71 Y-100 K-16
Spiraea japonica Gold Mound	 C-69 M-36 Y-100 K-0	 C-79 M-48 Y-100 K-10	 C-11 M-6 Y-74 K-0	
Cerasus serrulata (Lindl.) G. Don ex London var. lannesiana (Carri.) Makino	 C-52 M-69 Y-100 K-16	 C-86 M-61 Y-100 K-43	 C-86 M-57 Y-100 K-33	
Salix alba L.	 C-42 M-9 Y-95 K-0	 C-71 M-48 Y-81 K-6	 C-8 M-20 Y-95 K-0	

Fig. 1. Seasonal difference of leaf color values of colorful plants in Bayi district.

In the surveyed plant community landscape, not the species abundance, affects the variability of plant landscape (Li 2018). Therefore, one should increase plant species in plant community landscape, select the plant species with good viewing characteristics, long life, rich color, beautiful shape, less disease and notice the ecological natures of plants. Besides value the introduction and popularization of excellent exotic tree species, increase beautifying effect, and improvement of the diversity of landscape function (Fig. 3 and Table 2), easy transplantation easy and crude management should be taken care.

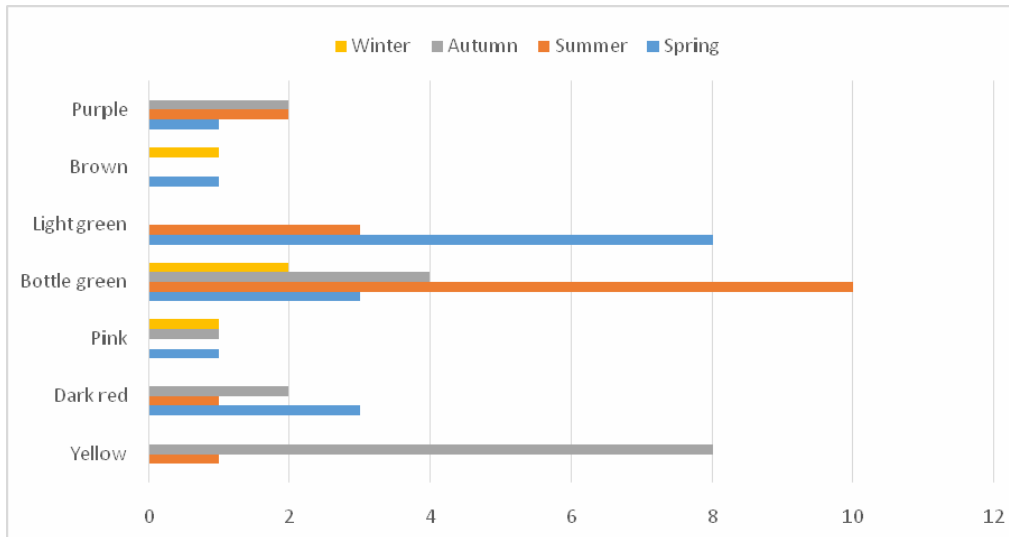


Fig. 2. Seasonal color analysis of colorful plants in Fujian park and Wetland park.



Fig. 3. The optimization of plant landscape configuration.

Fujian park has less plant species and single collocation, which is easy to make pedestrians feel aesthetic fatigue. Various plants are arranged to promote the richness of plants based on original species. From Fig. 3 and Table 2, it is apparent that, in the improved scheme, local species with better growth in Nyingchi is mainly used, to improve the richness of plants.

The level of the community refers to the vertical structure of the community. Due to the height change of plant species in the community, it makes the community stratification, and the more the community level, the richer the landscap change (Song 2001). Rational configuration of arbor, shrub, vine and herb could form stable, multiple-level, mixed and well-proportioned plant community. The improvement from plant landscape level is conducted, high and low plants are matched, and tall trees match with low shrubs and ornamental plant, one scene by one step, the plants landscape effects are further enhanced (Fig. 4).

In each period, the shape, color and volume of leaves are different, as well as the florescence, flower shape, flower color, flower appearance, and the released smell of flower, and color of plant branch also changes in different seasons (Wang 1998) (Fig. 5).

Table 2. List of plants with the optimization of plant landscape configuration.








No.	Name	Legend
1	<i>Cerasus serrulata</i> (Lindl.) G. Don ex <i>London</i> var. <i>lannesiana</i> (Carri.) Makino	
2	<i>Prunus cerasifera</i> Ehrhar f. L.	
3	<i>Quercus semecarpifolia</i> Smith	
4	<i>Magnolia grandiflora</i> Linn.	
5	<i>Ligustrum quihoui</i> Carr. f. <i>atropurea</i>	
6	<i>Buxus megistophylla</i> Levl.	
7	<i>Ligustrum quihoui</i> Carr.	












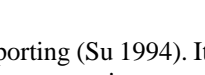
Fig. 4. Optimization effect of plant landscape level (the picture by Qiang Duan).

From Fig. 5 and Table 3 it was revealed that, in landscape architecture design of plant, one should sufficiently use seasonal change of plant and rationally arrange to create beautiful seasonal landscape. Many types of colorful plants and small shrubs are used, such as *Cerasus serrulata* (Lindl.) G. Don ex *London* var. *lannesiana* (Carri.) Makino flowering in spring, and *Ginkgo biloba* L. with golden leaves in autumn form a well-defined seasonal landscape.



Fig. 5. Seasonal optimization effect of plant landscape.

Table 3. List of plants with seasonal optimization effect of plant landscape.

No	Name	Legend
1	<i>Cerasus serrulata</i> (Lindl.) G. Don ex <i>London</i> var. <i>lannesiana</i> (Carri.) Makino	
2	<i>Sorbus rehderiana</i> Koehne	
3	<i>Chaenomeles speciosa</i> (Sweet) Nakai	
4	<i>Michelia alba</i> DC.	
5	<i>Populus tomentosa</i> Carr	
6	<i>Ginkgo biloba</i> Linn	
7	<i>Cerasus serrulata</i> (Lindl.) G. Don ex <i>London</i> var. <i>lannesiana</i> (Carri.) Makino	
8	<i>Ligustrum quihoui</i> Carr. f. <i>atropurea</i>	
9	<i>Matthiola incana</i> (L.) R. Br.	
10	<i>Buxus megistophylla</i> Levl.	

Recreation space is the place for citizens playing, sitting, walking and sporting (Su 1994). It is a main component of park green space, the landscape reachability of the plant community composed of arbor-herb, and shrub-herb is stronger, it is convenient for tourists stopping and resting. Therefore, in creation aspect of plant community landscape, it could increase rest facilities and

access road to enhance recreation function of plant landscape. In recreation scheme of plant landscape, it could properly add hydrophilic platform in the park to increase the interaction between tourists and plant landscape (Fig. 6).



Fig. 6 .Effect chart of recreation scheme of plant landscape.

From the field observation on research zone for one year, it was found that dynamic change of characteristics of color of colorful plants in Bayi district were obvious. (1) The main color of colorful plants in spring was light green, and light green > dark green and scarlet, purple, brown and pink > yellow, (2) The main color of colorful plants in summer was dark green, and dark green > light green > purple > scarlet and yellow, scarlet and yellow > pink and brown, (3) The main color of colorful plants in autumn was yellow, and yellow > dark green > purple and scarlet, purple and scarlet > pink > brown and light green, (4) The main color of colorful plants in winter was dark green, and dark green > brown and pink > purple, light green, scarlet and yellow, (5) CMYK values of the plants surveyed: the highest value of C in summer and 13 types of C values above 50, the highest value of in summer, and 9 types of M values above 50, the highest value of Y in spring, and 16 types of Y values above 50.

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References

- Cai ZY 1999. The application of *Ligustrum vicaryi* in modern garden, *Garden* **52**(4): 20.
- Geng H 2017. Exploration on the influence of seasonal change of plants on garden space. *Modern Horticult.* **4**(2): 124.
- Jia M, Jin HX and Wang SF 2016. On the progress of research of landscape plant volatile compounds and their influence on human health in rehabilitation landscape, *Chin. Landscape Archit.* **32**(12): 26-31.
- Jiang Y and Zhang HS 2017. Running in the beautiful four seasons-the plant design for the 5th and 6th sections of the Olympic forest park, *Chin. Landscape Architect.* **33**(6): 67-71.

- Kang ZL 2017. Colorful *Prunus cerasifera*. Flower Plant & Potter Landscape **497**(1): 30-31.
- Li GY 2018. Application of colorful plants in garden landscape design. Modern Agri. Sci. Tech. **1**: 49-50.
- Li YP 2016. Cuttage breeding technology of twigs of *Acer Pubrum*. Protection Forest Sci. Tech. **432**(1): 119-120.
- Ma XC 2016. Cultivation management technology of *Berberis thunbergii*. Agricultural Technology Service, **33**(8): 161.
- Pei YJ, Li G and Li GY 2010. Cultivation technology of *Liriodendron tulipifera*. Modern Agri. Sci. Tech., **226**(5): 180-182.
- Song YC 2001. Vegetation Ecology .Shanghai: East China Normal University Press. 46-51.
- Su XH 1994. Plant Landscape. Beijing: China Forestry Press. 87-93.
- Tian FF 2016. Occurrence damage and control measures of main pests of *Platanus occidentalis*. J. Hebei Forest. Sci. Tech. **209**(4): 104-107.
- Tian L 2003. Cuttage breeding technology of new shoots of *Spiraea japonica*. J. Liaoning Forest. Sci. Tech. **108**(2): 42-43.
- Wang BS 1998. Urban Vegetation and Urban Vegetology. Acta Scientiarum Naturalium Universitatis Sunyatseni. **37**(4): 9-11.
- Xu MS 1987. Showy ivy. China Flower & Potted Landscape **331**(11):11.
- Yu X, Deng RY and Wang XL 2013. Cultivation and garden application of *Met sequoia glyptostroboides*. Modern Agri. Sci. Tech. **460**(12): 52.
- Zhao DL and Chen HJ 2018, Application skills of colorful plants in garden landscape design. Molecul. Plant Breeding **16**(9): 3085-3090.

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