Journal of Landscape Research 2024, 16(3): 63-65, 69

Diversity and Application of Herbaceous Flowers in Urban Road Greening in Hefei City

HU Wenjuan, ZHAO Zhiyan*, WU Qian, XU Huaxue

(Department of Architecture and Landscape Design, Anhui Xinhua University, Hefei, Anhui 230088, China)

Abstract In urban road greening, the planting of ground cover flowers is essential, and herbaceous flowers are an important part. Through the investigation on the diversity of herbaceous flowers in urban road green spaces of Hefei City, the types, colors, application frequency and planting of herbaceous flowers in urban road green spaces were statistically analyzed, and the application forms of herbaceous flowers in the road greening of Hefei City were studied. The characteristics and problems of herbaceous flowers in the road greening of Hefei City were found, and some development suggestions were put forward.

Keywords Urban road green space, Herbaceous flowers, Diversity, Application form, Hefei City

DOI 10.16785/j.issn 1943-989x.2024.3.013

Since the 18th National Congress of the Communist Party of China, the forestry and garden department of Hefei City has adhered to the goal of creating a national ecological garden city, scientifically promoted land greening, strengthened ecological protection and restoration, and improved the quality of urban landscaping. Under this background, Hefei City actively implements the concept of "park city" and continuously promotes urban landscaping. As an important part of street greening, herbaceous flowers are worthy of further study, popularization and application. In 2023, herbaceous flowers used in the greening of main roads in Hefei City was investigated, and their diversity and application forms were studied to provide ideas for the application of herbaceous flowers in the greening of urban roads in Hefei City.

1 Research method

From January to December in 2023, herbaceous flowers used in the road greening of Hefei City were investigated, and the types, application frequency, color ratio, ornamental effect, growth adaptability and planting methods of these herbaceous flowers were analyzed. Besides, the problems and optimization plans for the application of herbaceous flowers in the road greening of Hefei City were summarized. Among them, the formula of the frequency is as follows: f=(the number of quadrats of a certain plant/the number of all quadrats)×100%.

2 Species of herbaceous flowers

As can be seen from Table 1, there are a total of 45 species of herbaceous flowers in nearly 50 road green spaces surveyed. Among them, there are 14 species of annual and biennial herbaceous flowers, accounting for nearly 30%, and there are 31 species of perennial herbaceous flowers, accounting for nearly 69%. Among the perennial herbaceous flowers, there are 24 perennial flowers (accounting for nearly 53%) and 6 bulbous flowers (accounting for nearly 13%). In conclusion, the main herbaceous flowers used for urban road greening in Hefei include perennial flowers, followed by annual and biennial flowers, while the proportion of bulbous flowers is the lowest. Flower color is of great significance to ornamental value. Urban roads are mostly gray, and will be single and dull if too much gray is applied. At this time, it is very important to adjust the color through herbaceous flowers in road greening[1].

According to the field investigation, it is found that among the flowers used in the green spaces of urban roads in Hefei, there are 12 kinds of purple flowers, accounting for about 27%. There are few polychromatic flowers, among which there are 3 kinds of yellow-green flowers, accounting for about 7%, and there are 2 kinds of blue-purple flowers, accounting for about 4%. From the perspective of color application of herbaceous flowers in Hefei City, most of the road greening adopts the form of multicolor superposition. For example, different colors of *Viola tricolor* is used in most roads to enrich the color of road greening spaces, but this application method may lead to insufficient color level, brightness and saturation of color, resulting in the absence of landscape cultural characteristics and personality forms, and failing to form a good visual impact[2].

From the perspective of application frequency, the application frequency of *V. tricolor* and *Viola cornuta* is very high in the urban road greening of Hefei City, and the utilization rate accounts for nearly 100%. There are 7 kinds of other herbaceous flowers with high frequency, accounting for 15.5%. There are 5 kinds of herbaceous flowers with low frequency, accounting for 11.1%. These herbaceous flowers with low frequency are mostly used in flower borders, but do not exist in other forms of application. At the same time, they are distributed intensively.

According to the survey, there are limited species of herbaceous flowers applied in the urban road greening of Hefei City, and the overall greening level is relatively simple. Meanwhile, the overall flower border is less applied beside roads, and most of them still use traditional simple green belts and hedges for road greening. Herbaceous flowers are relatively short, and are generally used for bottom and paving greening, which plays an important role in the improvement of urban green land rate[3].

It is concluded that the distribution of herbaceous flowers in the road greening of Hefei City is uneven. The use frequency of some herbaceous flowers is too high, while the use frequency of some other herbaceous flowers is too low. The application form of most herbaceous flowers is single. Meanwhile, it is found that there are invasive alien species in the urban road greening of Hefei City. For example, *Solidago canadensis* can be found in the many green belts of urban roads in Hefei City, and its survival rate is high.

Received: June 3, 2024 Accepted: June 3, 2024

Sponsored by the Innovation Training Project for College Students in Anhui Province (S202212216130); Key Research Project of Natural Science in Universities of Anhui Province (2023AH051816); General Teaching Research Project of Anhui Province (2022jyxm665).

* Corresponding author.

3 Application forms of herbaceous flowers

3.1 Flower shrubs

Different kinds of herbaceous flowers naturally form flower shrubs. The corresponding arrangement is usually carried out in combination with road design, building edge, underforest rest space, lawn, water landscape, sculpture and other structures[4]. In order to reflect the diversity of herbaceous flowers, one or two kinds of herbaceous flowers are generally selected as the main flowers, and then combine with other colors and styles of flowers to build the landscape. For example, the roadside flower shrubs at the intersection of Mingguang Road and North 1st Ring Road in Luyang District, Hefei City are mainly composed of annual purple *V. tricolor* and purple and white *B. oleracea*, in which there were *Rosmarinus officinalis* L., *F. japonicum*, *L. platyphylla*, *Oxalis triangularis* 'Urpurea', *A. viridiflora*, *C. selloana*, *Nandina domestica* Thunb., as well as common shrubs such as *Pittosporum tobira* (Thunb.) W. T. Aiton and *Photinia×fraseri*. The main colors are purple, white and green. This arrangement can not only avoid the monotony of the central green space at the intersection, but also has good turning road directivity. At the same time, the past people can see the rich layers of flower shrubs in every angle, and regular artificial environment can be harmonized and softened.

3.2 Flower beds

As a regular form of flower arrangement, flower beds are generally located in an important nodal or oriented green space. Through the investigation, it is found that in the triangle road green space at the intersection of Shouchun Road and Funan Road beside Xinghua Park in Luyang District, Hefei City, *S. splendens*,

Table 1 Statistical list of herbaceous flowers used for road greening in Hefei City

No.	Herbaceous flower	Family	Flower color	Frequency//%	Type	Planting range
1	*Viola tricolor*	Violaceae	Multicolor	100	Biennial	Flower border, flower bed, flowering shrub, and flower pot
2	*Drymaria cordata*	Caryophyllaceae	White	6	Annual	Flowering shrub and lower border
3	*Viola cornuta*	Violaceae	Multicolor	100	Biennial	Flower bed, flowering shrub, and flower border
4	*Salvia splendens*	Labiatidae	Red	46	Annual	Flower bed, flowering shrub, flower stand
5	*Ipomoea nill*	Convolvulaceae	Pink, and blue purple	62	Annual	Flower bed, flower pot, and flower border
6	*Petunia hybrida*	Solanaceae	Multicolor	48	Annual	Flower bed, flower pot, and flower border
7	*Impatiens balsamina*	Balsaminaceae	Pink and red	30	Annual	Flower border, and flowering shrub
8	*Catharanthus roseus*	Apocynaceae	Pink	34	Annual	Flower border, and flowering shrub
9	*Zinnia elegans*	Compositae	Red and yellow	42	Annual	Flower bed, flowering shrub, and flower stand
10	*Bellis perennis*	Compositae	White	70	Annual	Flower border, flowering shrub, and flower stand
11	*Papaver rhoeas*	Papaveraceae	Pink and red	18	Annual	Flower border
12	*Consolida ajacis*	Ranunculaceae	Purple and blue	32	Annual	Flower border, and flowering shrub
13	*Calendula officinalis*	Compositae	Orange	52	Annual	Flower border, flower stand, and flower bed
14	*Mauranthemum paludosum*	Compositae	White	30	Biennial	Flower border, and flowering shrub
15	*Cortaderia selloana*	Gramineae	Pink	46	Perennial flowers	Flower border
16	*Acorus gramineus*	Acoraceae	Yellow green	26	Perennial flowers	Flower border
17	*Farfugium japonicum*	Compositae	Yellow green and yellow	82	Perennial flowers	Flower border, flower bed, and flowering shrub
18	*Brassica oleracea*	Brassicaceae	Purple and white	90	Perennial flowers	Flower border, flower stand, and flower bed
19	*Liriope platyphylla*	Asparagaceae	Purple	52	Perennial flowers	Flower border, flowering shrub, and flower bed
20	*Liriope spicata*	Asparagaceae	Blue and purple	4	Perennial flowers	Flower border, flowering shrub, and flower bed
21	*Lavandula anguistifolia*	Labiatidae	Purple	4	Perennial flowers	Flower border
22	*Oxalis triangularis*	Oxalidaceae	Purple and white	50	Perennial flowers	Flower border, flowering shrub, and flower bed
23	*Aquilegia viridiflora*	Ranunculaceae	Yellow green	28	Perennial flowers	Flower border, flowering shrub, and flower bed
24	*Oxalis corymbosa*	Oxalidaceae	Pink	42	Perennial flowers	Flower border, flowering shrub, and flower bed
25	*Alcea rosea*	Malvaceae	Pink and purple	50	Perennial flowers	Flower border, and flowering shrub
26	*Dianthus chinensis*	Caryophyllaceae	Pink	64	Perennial flowers	Flower border, flowering shrub, and flower bed
27	*Phlox subulata*	Polemoniaceae	Pink	24	Perennial flowers	Flower border, flowering shrub, and flower stand
28	*Clematis florida*	Ranunculaceae	Purple	18	Perennial flowers	Flower border
29	*Solidago canadensis*	Compositae	Yellow	70	Perennial flowers	Flower border, and flowering shrub
30	*Coleus scutellarioides*	Labiatidae	Purple and green	84	Perennial flowers	Flower border, flowering shrub, and flower bed
31	*Sedum hyridun*	Crassulaceae	Yellow green	46	Perennial flowers	Flower border, and flowering shrub
32	*Phlox paniculata*	Polemoniaceae	Pink and purple	42	Perennial flowers	Flower border, flowering shrub, and flower bed
33	*Leucanthemum maximum*	Compositae	White	50	Perennial flowers	Flower border, flowering shrub, flower bed, and flower stand
34	*Salvia leucantha*	Labiatidae	Purple	30	Perennial flowers	Flower border, and flowering shrub
35	*Oenothera speciosa*	Onagraceae	Pink	34	Perennial flowers	Flower border, flowering shrub, and flower bed
36	*Glandularia×hybrida*	Verbenaceae	Pink	66	Perennial flowers	Flower border, flowering shrub, and flower bed
37	*Veronica didyma*	Plantaginaceae	Purple	62	Perennial flowers	Flower border, and flowering shrub
38	*Dianthus deltoides*	Caryophyllaceae	Red	32	Perennial flowers	Flower border, and flowering shrub
39	*Jacobaea maritima*	Compositae	Yellow and orange	64	Perennial flowers	Flower border, flowering shrub, flower bed, and flower stand
40	*Tulipa gesneriana*	Liliaceae	Red, white and pink	26	Bulbous flowers	Flower border, and flowering shrub
41	*Dahlia pinnata*	Compositae	Orange and pink	50	Bulbous flowers	Flower border, flowering shrub, and flower bed
42	*Allium giganteum*	Amaryllidaceae	Pink and white	62	Bulbous flowers	Flower border, flowering shrub, and flower bed
43	*Dutchlris*	Iridaceae	Bluish violet	52	Bulbous flowers	Flower border, and flowering shrub
44	*Hosta plantaginea*	Asparagaceae	White	52	Bulbous flowers	Flower border, and flowering shrub
45	*Cannaceae generalis*	Cannaceae	Red and yellow	28	Bulbous flowers	Flower border, and flowering shrub

Celosia cristata L., *V. tricolor*, and *G.×hybrida* form a colorful pattern of flower beds. On the government ring road of Hefei Municipal Government Service Center and the South Second Ring Road separating the Citizens Square, Fuyang Road to the west of the old City Square, there are pattern flower beds in the middle green area of the roads. There are three-dimensional flower beds in the three-dimensional cross green island green space at the intersection of West Second Ring Road and Huangshan Road in Hefei City, as well as the oriented green space at the intersection of Shouchun Road and Funan Road.

3.3 Flower borders

Flower borders are mainly composed of perennial and bulbous flowers, where there are some annual and biennial herbaceous flowers and a small number of flower shrubs and ornamental small trees with ornamental value. They are generally located in green belts along urban roads or central islands, guiding islands and other green spaces. Through the investigation, it is found that most flower borders along roads in the old town of Hefei are mostly located in the Ring Road and Changjiang Middle Road, and a few are located along Huizhou Avenue and Jinzhai Road. In New Municipal and Culture District, flower borders are mainly distributed along the roads around Swan Lake and Hefei Municipal People's Government. In addition, flower borders are also concentrated along roads near Luogang Central Park in Baohe District and the Dashu Mountain and Sijihuahai Park in Gaoxin District.

In the spring, flower borders are mostly composed of *V. tricolor*, *P. hybrida*, carnation and sedum flowers, shrubs such as *Photinia×fraseri*, *N. domestica* Thunb., small trees such as Acer palmatum Thunb., stones and landscape walls. In the summer, flower borders are mostly composed of *V. tricolor*, *Gladiolus×gandavensis* Van Houtte, *Farfugium japonicum* (L. f.) Kitam. and other paving plants. In the autumn, they are mainly composed of lower *C. officinalis*, *V. tricolor*, *Z. elegans*, *G.×hybrida*, *Tagetes erecta* L., as well as higher Salvia flowers. In the winter, the form is relatively simple, and they are generally composed of *J. maritima*, *V. tricolor*, and *B. oleracea* of different colors.

3.4 Flower pots

Flower pots are generally containers containing herbaceous flowers and a small amount of flowering shrubs[5]. For example, in front of Hefei Yintai Central Square at the intersection of Changjiang Middle Road and Behanshan Road in Hefei City, there are wooden flower pots, in which purple and yellow *V. tricolor* are planted. There are also flower pots on both sides of Nanhanshan Road. It is found that the arrangement of flower pots and roadblocks at the elevated entrance is more common in the road greening of Hefei City. From the entrance of the South First Ring Road of Changjiang West Road Viaduct to Wulidun Overpass, flower pots are used for greening.

4 Problems in the application of herbaceous flowers in Hefei City

4.1 The utilization rate of herbaceous flowers is low

According to the investigation and research, the utilization rate of herbaceous flowers in urban road greening in Hefei City is low, and the regional distribution is not uniform. The roads in the old urban area of Hefei City are mainly planted with shrubs, and the green belts of most roads are composed of single *P. tobira* (Thunb.) W. T. Aiton, *Loropetalum chinense* var. rubrum Yieh, and *Photinia×fraseri*. Most of the herbaceous flowers exist in the form of flower borders, and are mainly distributed in Changjiang Road. The frequency of use is high or low. In recent years, the utilization rate was still not high in the urban road green space of the newly built districts such as Xinzhan District, western High-tech District, southern New Municipal and Culture District, and Binhu New District.

4.2 The application form of herbaceous flowers is relatively simple

There are many application forms of herbaceous flowers in landscaping, such as flower beds, flower pots, flower beds, flower boxes, flower borders, etc[6]. However, the investigation show that the form of herbaceous flowers used in road greening in Hefei is relatively simple. Nearly 50% of them exist in flower borders, and nearly 40% of them exist in flower beds. A small amount of the rest exists in the flower stands and pots, and most of them are used as the form of scenery. A small number of them are used in the festival flower beds in the squares of government offices such as the People's Government of Hefei City in New Municipal and Culture District and the provincial government in Binhu New District, and colorful herbaceous flowers are mainly used, and lines are formed through color matching to form patterns.

4.3 The survival rate of herbaceous flowers in road greening belts is lower

The adaptability of herbaceous flowers to the environment is weak, and the environment of urban road greening is often poor, so the survival rate of herbaceous flowers is low[7]. Some newly built urban road green spaces of Hefei City are planted with many new varieties of herbaceous flowers, but with the growth of time, there are problems in the growth of these herbaceous flowers. For instance, they are yellow and even wilt, but dead flowers have not been replaced in time.

4.4 The change frequency of herbaceous flowers is low

In the survey, it is found that the change frequency of herbaceous flowers in urban road greening of Hefei City is low, and most replacement periods are seasonal changes between winter and spring, as well as autumn and winter. The survey in the past year show that the herbaceous flowers in many road greening spaces such as pocket park at the intersection of Changjiang Middle Road and Tongcheng Road are not replaced in time. At the beginning of 2023, the green space was rich in herbaceous flowers. However, because of not being replaced in time, the herbaceous flowers in this plot grew disorderly at the end of the year, affecting the landscape benefits of this plot.

5 Suggestions

5.1 Using 3S system to solve problems scientifically

The difference of spatial structure and ecological benefit of herbaceous flowers along roads can be better reflected by the estimation of three-dimensional quantity of greening. Attempts are made to measure the color density of herbaceous flowers by using colorful red aerial film[8]. The use of color red aerial film can detect the damage of plants earlier than the naked eyes. For instance, when the content of sulfur dioxide in the air around urban roads exceeds the standard, it can be found by color red aerial film in advance, thus improving the survival rate of herbaceous flowers in urban road green spaces.

5.2 Improving the survival rate of herbaceous flowers used for road greening

5.2.1 Paying attention to the selection of flowers, and choosing native tree species or improved flowers[5]. In the selection of flowers, local native flowers are mainly adopted, and domesticated exotic and wild flowers are selected appropriately, which can avoid the trouble of overseas procurement and transportation and the spread of foreign diseases and pests. In addition, local flowers can also better reflect local characteristics, and highlight the local style of Hefei City.

5.2.2 Regularly repairing and maintaining herbaceous flowers used for road greening by municipal departments. The management of

(To be continued in P69)

above the pruning wound; if it is too close, the pruning wound buds are prone to losing water and being dried to death. In the selection of pruning wound buds, full consideration should be given to the growth of the branches to be pruned and the distribution of the branches within the tree crown. If you want to suppress the vigorous growth of the branches, weak buds can be kept as pruning wound buds; otherwise, full and strong buds can be kept as pruning wound buds[6].

4.4 Not paying attention to protecting the wound

Neglecting wound protection is a common problem, and even relying entirely on wound self-healing can lead to infection in larger wounds, gradually spreading the scope of infection. Not only does it fail to achieve optimal pruning, but it also requires subsequent treatment. Or because the wound is too large and loses water too quickly, nearby living tissues may dry up and form dead branches. Therefore, it should choose the appropriate scissors when pruning based on the thickness of the branches, determine the position, angle, and cut with force in one go to achieve a smooth and non cracking cross-section. This way, the wound is small and easy to heal. This requires regular maintenance of tools such as scissors to maintain their sharp edges and good performance. Pruning should not be carried out on rainy days. After pruning, it does not water immediately. Large wounds caused by pruning should be promptly coated with protective agents, sterilized, and treated with waterproofing.

4.5 Neglecting the aesthetic characteristics of *P. mume*

The texture of the trunk and branches of *P. mume* trees is dry and hard; the flowers are small and bloom before the leaves, suitable for creating an old but vibrant landscape, giving people the joy and excitement of withered trees blooming. Fan Chengda in Song Dynasty summarized the essentials of appreciating plum blossoms and also pointed out the direction for pruning, shaping, and landscaping of plum blossoms. Although Gong Zizhen in Qing Dynasty used "sick plum" as a metaphor for political affairs, it also expressed the aesthetic standards of plum blossoms. So plum blossoms are beautiful in terms of slanting, curved, sparse, and thin. *P. mume* is not only a type of plum, but also needs to be pruned in accordance with the above aesthetic principles. And its branches are naturally twisted, resembling the tree shape of a swimming dragon, and creating a linear beauty of swimming. At the same time, the dragon is a symbol of the Chinese nation, which further enhances its affinity. When pruning, twisted and peculiar parts should be preserved to the greatest extent possible, and reasonable utilization should be made in the shaping concept. Pruning is a process of shaping shape, which should comprehensively consider the biological and aesthetic characteristics of plum blossoms, as well as the twisted characteristics of *P. mume*, in order to maintain their beautiful form and promote healthy growth. Especially when pruning, it does not leave branches too dense, otherwise the branches will twist and crowded together, making the curly posture invisible.

5 Conclusions

In summary, pruning is an important task in the maintenance of *P. mume*, with many methods and different effects. It should be flexibly applied in different stages of *P. mume* growth, taking into account its growth status, aesthetic characteristics, and other factors. At the same time, it should strengthen water and fertilizer management, pest control and other maintenance work, to cultivate high-quality *P. mume*.

References

[1] Ma, D. J. (2021). Study on the importance and technology of garden tree pruning and maintenance. *Modern Agriculture Research*, *27*(4), 102-103.

[2] Li, Y., Li, Z. Q. & Li, Y. W. et al. (2023). *Diagram of tree shaping and pruning techniques*. Beijing: Chemical Industry Press.

[3] Ai, M. (2021). Since ancient times, plum blossom bonsai has been highly favored. Have you ever experienced the beauty of plum blossom bonsai. *Flower Plant & Penjing*, (12), 58-61.

[4] Chen, J. Y., Liu, J. & Wang, D. F. et al. (2005). *Plum blossom*. Beijing: Beijing Changping Baishan Printing Factory.

[5] Wu, Y. F. (2008). Key techniques for shaping and pruning garden trees. *Agricultural Technology Service*, *25*(1), 109-110.

[6] Wang, J., Xiao, R. (2015). Importance and technical analysis of pruning and maintenance of garden trees. *Science and Wealth*, *7*(22), 199-200.

****

(Continued from P65)

herbaceous flowers by municipal departments should be enhanced, and relevant personnel can be organized to conduct irregular learning and training to understand the repair and maintenance knowledge of herbaceous flowers.

5.3 Mainly using flowers that are resistant to harmful gases

Urban roads belong to the gray area of a city, so the herbaceous flowers used in urban road greening should have strong ecological adaptability, and it is recommended to choose grade-A or grade-B flowers with strong resistance in urban road greening, such as *Dianthus chinensis*, *Oxalis corniculata* L., and *Calendula officinalis* with strong resistance to sulfur dioxide carnation, as well as *Begonia grandis* Dryand., and *Ipomoea nil* (L.) Roth with strong resistance to hydrogen fluoride. Meanwhile, some herbaceous flowers that can monitor atmospheric pollution can be chosen, such as *P. hybrida* that can monitor ozone, *Z. elegans* that can monitor chlorine, and *B. grandis* Dryand. that can monitor nitrogen oxides. Thus, the pollution problems in roads can be found and solved in time, and the ecological benefits of herbaceous flowers can be enhanced.

References

[1] Liu, Y. (2020). *Garden floriculture*. Beijing: China Forestry Press.

[2] Liu, Z. D. (2021). *Principles of landscape architecture design*. Wuhan: Huazhong University of Science and Technology Press.

[3] Xu, Y. S., Gao, H. L. & Wang, X. H. (2006). Study on the development status and countermeasures of wild flowers. *Contemporary Horticulture*, (2), 7-8.

[4] Yue, J. F. (2012). Application of flowers in urban landscape. *Modern Agricultural Science and Technology*, (23), 172-173.

[5] Zhao, Z. Y., Ling, L. H. & Xia, D. Y. et al. (2021). Evaluation of flower border landscape application value of 45 wild herbaceous plants in Hefei. *Journal of Xinyang Agriculture and Forestry University*, (1), 93-98.

[6] Yang, S. J., Tang, L. H. & Zhao, H. T. et al. (2022). Construction and application of evaluation system for introduction and selection of ornamental grass and flowers in Guiyang. *Guizhou Agricultural Sciences*, (6), 85-93.

[7] Hua, C. X., Lei, T. & Huang, B. X. et al. (2024). Comprehensive evaluation of flower border landscape of Beilonghu Wetland Park in Zhengzhou City. *Forest Inventory and Planning*, (2), 66-75.

[8] Sheng, Z. Z., Yu, X. Y. & Dong, J. L. et al. (2016). Landscape application of herbaceous flowers in Changsha. *Hunan Agricultural Sciences*, (3), 74-78.