Comprehensive Evaluation of Application Value of Wild Flower Resources in Flower Border in Hefei City

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Abstract In order to further understand and better develop and utilize wild flower resources in Hefei City, a comprehensive evaluation model of landscape value of wild flowers in the application of flower border was constructed by field investigation and analytic hierarchy process (AHP). The application value of wild flowers in Hefei was evaluated by selecting evaluation indicators from three aspects of ornamental value, adaptability and resource potential.

Keywords Analytic hierarchy process (AHP); Wild flower resources; Application value; Comprehensive evaluation

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China is rich in wild plant resources and has a wide variety of species, but many wild plants with unique ornamental properties and application prospects have not been paid attention to, developed and utilized[1]. Flower border has a broad development space, and provides a market for the development and promotion of wild plant resources. Wild flower resources have the advantages of strong adaptability, safe and convenient introduction, and resistance to extensive management, and have great application potential in China's flower border[2-3]. Wild flowers are ornamental plants with development value in a natural and spontaneous state, and are also an important part of unique natural landscape, ecological environment and biodiversity[4]. In this paper, analytic hierarchy process (AHP) was used to establish a comprehensive evaluation system for the landscape value of wild flower resources, so as to provide a scientific basis for the selection and application of urban wild flower resources and a reference for the development of native flower resources in Hefei.

1 Establishment and evaluation process of evaluation system based on AHP

1.1 Establishment of a comprehensive evaluation model

The landscape value of wild flower resources in the application of flower border was evaluated by AHP. Firstly, according to previous studies[6-8] as well as relevant characteristics of wild flowers and the requirements of plants applied in flower border, the comprehensive evaluation of application of wild flowers was as the target layer A, and the ornamental value, adaptability and resource potential was as the criterion layer C; 16 evaluation factors were selected as the specific evaluation indicators to construct a comprehensive evaluation model of application value of wild flower resources in flower border (Table 1). Secondly, the weight (W) of each indicator was calculated by using pairwise comparison method and 1−9 scale, and the consistency test of the judgment matrix was carried out. The weight value of each evaluation indicator was weighted with the weight of the criterion layer, and the total ranking weight was obtained. Finally, according to the evaluation criteria of 1−3 score system, the total ranking weight of the evaluation indicators and the score of a specific indicator were weighted to obtain the comprehensive evaluation value of wild flowers[9]. AHP, a multi-criteria decision-making method applicable to the evaluation of factors that are difficult to fully quantify, organically combines qualitative and quantitative analysis, and has been widely used in China at present[10-11].

1.2 Evaluation method and establishment of hierarchical structure

According to the characteristics of wild flowers and people's aesthetic and artistic characteristics, a comprehensive evaluation model with 4-layer progressive hierarchy structure was established by AHP. The landscape value of investigated wild flowers was as the target layer (A); the ornamental value, adaptability and resource potential of the plants were as the criterion layer (C). Under the criterion layer, the indicator layer (D) consisting of 16 evaluation factors was set. Finally, 31 species of herbaceous plants to be evaluated constituted the programme layer (D).

1.3 Construction of judgment matrix and consistency test

In AHP, the establishment of the basic information of each evaluation factor is the basis for constructing the judgment matrix and testing its consistency. Based on the survey data and extensive consultation with relevant personnel, the 1-9 ratio scaling method was used to construct pairwise comparison judgment matrix for the three factors of the criterion layer and the indicators of each criterion layer, and the consistency test was carried out (Table 1).

$CR < 0.1$ means that a judgment matrix passes the consistency test. As can be seen from Table 1, the *CR* values of the four constructed judgment matrices are all less than 0.1, so they pass the consistency test, and the weight is reasonable.

1.4 Calculation of the total ranking weight of hierarchy

The weight of the relative importance of each specific evaluation indicator (P) relative to the target layer (A) was calculated by weighting, so as to calculate the total ranking weight of hierarchy (Table 2).

1.5 Establishment of scoring criteria for plant materials

The scoring criteria for plant materials are shown in plant materials (Table 3).

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1.6 Evaluation results and grading

The score of each indicator was weighted with the weight of each evaluation indicator, and the score result *Vj* and the total ranking weight *Wj* were calculated to obtain the comprehensive evaluation value *Mj* of wild flowers finally. It can be divided into three grades: grade I ($J \geqslant 2.6$), grade II ($2.4 \leqslant J < 2.6$), and grade III ($J < 2.4$). According to the results of comprehensive evaluation (Table 4), the application value of wild flower resources at grade I was high, and there are 10 species; that of wild flower resources at grade II was relatively high, and there were 17 species. Four species of wild flower resources at grade III have general application value.

2 Results of comprehensive evaluation and discussion

The evaluation system of application landscape value of wild flower resources was established based on AHP. Seen from the evaluation results, 10 species of wild flower resources at grade I have high application value, including *L. amplexicaule*, *V. phillipina* and *V. persica*, etc. These flower resources have unique ornamental characteristics and adaptability, as well as high application value, and can be widely used in flower border resources. 17 kinds of flowers at grade II have high application value, including *L. chinensis*, *R. ternatus*, *R. dubia*, etc., but they are not suitable for large-scale application due to poor environmental adaptability and scarce resources. The plants at grade III have general application value, including *Polygonum lapathifolium*, *C. yanhusuo*, *P. depressa*, etc. Their common characteristics are low ornamental value, and some of them have weak adaptability to the surrounding environment, so the comprehensive score is not high.

Due to the lack of relevant research on the potential value of wild flowers and the immature cultivation technology of wild flowers, the application of wild flowers in flower border is still less. According to the comprehensive evaluation results of landscape value of wild flowers, wild flowers at grade I should be mainly developed in the application process. In the

Table 1 Judgment matrix and weight

Hierarchical model		Judgment matrix and its scale							W	Consistency test
A-C		C_1	C_2	C_3						
	C_1 Ornamental value	1	3	5					0.648	λ_{max}=3.004
	C_2 Adaptability	1/3	1	2					0.230	*CI*=0.002
	C_3 Resource potential	1/5	1/2	1					0.122	*CR*=0.004
C_1–P		P_1	P_2	P_3	P_4	P_5	P_6	P_7		
	P_1 Plant type	1	1/4	1/3	1/5	1/2	3	2	0.066	
	P_2 Flowering stage	4	1	2	1/2	4	7	6	0.258	λ_{max}=7.368
	P_3 Green stage	3	1/2	1	1/3	2	6	4	0.160	*CI*=0.061
	P_4 Flower viewing effect	5	2	3	1	3	9	7	0.350	*CR*=0.045
	P_5 Leaf viewing effect	2	1/4	1/2	1/3	1	3	2	0.092	
	P_6 Fruit viewing effect	1/3	1/7	1/6	1/9	1/3	1	1/2	0.029	
	P_7 Fragrance	1/2	1/6	1/4	1/7	1/2	2	1	0.044	
C_2–P		P_8	P_9	P_{10}	P_{11}	P_{12}				
	P_8 Cold resistance	1	5	1/2	1/3	3			0.172	λ_{max}=5.136
	P_9 Heat resistance	1/5	1	1/6	1/7	1/3			0.041	*CI*=0.034
	P_{10} Drought tolerance	2	6	1	1/2	4			0.278	*CR*=0.030
	P_{11} Disease resistance	3	7	2	1	5			0.429	
	P_{12} Salt and alkali resistance	1/3	3	1/4	1/5	1			0.081	
C_3–P		P_{13}	P_{14}	P_{15}	P_{16}					
	P_{13} Number of resources	1	4	3	1/2				0.287	λ_{max}=4.081
	P_{14} Regenerative capacity	1/4	1	1/3	1/7				0.061	*CI*=0.027
	P_{15} Difficulty of reproduction	1/3	3	1	1/5				0.123	*CR*=0.030
	P_{16} Diffusion velocity	2	7	5	1				0.530	

Table 2 Total ranking of hierarchy

Layer A	LayerC	W	Layer P	W	Total ranking weight	Oder
A	C_1	0.648	P_1	0.066	0.043	8
			P_2	0.258	0.167	2
			P_3	0.160	0.104	3
			P_4	0.350	0.227	1
			P_5	0.092	0.060	7
			P_6	0.029	0.019	12
			P_7	0.044	0.029	11
	C_2	0.230	P_8	0.172	0.040	9
			P_9	0.041	0.009	15
			P_{10}	0.278	0.064	6
			P_{11}	0.429	0.099	4
			P_{12}	0.081	0.019	13
	C_3	0.122	P_{13}	0.287	0.035	10
			P_{14}	0.061	0.007	16
			P_{15}	0.123	0.015	14
			P_{16}	0.530	0.065	5

Table 3 Comprehensive evaluation criteria of wild flower landscape

Evaluation indicator	Score		
	3	2	1
Plant type	Compact and graceful	More compact and average in effect	Loose and bad group effect
Flowering stage	More than 3 months	More than 1 month, and less than 3 months	Less than 1 month
Green stage	Evergreen	Dry period is about 3 months	Dry period is 5 months or more
Flower viewing effect	Strange, larger, more and colorful flowers	Ordinary flowers in type and color	Low ornamental value
Leaf viewing effect	Peculiar leaves in shape, color and mottled leaves	Average leaves in shape and color	Poor leaves in shape and color
Fruit viewing effect	Bright and strange in appearance	Normal	No ornamental value
Fragrance	Pleasant smell	Fragrant	No fragrance
Cold resistance	Strong freezing resistance, and no freezing injury	Relatively strong, and no frost injury in a general year	Prone to frost injury
Heat resistance	Strong heat resistance	Relatively strong heat resistance, and being restored after sunburn	Poor heat resistance
Drought tolerance	Strong drought resistance, and less watering	Needing watering due to long drought	Weak drought resistance, and needing watering frequently
Disease resistance	Healthy growth, and not easy to suffer diseases	Diseases do not affect growth	Prone to diseases, and affecting growth
Salt and alkali resistance	Strong	Relatively strong	Weak
Number of resources	Rich	General	Sparse
Regenerative capacity	Strong	General	Weak, not easy to recover
Difficulty of reproduction	Underutilized	General	Difficult reproduction, and harsh conditions
Diffusion velocity	Not easy to diffuse	Average diffusion velocity	Easy to spread to affect the overall landscape

Table 4 Comprehensive evaluation and ranking of wild flower landscape

No.	Wild flowers	Family	Score	Grade
1	*Tulipa edulis*	Liliaceae	2.099	III
2	*Lamium amplexicaule*	Primulaceae	2.657	I
3	*Plantago depressa*	Plantaginaceae	2.305	III
4	*Lamium barbatum*	Lamiaceae	2.648	I
5	*Euphorbia helioscopia*	Euphorbiaceae	2.527	II
6	*Viciase pium*	Fabaceae	2.624	I
7	*Astragalus sinicus*	Fabaceae	2.597	II
8	*Medicago sativa*	Fabaceae	2.505	II
9	*Stephania japonica*	Menispermaceae	2.499	II
10	*Viola phillipina*	Violaceae	2.603	I
11	*Veronica persica*	Violaceae	2.677	I
12	*Viola patrinii*	Violaceae	2.672	I
13	*Lobelia chinensis*	Campanulaceae	2.496	II
14	*Taraxacum mongolicum*	Campanulaceae	2.585	II
15	*Lactuca indica*	Campanulaceae	2.621	I
16	*Erigeron annuus*	Campanulaceae	2.637	I
17	*Cirsium japonicum*	Campanulaceae	2.534	I
18	*Rostellularia procumbens*	Acanthaceae	2.531	II
19	*Polygonum lapathifolium*	Polygonaceae	2.324	III
20	*Aristolochia debilis*	Aristolochiaceae	2.493	II
21	*Ranunculus ternatus*	Ranunculaceae	2.491	II
22	*Ranunculus japonicus*	Ranunculaceae	2.610	II
23	*Clematis heracleifolia*	Ranunculaceae	2.538	II
24	*Paederia scandens*	Rubiaceae	2.484	II
25	*Duchesnea indica*	Rosaceae	2.604	I
26	*Daucus carota*	Umbelliferae	2.472	II
27	*Orychophragmus violaceus*	Brassicaceae	2.468	II
28	*Rorippa dubia*	Brassicaceae	2.567	II
29	*Convolvulus arvensis*	Convolvulaceae	2.541	II
30	*Corydalis yanhusuo*	Papaveraceae	2.353	III
31	*Oxalis pes-caprae*	Oxalidaceae	2.547	II

early stage, plants with strong environmental adaptability and easy propagation and cultivation, such as *V. persica*, *E. annuus* and *V. phillipina*, should be chosen, which can not only realize high efficiency, but also quickly form flower border plant landscape with Hefei characteristics. Some wild flowers with requirements for altitude, such as *L. barbatum*, *Prunella vulgaris* L., *C. yanhusuo*, etc., can be planted in the Dashu Mountain and other places with higher terrain, so as to make use of these wild flower resources according to local conditions and exert their application value in flower border.

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concept of green development. This entails minimizing the ecological demand for fossil fuels through technological innovation, enhancing the ecological carrying capacity of the land, and promoting comprehensive coordination and sustainable development of human and natural systems. Secondly, it is imperative to practice economic restraint and to minimize the ecological footprint. Finally, the land use structure should be adjusted in order to enhance the ecological carrying capacity of pasture lands, wetlands, and forest lands.

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