Investigation and Application of Colored-leaf Plants in Tibet

Peng ZHOU, Hongfeng ZHANG, Gang PAN, Zhineng LIU*

Department of Resources and Environment, Tibet Agricultural and Animal Husbandry College, Linzhi 860000, China

Abstract For the quantitative analysis of colored-leaf plants in Tibet, the five-point sampling method is used for stratified investigation of garden plant communities in Tibet. (i) There are a total of 46 families, 76 genera and 110 species of garden colored-leaf plants in Tibet, including 56 kinds of trees, 40 kinds of bushes, 9 kinds of herbs, 4 kinds of vines and 1 kind of bamboo. There are too few colored-leaf herbs and bamboos, and there is a serious imbalance between evergreen and deciduous trees, between coniferous and broad leaved forests. (ii) The most widely applied families include Rosaceae (26), Salicaceae (12), Fabaceae (6), Aceraceae (5), Oleaceae (4) and Elaeagnaceae (4), accounting for 23.64%, 10.91%, 5.46%, 4.55%, 3.64% and 3.64% of the investigated colored-leaf plants, respectively. (iii) In terms of color, there are 55 kinds of red plants, 43 kinds of yellow plants and 12 kinds of plants with other colors, accounting for 50.00%, 39.09% and 10.91% of colored-leaf plants, respectively. There are 9 kinds of spring color leaf plants, 63 kinds of autumn color leaf plants, 29 kinds of constant color leaf plants, 7 kinds of double color leaf plants and 2 kinds of spot color leaf plants, accounting for 8.18%, 57.27%, 26.36%, 6.36% and 1.82% of colored-leaf plants, respectively, indicating that it is dominated by autumn color leaf and constant color leaf plants. (iv) In terms of importance value of trees, the top two are *Salix alba* (37.623) and *Prunus cerasifera* f. *atropurpurea* (26.063); in terms of importance value of bushes, the top three are *Ligustrum* × *vicaryi* Hort (22.577), *Berberis thunbergii* 'atropurpurea Nana' (18.987) and *Platycladus orientalis* Franco cv. *Sieboldii* (10.529); in terms of importance value of herbs, the top two are *Taraxacum sherriffii* (0.915) and *Oxalis triangu laris* cv. purpurea (0.326). (v) In terms of species abundance of colored-leaf plants, it is in the order of Nyingchi (94) > Lhasa (47) > Qamdo (43) > Shannan (34) > Xigaze (21) > Ali (7) > Nagqu (5). There are great differences between regions: it is highest in Nyingchi while it is lowest in Nagqu. Based on the main problems in the application of colored-leaf plants in Tibet, this paper makes the corresponding recommendations.

Key words Tibet, Garden, Colored-leaf plants, Importance value

1 Introduction

The colored-leaf plants have greatly enriched the city's landscape level with their brilliant color, thus dominating the current landscaping. From a broad perspective, the colored-leaf plants are the plant communities with leaves distinctly different from natural green in the growth period, and have consistent color change period, long viewing period and same defoliation period[1]. From the ornamental point of view, based on the color distribution on leaf surface and viewing period, the colored-leaf plants can be divided into spring, autumn, double, constant and spot color leaf plants[2-4]. In recent years, a lot of colored-leaf plants have been introduced into the urban greening of Tibet. Currently, Beijing, Xi'an, Yinchuan, Shijiazhuang and other cities have been carrying out this type of research[5-8], but unfortunately, the relevant research about Tibet has not been reported. After years of garden construction and transformation, there have been 368 kinds of common garden plants in Tibet[9], providing favorable conditions for the study of colored-leaf plants. This paper systematically investigates and analyzes the colored-leaf plant resources and garden application in Tibet, in order to provide a useful reference for the rational development and garden application of colored-leaf plants in Tibet.

Received: December 1, 2016 Accepted: February 10, 2017
Supported by Key Project of National Science and Technology Support Program (2013BAJ03B00).
* Corresponding author. E-mail: 799748121@qq.com

2 Study area

Tibet is a region on the Tibetan Plateau in Asia. Tibet is the highest region on Earth, with an average elevation of 4900 and an area of more than 1220000 km^2. The highest elevation in Tibet is Mount Everest, Earth's highest mountain, rising 8848 m above sea level. It administers 5 prefecture-level cities, 2 regions, 72 counties, and it is known as "roof of the world" or "the third pole of the Earth". Terrain is complex and diverse, tilting from northwest to southeast, and it can be divided into the Himalayan regions, southern Tibetan valleys, northern Tibetan plateau, and eastern Tibetan mountains and valleys. The climate of Tibet is characterized by cold and dry northwest and warm and humid southeast. From southeast to northwest, the climate types include tropical climate, subtropical climate, plateau temperate climate, plateau subfrigid climate and plateau frigid climate[10].

3 Investigation and analysis

3.1 Investigation Using site exploration method, the investigation was done on 7 cities in Tibet during June 2014-September 2015. According to the investigation point size, the "five-point sampling method" is used to randomly set up several 20 m × 20 m, 1 m × 1 m standard plots in the tree-bush layer and herb layer respectively for community and diversity investigation[11-13]. It is jointly sampled in the tree-bush layer and it is sampled separately in the herb layer. The plot area of tree-bush layer and herb layer is 1‰ of urban green area, respectively, and the minimum number of plots is not less than 20[14-15]. For the tree layer, the species name, plant number, height,

DBH, crown width, coverage area and growth index of plants are recorded; for the bush layer, the species name, plant number, plant height, crown width and growth index of plants are recorded, and hedgerows and patches are estimated according to area and planting density; for the herb layer, the species name, growth index and coverage area are recorded. The planting patterns in the plot are recorded in detail and the photos of planting are taken. The investigation focuses on the open field colored-leaf plants and their configuration, and the indoor greening is not the focus of this investigation.

3.2 Analysis The analysis method for quantitative characteristics of plant communities is used to calculate the importance value[11]. The importance value formula for the three types of plants is as follows: *importance value (trees) = relative abundance + relative frequency + relative dominance*; *importance value (bushes) = relative frequency + relative projection coverage*; *importance value (ground cover) = relative frequency + relative projection coverage*. As to the growth index evaluation method, the vegetative organs of each plant are graded according to a certain index system and the total score is weighted to determine the health level. It is divided into 5 levels, and the grading standard is shown in Table 1[16-17].

Table 1 Growth index classification standard

Level	Index
0	Dry branches, whole plant on the brink of death or withered, loss of ornamental value
1	Weak growth, serious pests and diseases, truncated trees, repugnant to the eye
2	Good growth, common state, pests or wind break some times, a certain ornamental value
3	Good plant form and growth, a small number of pests and diseases, high ornamental value
4	Beautiful plant form, strong growth, no pests and diseases, high ornamental value

$$\text{Growth index} = \frac{\text{Plant number at each level} \times \text{Number of level}}{\text{Total plant number} \times \text{Number of level at the highest level}} \times 100$$

4 Investigation results and analysis

4.1 Garden colored-leaf plant type in Tibet Investigation results show that a total of 46 families, 76 genera and 110 species of colored-leaf plants are applied in Tibet. The most widely applied families include Rosaceae (26), Salicaceae (12), Fabaceae (6), Aceraceae (5), Oleaceae (4) and Elaeagnaceae (4), accounting for 23.64%, 10.91%, 5.46%, 4.55%, 3.64% and 3.64% of the investigated colored-leaf plants, respectively.

Table 2 List of garden colored-leaf plants in Tibet

Types	Species	Families	Habits	Main ornamental features and garden use
Spring color leaf plants	*Salix babylonica*	Salicaceae	Deciduous trees	Yellowish spring leaves, street trees, shade trees, lakeside appreciation
	Chaenomeles speciosa Nakai	Rosaceae	Deciduous bushes	Red new leaves; enjoying the sight of garden, flower beds
	Eriobotrya japonica	Rosaceae	Evergreen small trees	Yellow tender spring leaves; garden trees
	Nandina domestica Thunb.	Berberidaceae	Evergreen tufted erect bushes	Purple red autumn leaves, fresh red leaves; garden trees, forest park group planting, flower beds
	Euonymus tibeticus	Euonymus tibeticus	Deciduous vine-like bushes	Red tender spring leaves, Purple red autumn leaves; courtyard viewing
	Toona sinensis Roem.	Meliaceae	Deciduous trees	Red tender spring leaves; shade trees, street trees
	Ailanthus altissima	Simaroubaceae	Deciduous trees	Purple tender spring leaves; shade trees, street trees
	Koelreuteria paniculata Laxm.	Sapindaceae	Deciduous trees	Spring leaves and reddish brown new leaves; deep yellow autumn leaves; street trees, garden trees
	Lagerstroemia indica L.	Thunberg	Deciduous bushes	Orange-red spring leaves, orange-red autumn leaves, purple leaves; courtyard viewing
Autumn color leaf plants	*Larix griffithiana*	Pinaceae	Deciduous trees	Golden yellow autumn leaves, yellow tender spring leaves; street trees, garden trees
	Metasequoia glyptostroboides	Sequoia	Deciduous trees	Brown red autumn leaves; garden trees
	Castanea mollissima	Fagaceae	Deciduous trees	Brown yellow autumn leaves; courtyard viewing
	Betula utilis	Betulaceae	Deciduous trees	Bright yellow autumn leaves, golden yellow leaves, white trunk; street trees, shade trees, seasonal landscape forest
	Ginkgo biloba L.	Ginkgoaceae	Deciduous trees	Golden yellow autumn leaves; street trees, garden trees
	Michelia alba	Magnoliaceae	Deciduous trees	Bright yellow autumn leaves; garden trees
	Juglans regia	Juglandaceae	Deciduous trees	Yellow autumn leaves; garden trees, shade trees
	Platanus acerifolia Willd.	Platanaceae	Deciduous trees	Yellowish autumn leaves, yellowish-brown leaves; street trees, shade trees
	Populus × beijingensis W. Y. Hsu	Salicaceae	Deciduous trees	Golden yellow autumn leaves; street trees, garden trees, shelter

(to be continued)

(continued)

Types	Species	Families	Habits	Main ornamental features and garden use
	Salix wangiana var. *tibetica* C. Wang et C. F. Fang	Salicaceae	Deciduous bushes	Orange yellow autumn leaves, reddish-brown leaves; shade trees, street trees
	Salix daltoniana	Salicaceae	Deciduous bushes	Orange autumn leaves; garden trees, lakeside group planting
	Myricaria wardii Marquand	Tamaricaceae	Deciduous erect bushes	Bright red autumn leaves and twigs, purple leaves, blue-purple leaves; lakeside block planting
	Ulmus pumila L.	Ulmaceae	Deciduous trees	Deep yellow autumn leaves; street trees, shelter, hedgerows
	Ulmus parvifolia	Ulmaceae	Deciduous trees	Deep yellow autumn leaves; street trees, bonsai
	Morus mongolica var. *diabolica*	Moraceae	Deciduous trees	Yellowish brown autumn leaves; isolated planting, coupled planting, garden trees, shade trees
	Morus alba cv. *Pendula*	Moraceae	Deciduous trees	Yellow tender autumn leaves, golden yellow leaves; isolated planting, coupled planting, garden trees, street trees
	Morus australis	Moraceae	Deciduous bushes	Golden yellow autumn leaves; isolated planting, coupled planting, garden trees
	Rosa omeiensis Rolfe	Rosaceae	Deciduous erect bushes	Brown red autumn leaves; garden trees
	Rosa fedtschenkoana	Rosaceae	Deciduous undershrubs	Brown red autumn leaves; garden trees
	Amygdalus triloba Ricker	Rosaceae	Deciduous bushes	Dark reddish-brown autumn leaves; garden trees
	Pyrus bretschneideri Rehd.	Rosaceae	Deciduous trees	Purple red autumn leaves; garden trees, shade trees
	Armeniaca mume Sieb. var. *bungo* Makino	Rosaceae	Deciduous trees	Apricot yellow autumn leaves, golden yellow leaves, purple leaves; street trees, garden trees
	Cerasus yedoensis Yu et Li	Rosaceae	Deciduous trees	Yellow autumn leaves, orange leaves, orange-red leaves, dark red leaves, rich leaf color; courtyard viewing, street trees
	Cerasus tomentosa	Rosaceae	Deciduous bushes	Yellow autumn leaves; courtyard viewing
	Malus micromalus Makino	Rosaceae	Deciduous small trees	Russet brown autumn leaves, brown yellow leaves, brown red leaves; street trees, garden trees
	Malus halliana	Rosaceae	Deciduous small trees	Rust-red autumn leaves; street trees, garden trees
	Malus rockii	Rosaceae	Deciduous trees	Rust-red autumn leaves; garden trees, shade trees
	Crataegus pinnatifida	Rosaceae	Deciduous trees	Yellow autumn leaves; courtyard viewing
	Sorbus rehderiana	Rosaceae	Deciduous small trees	Red autumn leaves; courtyard viewing
	Cotoneaster buxifolius Lindl.	Rosaceae	Evergreen dwarf-shrubs	Purple autumn leaves, dark red leaves; forest park group planting, hedgerows, bonsai
	Cotoneaster rotundifolius Wall. ex Lindl.	Rosaceae	Evergreen bushes	Purple autumn leaves, blue purple leaves; garden trees, forest park group planting
	Spiraea canescens	Rosaceae	Deciduous bushes	Reddish-brown autumn leaves; courtyard viewing
	Sorbaria sorbifolia A. Br.	Rosaceae	Deciduous bushes	Reddish-brown autumn leaves; garden trees, forest park group planting
	Sorbaria arborea Schneid.	Rosaceae	Deciduous bushes	Reddish-brown autumn leaves; garden trees, forest park group planting
	Albizia sherriffii Baker	Leguminosae	Deciduous trees	Yellow autumn leaves; garden trees, shade trees, street trees
	Erythrina arborescens	Leguminosae	Deciduous trees	Bright yellow autumn leaves; garden trees, shade trees, street trees
	Cercis chinensis Bunge	Leguminosae	Deciduous bushes	Yellow autumn leaves; courtyard viewing
	Wisteria sinensis	Leguminosae	Deciduous vines	Yellowish leaves, dark yellow leaves; courtyard viewing
	Desmodium elegans	Leguminosae	Deciduous bushes	Yellowish autumn leaves; garden trees, forest park group planting, barren hillside slope protection and greening
	Desmodium callianthum Franch.	Leguminosae	Deciduous bushes	Yellowish autumn leaves; garden trees, forest park group planting, barren hillside slope protection and greening
	Syringa oblata Lindl.	Oleaceae	Deciduous bushes	Bright yellow autumn leaves; garden trees, forest park group planting
	Fraxinus chinensis Roxb.	Oleaceae	Deciduous trees	Bright yellow autumn leaves; shade trees, street trees
	Firmiana platanifolia Marsil	Sterculiaceae	Deciduous trees	Yellow autumn leaves; courtyard viewing
	Diospyros kaki	Ebenaceae	Deciduous large trees	Bright red autumn leaves; garden trees, street trees
	Diospyros lotus L.	Ebenaceae	Deciduous trees	Orange yellow autumn leaves; garden trees, street trees
	Chimonanthus praecox	Calycanthaceae	Deciduous bushes	Bright yellow autumn leaves; garden trees, forest garden block planting
	Dendrobenthamia capitata	Cornaceae	Evergreen trees	Purple red autumn leaves; garden trees

(to be continued)

(continued)

Types	Species	Families	Habits	Main ornamental features and garden use
	Swida alba	Cornaceae	Deciduous bushes	Red autumn leaves, bright red young branches, dark red old branches; planted in the lawn and forest garden, lakeside appreciation
	Berberis sherriffii	Berberidaceae	Deciduous bushes	Purple red autumn leaves; ornamental hedge, basal planting
	Acer caudatum	Aceraceae	Deciduous trees	Bright yellow autumn leaves; shade trees, street trees, seasonal landscape forest
	Acer caesium subsp. *giraldii*	Aceraceae	Deciduous trees	Bright yellow autumn leaves; shade trees, street trees, seasonal landscape forest
	Acer buergerianum	Aceraceae	Deciduous trees	Orange yellow autumn leaves, orange red leaves, rich leaf color; shade trees, street trees, seasonal landscape forest
	Acer truncatum Bunge	Aceraceae	Deciduous trees	Orange yellow autumn leaves, orange red leaves, rich leaf color; shade trees, street trees, seasonal landscape forest
	Celastrus stylosus	Euonymus tibeticus	Deciduous large vines	Orange yellow autumn leaves, red leaves; vertical greening, ground cover
	Buxus sinica Cheng subsp. *sinica* var. *parvifolia* M. Cheng	Buxaceae	Evergreen bushes	Golden yellow autumn leaves, orange-yellow leaves, purple leaves, blue purple leaves, yellow green new leaves; forest garden block planting, hedgerows
	Ilex cornuta	Aquifoliaceae	Evergreen bushes	Brown red autumn leaves; forest park group planting, thorn hedges
	Hypericum hookerianum	Guttiferae	Deciduous bushes	Dark red autumn leaves, purple leaves, brown red leaves; garden trees, forest park group planting
	Hibiscus syriacus	Malvaceae	Deciduous bushes	Yellowish autumn leaves; garden trees, forest park group planting
	Punica granatum	Punicaceae	Deciduous bushes	Yellow autumn leaves; garden trees, forest park group planting
	Parthenocissus tricuspidata	Vitaceae	Woody vines	Red autumn leaves; vertical greening
	Parthenocissus quinquefolia	Vitaceae	Woody vines	Red autumn leaves; vertical greening, ground cover
	Azolla imbricata	Azollaceae	Annual herbs	Purple red autumn leaves; water greening
	Taraxacum sherriffii	Asteraceae	Perennial herbs	Red-brown autumn leaves, purple leaves; ground cover plants, flower border
Constant color leaf plants	*Platycladus orientalis* Franco cv. *Sieboldii*	Cupressaceae	Evergreen shrubs	Golden yellow new leaves; pattern planting, group planting, line planting and viewing
	Salix × *aureo-pendula*	Salicaceae	Deciduous trees	Bright yellow twigs; garden trees, street trees, lakeside viewing
	Salix microstachya	Salicaceae	Deciduous bushes	Red twigs, purple leaves; forest park group planting, riverside planting, shelter
	Salix cheilophila	Salicaceae	Deciduous bushes	Purple twigs and leaves; shelter, garden trees, lakeside group planting
	Salix dalungensis	Salicaceae	Deciduous small trees	Dark purple twigs and leaves; shelter, garden trees, lakeside group planting
	Populus deltoids cv. *Zhonghua hongye*	Salicaceae	Deciduous trees	Bright red leaves, purple leaves; garden trees, street trees
	Ulmus pumila 'jinye'	Ulmaceae	Deciduous trees	Golden yellow young shoots and leaves; garden trees, hedgerows
	Prunus persica f. *atropurpurea*	Rosaceae	Deciduous small trees	Purple leaves; garden trees, forest park group planting
	Prunus cerasifera f. *atropurpurea*	Rosaceae	Deciduous bushes	Purple new leaves, dark red old leaves; garden trees, color-leafed hedges, pattern planting
	Prunus × *blireana* cv. Meiren	Rosaceae	Deciduous small trees	Purple leaves; garden trees, street trees, forest garden block planting
	Rubus biflorus Buch.-Ham var. *biflorus*	Rosaceae	Deciduous bushes	Yellow-brown leaves, reddish-brown leaves; white trunk; garden trees, forest park group planting, thorn hedges
	Photiniax serrulata 'Rubens'	Rosaceae	Evergreen small trees	Fresh red leaves, dark red old leaves; street trees, garden trees, pattern planting, color-leafed hedges, forest garden block planting
	Physocarpus amurensis 'Summer Wine'	Rosaceae	Deciduous bushes	New purple leaves, dark red old leaves; pattern planting, forest garden block planting, flower border
	Buxus megistophylla L. var. *aureo-marginatus*	Euonymus tibeticus	Evergreen bushes	Golden yellow leaf edge; hedgerows
	Rosa xanthina Lindl.	Rosaceae	Deciduous bushes	Bright red twigs; garden trees, street trees
	Ligustrum × *vicaryi* Hort	Oleaceae	Semi-evergreen small shrubs	Golden yellow leaves, green purple autumn and winter leaves; pattern planting, color-leafed hedges, forest garden block planting

(to be continued)

(continued)

Types	Species	Families	Habits	Main ornamental features and garden use
	Forsythia suspensa cv. Sun Gold	Oleaceae	Deciduous bushes	Golden yellow leaves; garden trees, pattern planting, color-leafed hedges, lakeside planting
	Loropetalum chinense var. *rubrum*	Hamamelidaceae	Deciduous bushes	Purple leaves; pattern planting, color-leafed hedges, forest garden block planting
	Berberis thunbergii 'atropurpurea Nana'	Berberidaceae	Deciduous bushes	Purple red leaves, dark red leaves; pattern planting, ornamental hedgerows
	Acer palmatum Thunb cv. *atropurpureum*	Aceraceae	Deciduous small trees	Bright red leaves, purple leaves; garden trees, seasonal landscape forest
	Caryopteris divaricata 'Worcester Gold'	Verbenaceae	Deciduous bushes	Golden yellow leaves; pattern planting, color-leafed hedges
	Hedera helix 'Aureovariegata'	Araliaceae	Evergreen climbing shrubs	Yellow and green leaves; vertical greening, ground cover
	Phyllostachys nigra	Gramineae	Evergreen shrub-like perennial lignified herbs	Dry purple-black leaves; garden trees, forest park group planting, street trees
	Oxalis triangu laris cv. *purpurea*	Oxalidaceae	Perennial erect herbs	Purple leaves; ground cover block planting, flower beds, flower border
	Canna warscewiczii	Cannaceae	Perennial herbs	Purple stems and leaves; forest park group planting, ground cover block planting, flower beds, flower border
	Beta vulgaris L. var. *cicla* L.	Chenopodiaceae	Biennial herbs	Purple leaves; ground cover block planting, courtyard viewing
	Commelina communis Boom.	Commelinaceae	Annual procumbent herbs	Purple leaves; ground cover block planting, indoor potted plants
	Imperata cylindrical 'Rubra'	Gramineae	Perennial herbs	Crimson leaves; forest park group planting, ground cover block planting, flower beds, flower border
	Pennisetum setaceum 'Rubrum'	Gramineae	Perennial herbs	Purple leaves; forest park group planting, ground cover block planting, flower border
Double color leaf plants	*Populus alba*	Salicaceae	Deciduous trees	Golden yellow autumn leaves, dense silver white hairs on leaves; street trees, garden trees, shelter
	Populus alba var. *pyramidalis*	Salicaceae	Deciduous trees	Silver white hairs on leaves, golden yellow autumn leaves; street trees, garden trees, shelter
	Salix alba	Salicaceae	Deciduous trees	Gray hairs on leaves, orange yellow autumn leaves, yellow green new leaves; street trees, shade trees, shelter
	Hippophae rhamnoides L. subsp. *gyantsensis* Rousi	Elaeagnaceae	Deciduous trees	Silver white hairs on leaves; shade trees, lakeside planting, shelter
	Hippophae rhamnoides subsp. *sinensis*	Elaeagnaceae	Deciduous trees	Silver-white scales on both sides of leaves; shade trees, lakeside planting, shelter
	Hippophae rhamnoides subsp. *Yunnanensi*	Elaeagnaceae	Deciduous trees	Silver white hairs on leaves; shade trees, lakeside planting, shelter
	Elaeagnus umbellata Thunb.	Elaeagnaceae	Deciduous bushes	Silver white hairs on leaves; garden trees
Spot color leaf plants	*Aucuba chinensis* var. *iegata*	Cornaceae	Evergreen bushes	Yellow and yellowish spots on leaves; forest park group planting
	Brassica oleracea L. var. *acephala DC.* f. *tricolor* Hort.	Cruciferae	Biennial herbs	A variety of leaf colors; flower beds, flower border

4.2 Quantitative characteristics of species As can be seen from Table 3, there are a total of 56 kinds of colored-leaf tree plants. The importance value of *Salix alba*, *Prunus cerasifera* f. atropurpurea is highest, accounting for 47.27% of that of colored-leaf trees, with significant advantages. As a very good local tree species, *Salix alba* has been widely applied in the garden in Tibet. Due to excellent adaptation to Tibet's natural conditions, *Prunus cerasifera* f. *atropurpurea*, as a species introduced in recent years, has been rapidly promoted in in Tibet. There are some limitations in the adaptation of *Photiniax serrulata* 'Rubens' in Tibet, and it is mainly applied in Nyingchi, Lhasa and Qamdo. The tree species is generally small, for example, the average DBH of *Prunus cerasifera* f. *atropurpurea* is only 2.62 cm, because it is mainly used as color-leafed hedge and pattern plant. The average growth index of colored-leaf tree plants is 88.74.

As can be seen from Table 4, there are 45 kinds of colored-leaf bush plants. In terms of the importance value, the top three are *Ligustrum* × *vicaryi* Hort, *Berberis thunbergii* 'atropurpurea Nana', and *Platycladus orientalis* Franco cv. *Sieboldii*, with the importance value accounting for 58.1% of that of constant color leaf bushes,

showing very significant advantages. Due to good adaptation to Tibet's natural environment conditions, *Ligustrum* × *vicaryi* Hort has been widely used in landscaping of Tibet; *Platycladus orientalis* Franco cv. *Sieboldii* is widely used in Lhasa, Xigaze and Shannan. The average growth index of colored-leaf bush plants is 86.25, indicating that the growth of bush species is generally passable. In addition, *Berberis thunbergii* 'atropurpurea Nana' is widely used in Tibet, but there are many pests and diseases, the growth is generally poor, so it should be limited in the future.

Table 3 Quantitative characteristics of colored-leaf tree species in Tibet

No.	Species	Abundance	Frequency	Mean DBH cm	Growth index	Relative abundance	Relative frequency	Relative dominance	Importance value
1	*Salix alba*	1578	185	19.63	91.66	0.94500	7.9570	28.72000	37.6230
2	*Prunus cerasifera* f. *atropurpurea*	21948	233	2.62	89.85	13.14900	10.0200	2.89300	26.0630
3	*Populus* × *beijingensis* W. Y. Hsu	1337	149	21.12	90.20	0.80100	6.4090	10.45000	17.6620
4	*Ulmus pumila* L.	8166	120	3.28	90.39	4.89200	5.1610	2.11000	12.1630
5	*Photiniax serrulata* 'Rubens'	11595	34	1.97	89.06	6.94600	1.4620	0.62600	9.0350
6	*Morus mongolica* var. *diabolica*	37	19	104.43	91.73	0.02220	0.8170	7.13200	7.9710
7	*Populus alba*	448	52	10.01	90.03	0.26800	2.2370	1.07600	3.5810
8	*Cerasus yedoensis* Yu et Li	360	62	6.75	87.43	0.21600	2.6670	0.28200	3.1650
9	*Salix babylonica*	271	41	13.90	83.87	0.16200	1.7630	0.92400	2.8500
10	*Armeniaca mume* Sieb. var. *bungo Makino*	173	39	8.74	86.16	0.10400	1.6770	0.20400	1.9850
11	*Juglans regia*	53	18	22.96	89.15	0.03180	0.7740	1.17000	1.9760
12	*Platanus acerifolia* Willd.	132	9	18.73	91.59	0.07910	0.3870	0.89100	1.3570
13	*Malus micromalus* Makino	102	18	8.63	86.80	0.06110	0.7740	0.11100	0.9460
14	*Ginkgo biloba* L.	72	11	14.07	74.86	0.04310	0.4730	0.22200	0.7390
15	*Acer palmatum* Thunb cv. *atropurpureum*	30	13	6.60	88.91	0.01800	0.5590	0.02700	0.6040
16	*Fraxinus chinensis* Roxb.	50	10	11.94	91.73	0.03000	0.4300	0.10700	0.5670
17	*Michelia alba*	23	11	6.39	78.74	0.01380	0.4730	0.01500	0.5020
18	*Salix dalungensis*	32	8	12.03	92.15	0.01920	0.3440	0.07200	0.4350
19	*Hippophae rhamnoides* L. subsp. *gyantsensis* Rousi	92	6	5.30	92.81	0.05510	0.2580	0.05400	0.3670
20	*Lagerstroemia indica* L.	52	7	3.89	69.04	0.03120	0.3010	0.01200	0.3440
21	*Pyrus bretschneideri* Rehd.	14	7	6.46	90.71	0.00840	0.3010	0.01500	0.3250
22	*Metasequoia glyptostroboides*	16	3	21.50	90.18	0.00959	0.1290	0.13810	0.2770
23	*Albizia sherriffii* Baker	21	4	16.19	89.86	0.01260	0.1720	0.09140	0.2760
24	*Populus alba* var. *pyramidalis*	37	5	8.46	89.11	0.02220	0.2150	0.03780	0.2750
25	*Hippophae rhamnoides* subsp. *sinensis*	88	4	3.89	91.52	0.05270	0.1720	0.03580	0.2610
26	*Prunus persica* f. *atropurpurea*	42	5	4.33	79.17	0.02520	0.2150	0.01090	0.2510
27	*Sorbus rehderiana*	10	4	13.81	91.35	0.00599	0.1720	0.02690	0.2050
28	*Erythrina arborescens*	10	2	27.62	88.26	0.00599	0.0860	0.10300	0.1950
29	*Morus alba* cv. *Pendula*	13	4	7.23	91.54	0.00779	0.1720	0.00951	0.1890
30	*Salix* × *aureo-pendula*	14	4	4.46	88.93	0.00839	0.1720	0.00403	0.1840
31	*Malus halliana*	16	3	11.63	73.36	0.00959	0.1290	0.03010	0.1690
32	*Acer buergerianum*	11	3	9.36	93.03	0.00659	0.1290	0.01290	0.1490
33	*Morus australis*	5	3	14.60	90.50	0.00300	0.1290	0.01520	0.1470
34	*Ailanthus altissima*	3	3	6.67	92.33	0.00180	0.1290	0.00224	0.1330
35	*Koelreuteria paniculata* Laxm.	16	2	12.89	92.07	0.00959	0.0860	0.03610	0.1320
36	*Acer caesium* subsp. giraldii	22	2	8.82	93.28	0.01320	0.0860	0.02330	0.1230
37	*Ulmus parvifolia*	6	2	19.36	80.01	0.00359	0.0860	0.03200	0.1220
38	*Prunus* × *blireana* cv. *Meiren*	28	2	4.50	82.50	0.01680	0.0860	0.00766	0.1110
39	*Diospyros kaki*	14	2	8.61	92.17	0.00839	0.0860	0.01200	0.1060
40	*Acer truncatum* Bunge	7	2	6.57	94.43	0.00419	0.0860	0.00411	0.0943
41	*Betula utilis*	2	2	13.53	93.50	0.00120	0.0860	0.00540	0.0926
42	*Crataegus pinnatifida*	6	2	5.67	90.33	0.00359	0.0860	0.00259	0.0922
43	*Castanea mollissima*	3	2	7.33	89.33	0.00180	0.0860	0.00216	0.0900
44	*Salix cheilophila*	5	2	2.87	91.50	0.00300	0.0860	0.00053	0.0895
45	*Eriobotrya japonica*	2	2	5.59	83.50	0.00120	0.0860	0.00081	0.0880

(to be continued)

(continued)

No.	Species	Abundance	Frequency	Mean DBH cm	Growth index	Relative abundance	Relative frequency	Relative dominance	Importance value
46	*Larix griffithiana*	3	1	27.10	90.33	0.00180	0.0430	0.02920	0.0740
47	*Acer caudatum*	10	1	11.92	93.50	0.00599	0.0430	0.01920	0.0682
48	*Toona sinensis* Roem.	6	1	10.82	88.36	0.00359	0.0430	0.01150	0.0581
49	*Malus rockii*	6	1	11.35	89.32	0.00359	0.0430	0.01150	0.0581
50	*Hippophae rhamnoides* subsp. *Yunnanensi*	10	1	8.97	93.50	0.00599	0.0430	0.00854	0.0575
51	*Dendrobenthamia capitata*	12	1	6.03	88.20	0.00719	0.0430	0.00576	0.0560
52	*Ulmus pumila* 'jinye'	15	1	4.53	94.58	0.00899	0.0430	0.00320	0.0552
53	*Firmiana platanifolia* Marsil	6	1	10.11	83.56	0.00359	0.0430	0.00800	0.0546
54	*Populus deltoids* cv. *Zhonghua hongye*	12	1	5.23	92.36	0.00719	0.0430	0.00400	0.0542
55	*Diospyros lotus* L.	1	1	18.05	94.28	0.00060	0.0430	0.00432	0.0479
56	*Salix wangiana* var. *tibetica* C. Wang et C. F. Fang	1	1	10.88	93.01	0.00060	0.0430	0.00012	0.0437
57	Total	47044	1132	–	–	28.18300	48.6840	57.86300	134.7390

Table 4 Quantitative characteristics of colored-leaf bush species in Tibet

No.	Species	Frequency	Growth index	Relative frequency	Relative coverage	Importance value
1	*Ligustrum* × *vicaryi* Hort	86	88.28	8.190	14.387	22.577
2	*Berberis thunbergii* 'atropurpurea Nana'	69	75.34	6.571	12.415	18.987
3	*Platycladus orientalis* Franco cv. *Sieboldii*	52	83.90	4.952	5.577	10.529
4	*Syringa oblata* Lindl.	42	91.44	4.000	2.434	6.434
5	*Rosa xanthina* Lindl.	27	87.39	2.571	3.354	5.925
6	*Amygdalus triloba* Ricker	35	90.34	3.333	2.253	5.586
7	*Chaenomeles speciosa* Nakai	28	86.21	2.667	1.152	3.819
8	*Swida alba*	4	88.23	0.381	0.860	1.241
9	*Elaeagnus umbellata* Thunb.	6	90.04	0.571	0.542	1.114
10	*Nandina domestica* Thunb.	7	79.11	0.667	0.260	0.927
11	*Rubus biflorus* Buch.-Ham var. *biflorus*	7	92.60	0.667	0.167	0.834
12	*Sorbaria sorbifolia* A. Br.	3	71.06	0.286	0.539	0.824
13	*Rosa omeiensis* Rolfe	2	88.75	0.190	0.595	0.785
14	*Cotoneaster rotundifolius* Wall. ex Lindl.	6	86.33	0.571	0.189	0.760
15	*Buxus sinica* Cheng subsp. sinica var. *parvifolia* M. Cheng	5	81.86	0.476	0.188	0.664
16	*Forsythia suspensa* cv. Sun Gold	4	86.15	0.381	0.247	0.628
17	*Cercis chinensis* Bunge	5	75.01	0.476	0.129	0.605
18	*Myricaria wardii* Marquand	3	92.51	0.286	0.295	0.580
19	*Caryopteris divaricata* 'Worcester Gold'	2	86.77	0.190	0.372	0.563
20	*Hibiscus syriacus*	4	83.73	0.381	0.141	0.522
21	*Cotoneaster buxifolius* Lindl.	3	95.26	0.286	0.175	0.461
22	*Wisteria sinensis*	4	82.22	0.381	0.066	0.447
23	*Sorbaria arborea* Schneid	4	83.12	0.381	0.057	0.438
24	*Salix microstachya*	3	91.06	0.286	0.140	0.426
25	*Desmodium callianthum* Franch	3	94.85	0.286	0.138	0.424
26	*Physocarpus amurensis* 'Summer Wine'	2	88.61	0.190	0.172	0.362
27	*Hypericum hookerianum*	3	92.23	0.286	0.021	0.306
28	*Desmodium elegans*	2	93.52	0.190	0.083	0.274
29	*Phyllostachys nigra*	1	88.25	0.095	0.176	0.272
30	*Punica granatum*	2	83.55	0.190	0.061	0.252
31	*Chimonanthus praecox*	2	90.55	0.190	0.047	0.238
32	*Parthenocissus quinquefolia*	2	88.56	0.190	0.017	0.207
33	*Euonymus tibeticus*	1	88.37	0.0952	0.108	0.203
34	*Celastrus stylosus*	1	92.82	0.0952	0.086	0.181
35	*Spiraea canescens*	1	89.78	0.0952	0.045	0.141

(to be continued)

(continued)

No.	Species	Frequency	Growth index	Relative frequency	Relative coverage	Importance value
36	*Salix daltoniana*	1	90.67	0.0952	0.035	0.131
37	*Hedera helix*'Aureovariegata'	1	90.21	0.095	0.028	0.124
38	*Loropetalum chinense* var. *rubrum*	1	50.46	0.095	0.028	0.124
39	*Parthenocissus tricuspidata*	1	88.17	0.095	0.022	0.118
40	*Berberis sherriffii*	1	94.89	0.095	0.013	0.108
41	*Ilex cornuta*	1	72.26	0.095	0.011	0.107
42	*Rosa fedtschenkoana*	1	89.53	0.095	0.011	0.107
43	*Cerasus tomentosa*	1	92.05	0.095	0.011	0.107
44	*Buxus megistophylla* L. var. *aureo-marginatus*	1	86.17	0.095	0.007	0.103
45	*Aucuba chinensis* var. *iegata*	1	79.12	0.095	0.002	0.098
46	Total	441	–	42.000	47.663	89.663

As can be seen from Table 5, there are 9 kinds of colored-leaf herb plants. Compared with the colored-leaf woody plants (Table 3, 4), the colored-leaf herb plants are extremely scarce in Tibet. Because of the natural environment, garden development level and other factors, the application of ground cover plants, flower beds and flower borders is inadequate, and the colored-leaf herb plants are rarely used.

Table 5 Quantitative characteristics of colored-leaf herb species in Tibet

No.	Species	Frequency	Growth index	Relative frequency	Relative coverage	Importance value
1	*Taraxacum sherriffii*	6	83.84	0.376	0.538	0.915
2	*Oxalis triangu laris* cv. *purpurea*	5	88.13	0.313	0.013	0.326
3	*Brassica oleracea* L. var. *acephala DC.* f. *tricolor Hort*	4	82.41	0.251	0.063	0.314
4	*Commelina communis* Boom.	3	89.33	0.188	0.022	0.210
5	*Beta vulgaris* L. var. *cicla* L.	3	90.33	0.188	0.020	0.209
6	*Canna warscewiczii*	2	79.50	0.125	0.039	0.165
7	*Azolla imbricata*	2	92.53	0.125	0.007	0.133
8	*Pennisetum setaceum*'Rubrum'	1	85.28	0.062	0.047	0.110
9	*Imperata cylindrical*'Rubra'	1	80.09	0.062	0.015	0.078
10	Total	27	–	1.691	0.768	2.459

Table 6 Composition of colored-leaf plants in Tibet

Classification standard	Tree species type	Number	Percentage//%
Leaf ornamental type	Spring color leaf plants	9	8.18
	Autumn color leaf plants	63	57.27
	Constant color leaf plants	29	26.36
	Double color leaf plants	7	6.36
	Spot color leaf plants	2	1.82
Growth traits	Trees	56	50.91
	Bushes	40	36.36
	Herbs	9	8.18
	Vines	4	3.64
	Bamboos	1	0.91
Distribution area	Native plants	50	45.45
	Introduced plants	60	54.55

4.3 Species composition From the composition (Table 6 – 7), it is found that there are 56 kinds of trees, 40 kinds of bushes, 9 kinds of herbs, 4 kinds of vines, 1 kind of bamboo, and the ratio is 1∶0.71∶0.16∶0.071∶0.018. Clearly, the configuration is very uneven, and colored-leaf herbs and bamboos are seriously scarce and seldom used. The ratio of native species to introduced species 1∶1.20, and it is reasonable; the ratio of evergreen species to deciduous species 1∶6.21, and the ratio of coniferous species to broad-leafed species is 1∶24.25, suggesting that the there are few evergreens and conifers, and the ratio of evergreen species to deciduous species or coniferous species to broad-leafed species is in serious imbalance. In terms of leaf color type, it is dominated by autumn and constant color leaf plants, and there are too few spring and spot color plants.

Table 7 Composition of colored-leaf woody tree species

Classification standard	Tree species type	Number	Percentage//%
Winter or dry season deciduous habit	Evergreen trees	14	13.86
	Deciduous trees	87	86.14
Leaf shape	Coniferous trees	4	3.96
	Broad-leafed trees	97	96.04
Distribution area	Native tree species	48	47.52
	Introduced tree species	53	52.48

It can be seen from Table 8 that in terms of leaf color distribution, it is mainly dominated by red and yellow, and the ratio of red species to yellow species is 1∶0.78, which indicates that the main color configuration of colored-leaf plants is reasonable in this area.

4.4 Composition of colored-leaf plants in Tibet It can be seen from Fig. 1 that the species abundance of colored-leaf plants in Tibet is in the order of Nyingchi (94) > Lhasa (47) > Qamdo (43) > Shannan (34) > Xigaze (21) > Ali (7) > Nagqu (5). The difference between the various regions is very large, highest in Nyingchi

and lowest in Nagqu. Nyingchi, known as the "Tibet Jiangnan", has superior natural environment, and it uses most abundant colored-leaf plants. Lhasa, Qamdo, Shannan and Xigaze are in the middle level, while Ali and Nagqu apply too few colored-leaf plants due to extremely harsh natural environmental conditions, leading to monotonous landscape.

Table 8 Leaf color distribution of colored-leaf plants in Tibet

Leaf color	Number	Percentage//%	Species
Red	55	50.00	*Chaenomeles speciosa* Nakai, *Nandina domestica* Thunb., *Euonymus tibeticus*, *Toona sinensis* Roem., *Ailanthus altissima*, *Koelreuteria paniculata* Laxm., *Lagerstroemia indica* L., *Metasequoia glyptostroboides*, *Salix cheilophila*, *Salix dalungensis*, *Myricaria wardii* Marquand, *Rosa omeiensis* Rolfe, *Rosa fedtschenkoana*, *Amygdalus triloba* Ricker, *Pyrus bretschneideri* Rehd., *Cerasus yedoensis* Yu et Li, *Prunus* × *blireana* cv. Meiren, *Malus halliana*, *Malus rockii*, *Sorbus rehderiana*, *Cotoneaster buxifolius* Lindl., *Cotoneaster rotundifolius* Wall. ex Lindl., *Spiraea canescens*, *Sorbaria sorbifolia* A. Br., *Sorbaria arborea* Schneid., *Diospyros kaki*, *Dendrobenthamia capitata*, *Swida alba*, *Berberis sherriffii*, *Acer buergerianum*, *Acer truncatum* Bunge, *Populus deltoids* cv. *Zhonghua hongye*, *Prunus cerasifera* f. *atropurpurea*, *Prunus persica* f. *atropurpurea*, *Celastrus stylosus*, *Buxus sinica* Cheng subsp. sinica var. *parvifolia* M. Cheng, *Ilex cornuta*, *Hypericum hookerianum*, *Parthenocissus tricuspidata*, *Parthenocissus quinquefolia*, *Azolla imbricata*, *Taraxacum sherriffii*, *Salix microstachya*, *Physocarpus amurensis* 'Summer Wine', *Photiniax serrulata* 'Rubens', *Rosa xanthina* Lindl., *Loropetalum chinense* var. *rubrum*, *Berberis thunbergii* 'atropurpurea Nana', *Acer palmatum* Thunb cv. *atropurpureum*, *Oxalis triangu laris* cv. purpurea, *Canna warscewiczii*, *Beta vulgaris* L. var. *cicla* L., *Commelina communis* Boom., *Imperata cylindrical* 'Rubra', *Pennisetum setaceum* 'Rubrum'
Yellow	43	39.09	*Salix babylonica*, *Eriobotrya japonica*, *Larix griffithiana*, *Castanea mollissima*, *Betula utilis*, *Ginkgo biloba* L., *Michelia alba*, *Juglans regia*, *Platanus acerifolia* Willd., *Populus* × *beijingensis* W. Y. Hsu, *Salix wangiana* var. *tibetica* C. Wang et C. F. Fang, *Salix daltoniana*, *Ulmus pumila* L., *Ulmus parvifolia*, *Morus mongolica* var. *diabolica*, *Morus alba* cv. *Pendula*, *Morus australis*, *Armeniaca mume* Sieb. var. *bungo* Makino, *Cerasus tomentosa*, *Malus micromalus* Makino, *Crataegus pinnatifida*, *Albizia sherriffii* Baker, *Erythrina arborescens*, *Cercis chinensis* Bunge, *Wisteria sinensis*, *Desmodium elegans*, *Desmodium callianthum* Franch., *Syringa oblata* Lindl., *Fraxinus chinensis* Roxb., *Firmiana platanifolia* Marsil, *Diospyros lotus* L., *Chimonanthus praecox*, *Acer caudatum*, *Acer caesium* subsp. *giraldii*, *Buxus megistophylla* L. var. *aureo-marginatus*, *Hibiscus syriacus*, *Punica granatum*, *Platycladus orientalis Franco* cv. *Sieboldii*, *Salix* × *aureo-pendula*, *Ulmus pumila* 'jinye', *Ligustrum* × *vicaryi* Hort, *Forsythia suspensa* cv. Sun Gold, *Caryopteris divaricata* 'Worcester Gold'
Other colors	12	10.91	*Brassica oleracea* L. var. *acephala DC.* f. *tricolor* Hort., *Rubus biflorus* Buch.-Ham var. *biflorus*, *Hedera helix* 'Aureo-variegata', *Phyllostachys nigra*, *Populus alba*, *Populus alba* var. *pyramidalis*, *Salix alba*, *Hippophae rhamnoides* L. subsp. *gyantsensis* Rousi, *Hippophae rhamnoides* subsp. *sinensis*, *Hippophae rhamnoides* subsp. *Yunnanensi*, *Elaeagnus umbellata* Thunb., *Aucuba chinensis* var. *iegata*
Total	110	100	–

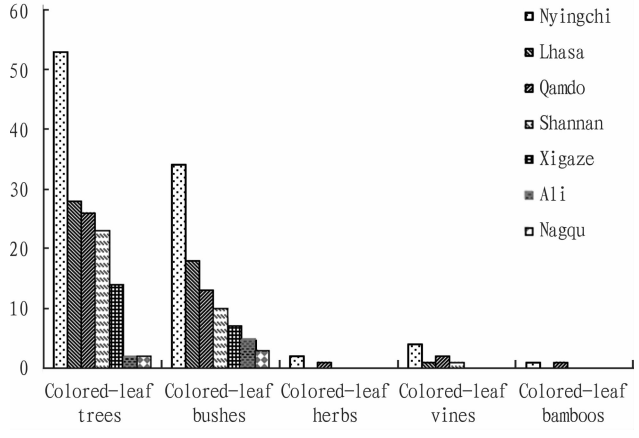

Fig. 1 Composition of colored-leaf plants in Tibet

4.5 Main application patterns The configuration of colored-leaf plants in garden landscape is considered mainly based on the ecological habits, planting environment and landscape effect. The main application patterns of colored-leaf plants in Tibet include pattern color, color-leafed hedges, isolated planting, group planting and three-dimensional greening. In terms of landscaping and configuration of colored-leaf plants, block planting and pattern planting are mostly used for the perennial ornamental foliage plants, to highlight the beautiful colored leaves; for the spring, autumn foliage plant configuration, it mainly focuses on the viewing during green leaf and flowering periods and neglects the esthetic expression.

5 Discussions

5.1 Improper composition of colored-leaf plants The investigation results show that there are only 9 kinds of colored-leaf herbs, 4 kinds of colored-leaf vines and 1 kind of colored-leaf bamboo (Table 6). There are too few colored-leaf herbs, while the colored-leaf vines and bamboos are particularly scarce. There are 9 kinds of spring color leaf plants, 63 kinds of autumn color leaf plants, 29 kinds of constant color leaf plants, 7 kinds of double color leaf plants, and 2 kinds of spot color leaf plants (Table 6). It is dominated by autumn color leaf plants and constant color leaf plants, and there are too few spring color leaf plants and spot color leaf plants. In addition, the ratio of evergreen species to deciduous species or coniferous species to broad-leafed species is in serious imbalance. In the future, it is necessary to adjust the structure and proportion of

colored-leaf plants in the area, and especially increase the types of colored-leaf herbs, spring color leaf plants, and evergreen colored-leaf plants.

5.2 Unbalanced distribution of colored-leaf plants In terms of species abundance of colored-leaf plants, it is in the order of Nyingchi (94) > Lhasa (47) > Qamdo (43) > Shannan (34) > Xigaze (21) > Ali (7) > Nagqu (5). There are great differences between regions: it is highest in Nyingchi while it is lowest in Nagqu (Fig. 1). In the future, it is necessary to improve the types and abundance of local colored-leaf plants based on the specific circumstances of Tibet.

5.3 Generally low frequency of application of native colored-leaf plants Some native colored-leaf plants with local characteristics (such as *Hypericum hookerianum*, *Acer caudatum*, *Salix daltoniana*, *Erythrina arborescens*, *Albizia sherriffii* Baker, *Hippophae rhamnoides* L. subsp. *gyantsensis* Rousi, *Cotoneaster rotundifolius* Wall. ex Lindl.) are not frequently and widely applied in greening. In the future, it is urgent to strengthen the optimal breeding of native colored-leaf plants, strive to cultivate new varieties, and cooperate with the relevant departments to increase the development and popularization of native colored-leaf plants. Moreover, based on the climatic characteristics of Tibet, it is necessary to introduce some outstanding Mainland's colored-leaf plants and increase some colored-leaf vines and bamboos to improve the region's colored-leaf plant type and garden landscape.

5.4 Configuration of colored-leaf plants according to local conditions Based on the unique natural conditions of Tibet, there is a need to strengthen the application type, quantity and proportion of colored-leaf plants in the future landscaping, and create colorful garden landscape with plateau characteristics. In addition, in the configuration details of colored-leaf plants, the colored-leaf plants are sensitive to light, and some plants (such as *Ligustrum* × *vicaryi* Hort, *Acer palmatum* Thunb cv. *atropurpureum*, *Rubus biflorus* Buch.-Ham var. *biflorus*, *Ulmus pumila* 'jinye', *Salix* × *aureopendula*, *Populus deltoids* cv. *Zhonghua hongye*, *Prunus cerasifera* f. *atropurpurea*, *Prunus* × *blireana* cv. Meiren) should be planted in sunny places to keep its leaf brightness. As to the configuration of fruit tree species, there is a need to consider the damage caused by visitors' picking to trees. It can also plant some plants that attract birds (such as *Cotoneaster buxifolius* Lindl., *Rubus biflorus* Buch.-Ham var. *biflorus*, *Rosa omeiensis* Rolfe, *Photiniax serrulata* 'Rubens', *Crataegus pinnatifida*, *Morus mongolica* var. *diabolica*, *Hippophae rhamnoides* L. subsp. *gyantsensis* Rousi, *Elaeagnus umbellata* Thunb., *Diospyros lotus* L., *Celastrus stylosus*) to attract birds to feed, which can not only increase the fun of the landscape, but also reflect the biological diversity.

References

[1] YU XN, ZHANG QX. Review of researches on leaf color changing of color-leafed plants[J]. Acta Horticulturae Sinica, 2000, 27(z1): 533-538. (in Chinese).

[2] HONG L, PANG SL. The classification of color-leafed plants and its application in landscaping[J]. Northern Horticulture, 2008(3): 182-183. (in Chinese).

[3] YUAN T. A brief discussion on color-leafed plant[J]. Plants, 2001(5): 12-13. (in Chinese).

[4] LI X, AN X, PAN HT. Species and landscape application of color-leafed plants in Beijing[J]. Chinese Landscape Architecture, 2010, 31(3): 62-68. (in Chinese).

[5] ZHANG MQ, YANG GD, ZHANG L. Study on seasonal aspect characteristics in Beijing City[J]. Journal of Capital Normal University (Natural Science Edition), 2008, 29(6): 62-65. (in Chinese).

[6] LI SJ, LIU YL. Ornamental characteristics and phenograms of plant leaf color in the main seasons in Xi'an[J]. Journal of Northwest Forestry University, 2013, 28(2): 42-47. (in Chinese).

[7] SONG LH, MENG WQ. Phenophase of landscape trees and plants disposition in Yinchuan City[J]. Heilongjiang Agricultural Science, 2015(4): 100-106. (in Chinese).

[8] JI LL, LU B, ZHAI SY, *et al.* The color leaved tree species resources and phenological ornamental characteristics in Shijiazhuang [J]. Journal of Northwest Forestry University, 2015, 30(4): 283-288. (in Chinese).

[9] LIU ZN, XU J, ZHANG HF, *et al.* Investigation and application of landscape plants in Tibet[J]. Acta Agriculturae Zhejiangensis, 2016, 28(6): 1009-1017. (in Chinese).

[10] Chinese Academy of Sciences. Tibetan forest[M]. Beijing: Science Press, 1985. (in Chinese).

[11] DU LH. Studies on the investigation and application of green plants in Nanjing new rural[D]. Nanjing: Nanjing Forestry University, 2012(6): 45-50. (in Chinese).

[12] ZHANG N. Research and evaluation on the green space of the built-up area in Baoding[D]. Shijiangzhuang: Hebei Agricultural University, 2012: 112-113. (in Chinese).

[13] WANG LK. Investigation of landscape tree species in Hengshui City[J]. Journal of Northwest Forestry University, 2014, 29(6): 250-254. (in Chinese).

[14] ZHAO JJ, OUYANG ZY, ZHENG H, *et al.* Proposed procedure in designing and planning stratified random selection investigation of urban vegetation[J]. Chinese Journal of Ecology, 2009, 28(7): 1430-1436. (in Chinese).

[15] LI DS, GUO WJ, XU ZQ, *et al.* The impact of sample area and sample amount on the results of community species diversity measure-A case study with the shrub community in the west region of Yanshan Mountain[J]. Acta Agriculturae Universitis Jiangxiensis, 2008, 30(6): 1079-1084. (in Chinese).

[16] LI YQ. Plant landscape research in Lijiang temple landscape architecture [D]. Ya'an: Sichuan Agricultural University, 2009: 16-18. (in Chinese).

[17] TANG L. Study on the characteristics of garden plant community of the main temple garden in Chengdu[D]. Ya'an: Sichuan Agricultural University, 2009: 20-21. (in Chinese).