Urban Forestry & Urban Greening 27 (2017) 1–8

Contents lists available at ScienceDirect

Urban Forestry & Urban Greening

journal homepage: www.elsevier.com/locate/ufug

Residents' preferences for roses, features of rose plantings and the relations between them in built-up areas of Beijing, China

Hua Wang[a,b], Yuan Yang[a,b,c], Maofu Li[a,b], Jiashen Liu[a,b], Wanmei Jin[a,b,*]

[a] Institute of Forestry and Pomology, Beijing Academy of Agriculture and Forestry Sciences, Beijing 100093, China
[b] Key Laboratory of Biology and Genetic Improvement of Horticultural Crops (North China), Ministry of Agriculture, Beijing 100093, China
[c] Beijing Engineering Research Center for Deciduous Fruit Trees, Beijing 100093, China

ARTICLE INFO

Keywords:
Rose
Residents' preference
Urban planning
Flower color
Ecosystem function

ABSTRACT

Rose (*Rosa* spp.), in addition to its commercial importance as a cut flower, forms part of the urban fabric of many cities and contributes to many ecological functions. To increase purchases by consumers and choose appropriate types of roses for urban planning, there is growing interest in understanding differences in residents' rose preferences, the distribution and features of roses, as well as the relations between them. The present study focuses on well-known ornamental roses, specifically on which cultivars should be chosen to promote their potential for the retail market and in urban planning. To determine the rose preferences of residents in Beijing, we analyzed responses to a questionnaire that required the residents to choose their preferred colors, types, and functions. To address the distribution and features of roses in Beijing, we surveyed 546 sites covering different types of urban green spaces in the built-up areas. The survey showed that roses served a significant ecological function in urban green space. They exhibited high resistance to the influence of environment stress, as well as different growth habits in the built-up areas of Beijing. In terms of residents' main expectations for roses, the predominant expectation was color, and particularly ecological outcome. The predominant preference for rose color was red. Our results indicated that the rose color, type preferences among residents were consistent with the rose color, type predominantly planted in Beijing. The best way to integrate such civic-led interventions into urban planning and retail markets remains to be determined.

1. Introduction

Rose (*Rosa* spp.) has been in cultivation for at least 5000 years by the ancient civilizations of China, western Asia, and northern Africa (Shepherd, 1954; Gudin, 2010). The introduction of *Rosa chinensis* into Europe resulted in the development of new rose cultivars (Zhang and Zhu, 2006). In addition to its beautiful flowers with their many romantic and sentimental associations, rose flowers and hips have strong antioxidant properties, and it is the most economically important ornamental plant (Cai et al., 2005; Haviland-Jones et al., 2005; Liu et al., 2013; Nađpal et al., 2016). The area used for cut rose cultivation has been expanding from 3273 ha in 2006–5297 ha in 2013 (Gudin, 2010). Many large rose nurseries have been established for rose cultivation and cut flower production. Cut roses account for about 21% and 31% of all cut flowers traded in China and Europe (Heinrichs, 2008). India and China are important producers of cut rose (AIPH, 2016). Production and trade of cut and potted flowers have been increasing rapidly in Indian floriculture (Ninama et al., 2016). Color is often found to be the most important factor driving consumer purchase decisions for flowers (Behe et al., 1999; Kelley et al., 2001; Palma et al., 2011; Getter and Behe, 2013; Grygorczyk et al., 2016). Surprisingly, we know very little about the actual properties that make roses so appealing to people. Therefore, a more comprehensive understanding of the residents' preferences for roses is needed.

The retail market for garden rose bushes in developed countries is substantial (Gudin, 2010). Making use of the advantages of Chinese rose cultivars such as recurrent blooming habit, color, and scent, thousands of new varieties were developed for the beautification of urban streets, gardens and parks, and business places and for home use (Zhang and Zhu, 2006). Beijing, the capital of China, has undergone rapid urban renewal and development. The city has a population over 21.7 million occupying a footprint of 873 km^2 (Editorial Board of China Statistical Yearbook, 2015). Beijing expends a great deal of effort to create and maintain urban green spaces. Approximately 48.4% (Editorial Board of China Statistical Yearbook, 2015) of the city is open and green spaces consisting of tree-lined traffic corridors, ornamental

* Corresponding author at: Institute of Forestry and Pomology, Beijing Academy of Agriculture and Forestry Sciences, A12 Ruiwangfen, Xiangshan, Haidian District, Beijing 100093, China.
E-mail address: jwm0809@163.com (W. Jin).

http://dx.doi.org/10.1016/j.ufug.2017.06.011
Received 8 April 2017; Received in revised form 21 June 2017; Accepted 21 June 2017
Available online 23 June 2017

landscapes, greenbelts, regional and neighborhood parks, botanical gardens, woods, and wetlands. Roses spreading in the temperate and subtropical regions are essential components of many urban green spaces (Nađpal et al., 2016). More than 15 million roses (Beijing gardening and greening bureau, 2005) are planted across the city. Roses, as part of urban forest ecosystems, positively affect the city's physical, biological, and socioeconomic environments, through improving air quality, helping to regulate climate, altering aesthetic surroundings, increasing enjoyment of everyday life, and improving health (Nowak and Dwyer, 2007). Given the importance of public engagement with many biological sciences (Fuller et al., 2007; Dickinson et al., 2012; Lin et al., 2017), some of ecosystem services of roses include a range of benefits that require active engagement for people to enjoy them, such as time spent in parks leading to benefits on health and well-being, and flower color preference leads to different choices for urban greening and utilization of public urban green spaces. The best way to integrate such civic-led interventions into urban areas remains to be determined.

Currently, there is no direct evidence showing that residents' preferences with regard to roses influence urban greening and the retail market for cut roses. Therefore, in this article, we describe the distribution and features of rose plantings, and residents' preferences with regard to flower color, type, and ecological functions of roses in the built-up areas of Beijing. Our results concern the relationship between residents' preferences and surveys on roses in Beijing.

2. Methods and materials

2.1. Study sites

The administrative boundary of Beijing includes very large areas of countryside. In this study, only the built-up areas of Beijing were analyzed, rather than including the whole area within the administrative boundary. Built-up areas refer to the urbanized area of a city, which always includes parts of the urban, suburban and rural areas (–2010; Zhao et al., 2013). Study sites were within the five rings covering an area of 670 km^2. The second ring roughly delineates the boundary of 'old Beijing'. Development in the 1980s occurred mainly around or within the third ring. In the 1990s and thereafter, the fourth and fifth rings have enabled conversion of rural or semi-rural areas into urban areas (Yang et al., 2012).

Roses were selected as the study species. They are a common urban plant species in Beijing. Distribution of roses was estimated by the random sampling in 2015 (Fig. 1). In addition, to investigate 546 representative study sites in the built-up areas of Beijing, we included different types of urban green spaces in the sampling. "Public urban green spaces" refers to non-private, freely-accessible outdoor areas with amenities within urban limits (Wright Wendel et al., 2012). Urban public green spaces were grouped into four typological categories, green roads (Fig. 2A–C), residential green space (Fig. 2D–F), public green space (Fig. 2G–I), urban parks (Fig. 2J–L).

2.2. Data of filed survey

Data of filed survey Observation studies were carried out from June to September at 546 representative study sites in the built-up areas of Beijing. The geographical information of each survey site was recorded using a hand-held GPS (G120, UniStrong Odin Series, Beijing, China). Digital photographs were taken using a Nikon S8000 camera. We recorded data by using a schedule in which different kinds of resistances, colors, numbers, heights were listed. We recorded rose colors (red, yellow, white, and multi color), number of rose bushes per site, The height of roses was measured with a tape. The black spot, caused by *Diplocarpon rosae*, and powdery mildew, caused by *Sphaerotheca pannosa* are recognized as the major diseases of roses (Horst et al., 1992; Linde et al., 2006). The infections were visually evaluated for their resistance using a three-class scale: H = resistant, no symptoms; M = less than 50% of the leaves infected; L = 50% or more infected. Similarly, pest resistance was also classified using a three-class scale: H = resistant, no symptoms; M = less than 50% of the leaves feeding; L = 50% or more feeding.

2.3. Questionnaire design

Within the built-up areas of Beijing, 276 young and middle-aged adult residents in various careers were randomly invited to participate in the questionnaire surveys. Before our proposed substantive study of rose preferences among residents, the response options were pretested to maximize the purpose of deriving reliable responses from residents. For the face-to-face interviews, paper-and-pencil questionnaires were given out personally, and potential respondents were asked to fill them in during their leisure time. Completed questionnaires were then collected. The study was done over a period of 3 consecutive months from July to September of 2015. The questionnaire included eight questions. All questions were related to knowledge about rose preferences among residents, including aspects such as color, type, and function (**Table S1**). All those invited responded. There were 276 questionnaires and 0 invalid questionnaires.

2.4. Statistical analyses

Pearson correlation analysis was conducted using SPSS 16.0 (SPSS Inc., Chicago, USA) to determine the relationships between rose color preference among residents and the predominant color of roses planted, and between the preference for red roses among residents and the proportion of red roses planted in Beijing.

3. Results

3.1. Surveys on roses planted in the built-up areas of Beijing

The top ten species were *Rosa hybrida* (15,478,796), *Euonymus japonicus* (4,376,068), *Parthenocissus tricuspidata* (3,785,512), *Sabina vulgaris* (3,279,320), *Berberis thunbergii* (1,544,502), *Rhus typhina* (1,443,957), *Platycladus orientalis* (1,423,225), *Ligustrum quihoui* (1,397,077), *Populus tomentosa* (1,257,524), and *Sabina chinensis* (1,181,130) in Beijing (Beijing gardening and greening bureau, 2005). The total number of rose bushes in Beijing has been increasing from 8,002,239 in 1995–15,478,796 in 2005, more than the number of evergreen shrubs (10,563,879) or deciduous shrubs (10,913,748) (Beijing gardening and greening bureau, 1995, 2005).

At these study sites, some roses were affected by pest attack (Fig. 3A–C), plant diseases (Fig. 3D–F), and environmental stresses (Fig. 3G–I) such as ozone, and showed the effects of shrinkage, reddening of leaves near veins, and other symptoms. At the study sites, the resistance to disease, insects, and drought of the roses at the study sites were categorized into three groups: high resistance (36%), medium resistance (63%), and low resistance (1%) (Fig. 4A). The predominant rose color was red (57%), whereas the least common color was dark red (1%), the proportions of yellow (15%), white (12%), and multi color (9%) roses were similar (Fig. 4B). The predominant number of rose bushes per site was < 100 (40%), followed by the number 100–200 (24%) (Fig. 4C). The most common height of roses was 50–100 cm (34%), and similar proportions of the roses were < 50 cm (29%), and 100–150 cm (28%) (Fig. 4D). The present results indicate the need for development of management strategies.

3.2. Comparative analysis of residents' rose preferences in the built-up areas of Beijing

A questionnaire survey of residents of the built-up areas of Beijing was performed. With regard to preference for urban greening plants (Fig. 5A and B), the most-preferred plant was rose (17%), while the