

‘Zi Dieer’ Crabapple

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Crabapples (*Malus* spp.) are small trees and shrubs in the rose family that are valued for their various types of flowers (single, semi-double, and double forms in shades of purple, red, pink, and white), colorful, small fruits (≤ 5 cm; primarily purple, red, pink, orange, yellow, and green), and diverse growth habits (columnar, fastigate, upright, spreading, drooping, weeping) (UPOV, 2003; Wyman, 1955). They also have an added advantage of wide environmental adaptability, thus facilitating their worldwide prominence as the focal points of landscapes and gardens. Although nearly 1200 *Malus* taxa are recorded in Fiala’s *Flowering Crabapple* (Fiala, 1994), less than 5% are semi-double or double-flowered, such as the outstanding ‘Brandywine’ (pink doubles), ‘Kelsey’ (red doubles), and ‘Sparkler’ (red-purple semi-doubles), result-

ing in a scarcity of double-type cultivars currently available. Additionally, petal colors of these existing double germplasm often fade easily, which significantly shortens their ornamental periods. Crabapple breeding is an active endeavor worldwide, with increasing efforts dedicated toward the rare double-flowered germplasm. During the 20th century, breeding of flowering crabapples was mainly performed in Canada and the United States, where ≈ 400 to 600 different forms and cultivars were grown (Dirr, 2010). However, for the past 20 years, only four new double-flowered crabapple cultivars—‘Spring Bride’ (white-flowered) (Spongberg, 1996), ‘Jarmin’ (pink-flowered)

(Jarmin, 2003), ‘Fenghong Nichang’ (pink-flowered) (Fan et al., 2019), and ‘Fen Balei’ (pink-flowered) (Zhou et al., 2019)—have been documented on the U.S. market.

Plant phenotypes display extremely high variations in size, color, structure, and function, which are the products of continuous remodeling to adapt to different environmental conditions and pollinators, and the important foundations for germplasm innovations (Dudash et al., 2011; Endress, 2011; Kumari et al., 2016; Mojica and Kelly, 2010; Santos et al., 2011). Therefore, it is of great importance to breed new crabapple cultivars with novel flower forms and colors. *Malus* ‘Zi Dieer’ was selected and released from the Nanjing Forestry University’s crabapple breeding program. This cultivar has gained much attention for its double and nonfading red-purple flowers, which enriched double germplasm resources in *Malus* and significantly prolonged their ornamental periods (12–15 d). To date, no serious pests or diseases have been observed. Damage to young tips and leaves caused by apple aphids, spider mites, and apple rust is rare. The cultivar is suitable for street trees, courtyard greening, park landscaping, and other theme attraction construction. We report the development and selection of the ‘Zi Dieer’ crabapple cultivar.

Origin

In Fall 2011, more than 1800 open pollinated crabapple fruits were collected from *M.* ‘Purple Prince’, *M.* ‘Indian Summer’, *M.* ‘Red Jade’, *M.* ‘Harvest Gold’, *M.* ‘Donald Wyman’, *M.* ‘Sugar Tyme’, *M.* *x* *zumi* ‘Calocarpa’, *M.* ‘Qian Cengjin’, and *M.* ‘Cinderella’ in the national repository of *Malus* spp. germplasm (Yangzhou City, Jiangsu Province, China). All seeds were mixed up during the cleaning process. Cleaning protocols entailed soaking seeds in warm water (40 to 45 °C) to soften seed coats before cracking the testa with a rubber mallet and extracting the seeds. To break seed dormancy, seeds were placed in sand media (saturated to reach field capacity), wrapped in gauze, and then stored in a brick pond at -5 to 10 °C for ≈ 1 month outdoors (Fig. 1). In Spring

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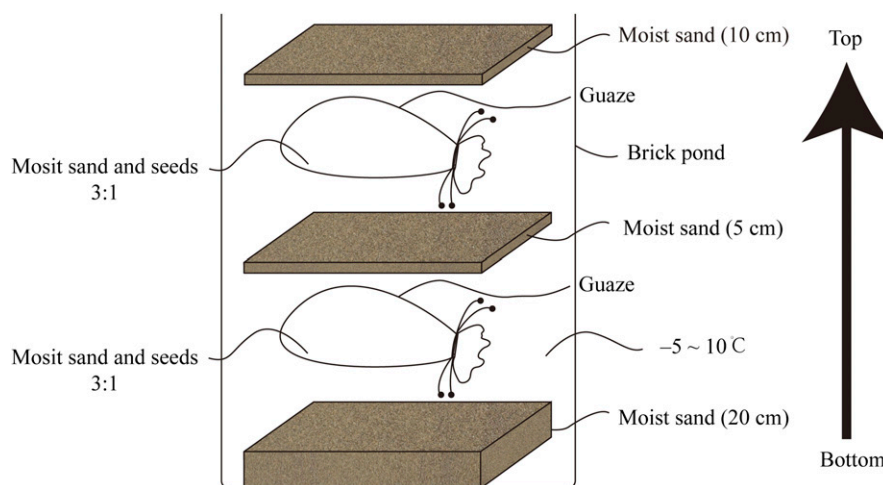


Fig. 1. Cold stratification and seed germination system.

2012, seeds were sown in a seedbed (width, 1.5 m; length, 50 m; depth 8.0–10.0 cm). After germination, seedlings were transplanted into the field with a 10.0-cm × 10.0-cm spacing. In Spring 2014, an individual plant with double and nonfading red-purple flowers shaped like butterflies was observed and selected for further evaluation. From 2015 to 2016, successive observations were conducted to assess the phenotypic stability of this individual, which was named ‘Zi Dier’. Between 2014 and 2017, three generations of ‘Zi Dier’ bud-grafted seedlings with *M. hupehensis* seedlings as rootstock were propagated, resulting in more than 100 individual plants. In Spring 2017, all budded plants produced the same blossom type, confirming the phenotypic characteristics of ‘Zi Dier’. The seedlings grew vigorously in height (distance from the grafting incision to the top) from May through September, and stem di-

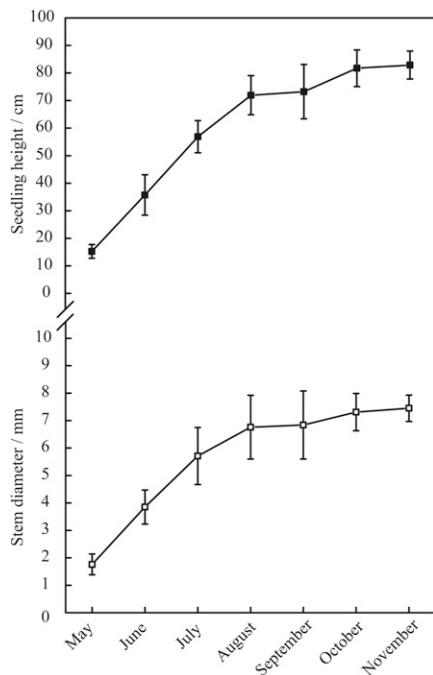


Fig. 2. Growth rhythm of 1-year-old grafted seedlings of *M. 'Zi Dier'*.

ameter (thickness at 3 cm above the grafting incision) increased from May through August (Fig. 2). They exhibited good adaptation to high temperatures of 37 to 40 °C and cold temperatures of 4 to 6 °C in Jiangsu. Few incidents of apple aphids, spider mites, and apple rust were observed. This cultivar was authorized by the Forest Variety Certification Committee of China in 2018.

Description

The distinguishing characteristics of ‘Zi Dier’ are double and nonfading red-purple flowers. Among existing double-flowered crabapple germplasm, ‘Zi Dier’ most resembles *M. 'Sparkler'*, which was selected in 1947 (University of Minnesota, Twin Cities, North America). *M. 'Sparkler'* is characterized by bowl-shaped collora with circular petals, whereas ‘Zi Dier’ present deep cup-shaped collora with elliptic petals. In addition, the two cultivars have distinctive petal color in the middle zone of the inner side: red-purple (68A) in ‘Sparkler’ and red-purple (N57C) in ‘Zi Dier’ (Table 1). The specific characteristics of ‘Zi Dier’ are as follows (Table 2):

Habit: The tree has reddish brown branches and an upright canopy. It reaches ≈3.5 m in height, with a 1.0-m spread at 4 years old (Fig. 3A).

Flower: The flowering time (10% open flowers) of ‘Zi Dier’ is early (near the end of March to the beginning of April in Jiangsu, China). It has an umbellate inflorescence, red buds (Fig. 3B), and highly doubled flowers (15–26 petals) that are deep cup-shaped with numerous stamens (40–50). Petals are elliptical and overlapping, with no prominent veins.

The petal color of the outer side is red-purple (Royal Horticultural Society Color Chart, 70A), the marginal zone of the inner side is red-purple (70B), the middle zone of the inner side is red-purple (N57C), and the basal zone of the inner side is white (N155D) (Royal Horticultural Society, 2007) (Fig. 3C).

Foliage: The leaves are papery and elliptical (7.0–9.0 cm in length × 4.0–4.5 cm in width, with a length-to-width ratio of 2.0), with short petioles (1.3–1.9 cm) and serrate margins. The leaves are reddish green with a medium gloss.

Fruit: ‘Zi Dier’ sets very few fruits. The fruits are red, globose, and small (vertical diameter, ≈1.2 cm; horizontal diameter, 1.35 cm), with weakly glossy exocarp and sometimes present sepals (Fig. 3D). Fruit peduncles are long (2.2–3.4 cm) and fruits persist for ≈5 months.

Cultivation

‘Zi Dier’ is regenerated mainly by grafting during the fall season (August to September in Jiangsu, China) using *M. hupehensis* crabapple seedlings as the rootstock (0.5-cm diameter at ground level) and the current year’s healthy, plump buds from hardwood branches of the cultivar as the scion. After grafting, plants were cultivated in the natural field. Buds must be wrapped in plastic to prevent desiccation, and they should be kept with minimal exposure to dry air until the following spring (March in Jiangsu, China). At that time, the plastic wrappers should be removed or cut to expose the grafted buds. Attention should be directed to constantly removing undesirable rootstock sprouts.

Damage to young tips and leaves caused by apple aphids, spider mites, and apple rust

Table 1. Comparison of phenotypic attributes of *M. 'Sparkler'* and *M. 'Zi Dier'*.

Comparison items	<i>M. 'Sparkler'</i>	<i>M. 'Zi Dier'</i>
Corolla shape	Bowl	Deep cup
Petal shape	Circular	Elliptical
Petal color of the middle zone of inner side	Red-purple (68A)	Red-purple (N57C)
Petals/flower	7–12	15–26
Stamens/flower	15–23	40–50
Stamen color	Light red-purple	Dark red-purple

Table 2. Phenotypic characteristics of *M. 'Zi Dier'*.

Flower genotype		Leaf genotype		Fruit genotype	
Inflorescence type	Umbellate	Leaf color	Reddish green	Fruit setting	Few
Bud color	Red	Leaf length (cm)	7.82 ± 1.18	Vertical diameter of fruits (cm)	1.20 ± 0.15
Flower type	Double	Leaf width (cm)	4.23 ± 0.21	Horizontal diameter of fruits (cm)	1.35 ± 0.25
Flower diameter (cm)	3.85 ± 1.26	Leaf length/leaf width	2.00 ± 0.36	Fruit shape	Globose
Flower shape	Deep cup	Petiole length (cm)	1.60 ± 0.24	Fruit sepals	Sometimes present
Petal shape	Elliptical	Leaf lobes	Absent	Length of fruit peduncle (cm)	2.75 ± 0.52
Arrangement of petals	Overlapping	Incisions of leaf margin	Serrate	Bloom of fruit skin	Absent
Veins in the petal	Not prominent	Glossiness of leaf upper side	Medium	Glossiness of fruit skin	Weakly expressed
Petal color of the marginal zone of the inner side	Red-purple (70B)	Green color of leaf upper side	Medium	Predominant fruit color	Red
Petal color of the middle zone of the inner side	Red-purple (N57C)	Anthocyanin coloration of leaf upper side	Present	Fruit flesh color	Yellowish white
Petal color of the basal zone of the inner side	White (N155D)	Intensity of anthocyanin coloration of leaf upper side	Weak	Fruit persistence (mo.)	5
Petal color of the outer side	Red-purple (70A)				



Fig. 3. Phenotypic characteristics of 'Zi Dieer' crabapple cultivar (A–D). (A) Upright growth habit. (B) Red buds. (C) Double and nonfadable red-purple flowers. (D) Red, globose, and small fruits.

is not common. To prevent apple aphids, the surfaces of the leaves can be sprayed with 50% Pimiricarb wettable powder (Kesheng, Yancheng, Jiangsu) at 2000× dilution. To prevent spider mites, the surface of the leaves can be sprayed with 1.8% Abamectin emulsion (Kesheng, Yancheng, Jiangsu) at 1000× dilution. Spraying the surface of the leaves with 20% Triadimefon emulsion (New Sun, Chengdu, Sichuan) at 2000× dilution can prevent apple rust.

Availability

Malus 'Zi Dieer' is available from the Nanjing Forestry University and Yangzhou Crabapple Horticulture Limited Company.

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