

Cultivation Performance of Blood Orange No.8 in Wanzhou District, Chongqing City

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Abstract: To evaluate cultivation performance of blood orange No.8 in Chongqing Wanzhou, we separately brought in the scions of this variety to 5-year-old 'Tarocco' blood orange new line which was on 'Carrizo' citrange [*Poncirus trifoliata* (L.) Raf.]×*Citrus sinensis* Osbeck] rootstock. 3 orchards were chose to grow the scions in Ganning town of Wanzhou, Chongqing in 2017. Through 5 years' follow-up survey, the results showed that blood orange No.8 was suitable for local climate, which got high survival rate, was easy to flower and had high fruition rate. The average fruit weight was 197.1g, TSS was 11.9%, TA was 0.7%, Vc was 42.0 mg/100ml, anthocyanin was 33.6mg/L, general flavone was 831.7mg/kg, and juice content was 58.8% on average. The average yield of the three orchards in 2019 was 17.6kg every tree, and 31.3kg every tree in 2020, 41.3 kg every tree in 2021. Therefore, Blood orange No.8 is very suitable for development in Wanzhou, Chongqing and can be used as an reserve variety.

1 INTRODUCTION

'Tarocco' blood orange (*Citrus sinensis* (L.) Osbeck) is the advantageous and characteristic citrus industry in Three Gorges Reservoir Region which was planted 33000 hm². Tarocco blood orange has a long maturity period, and they are normally harvested from January to March. Blood orange No.8 (*Citrus sinensis* (L.) Osbeck.vat.Tarocco) was discovered from the progeny of 'Tarocco' blood orange by Institute of Horticulture, Sichuan Academy of Agricultural Sciences and Sichuan Horticultural Crop Technology Extension Station. It was selected, bred and approved after many years of experiments. This variety had a strong, rosy pericarp and rosy scented flesh. To find new variety for sustainable development of 'Tarocco' blood orange industry in Wanzhou, Chongqing, blood orange No.8 was introduced and grafted onto 'Tarocco' blood orange new line for trial in 2017.

2 MATERIALS AND METHODS

2.1 Experimental Location and Plant Material

The field experiments were conducted for 'Tarocco' blood orange on 'Carrizo' citrange [*Poncirus trifoliata* (L.) Raf.] × [*Citrus sinensis* Osbeck] rootstock during 2017-2021 in three orchards. They were in Yongsheng Village (108°15 '35.98 "E, 30°40' 22.65" N), Heima Village (108°16 '6.75 "E, 30°39' 39.37" N) and Ganning Village Ganning Town (108°14 '41.66 "E, 30°40' 31.6" N), Wanzhou District, Chongqing City which were at the altitude of 395m, 320m and 280m. 'Tarocco' blood orange is for 5-year-old. The planting density was 3m×5m.

2.2 Treatments

1 tree was a replicate. There were 30 replicates in each treatment, and 30 trees in each orchard. A total of 90 trees were tested. All experiments were performed in triplicate.

2.3 Collection of Samples and Data Determination

In ripening-season, a total of 5 fruits were randomly collected from each tree and mixed into one sample. A total of 90 samples were harvested. Electronic vernier calipers were used to determine fruit vertical diameter, horizontal diameter and pericarp thickness. Fruit weight was determined using an electronic balance. Total soluble solid (TSS) was determined by PAL-1 digital glucostat (ATAGO, Japan) after juice extraction. The total acid (TA) was determined by NaOH neutralization titration method (Li, 2010) and calculated solid acid ratio (TSS/TA). Vitamin C (Vc) were respectively determined by 2, 6-dichlorophenol sodium titration method (Chen, 2014). All experiments were performed in triplicate. The pH differential method (Honda, 2014; Yu, 2019) was used to determine the content of total anthocyanins in fruit. The method of Ji Lu et al. (Ji, 2016) and Zhang Dongfeng et al. (Zhang, 2019) were used for determination of total flavonoids content. Juice content was computed as formula (1). Edible rate was computed as formula (2).

$$\text{Juice content (\%)} = \text{juice weight/fruit weight} \times 100 \quad (1)$$

$$\text{Edible rate (\%)} = \text{pulp weight/fruit weight} \times 100 \quad (2)$$

2.4 Statistical Analysis

The database was analyzed by IBM SPSS 16.0 (New York) and Microsoft Excel using one-way analysis of variance (ANOVA), and Tukey’s HSD post hoc test for means separation. The data are means of 30 replicates in twice.

3 RESULTS & DISCUSSION

3.1 Main Biological Characteristics of Blood Orange No.8

It was introduced to three villages in Ganning Town, Wanzhou District, Chongqing City, and showed some obvious characteristics after investigation. The variety showed middle growth, and the crown is round. The height of the tree was around 2.2 m, and the width is 2.5 m×2.7 m. There was strong germination in spring and summer. There were many upper branches and dark-green and thicker leaves. In spring, the strong flower-forming ability and large amounts of flower could be found. And the

production increased significantly compared with ‘Tarocco’ blood orange.

3.2 Phenological Periods Characteristics of Blood Orange No.8

In Wanzhou District, Chongqing City, the spring shoots generally germinated in late February to early March, and were the largest than other type of shoots in all year, which is also the most important parent branches. The buds appeared in late March, flowering come in early April, and full flowering was in mid-to-late April. The first physiological drop occurred in mid-May and the second was in the mid-June. After this period in mid-June, summer shoots began to be extracted, and in early August, autumn twigs began to be extracted. After spring shoots, the amount of autumn twigs is second-biggest which were important parent branches, and in mid-October, winter shoots began to be extracted.



Figure 1: Fruit of blood orange No.8.

(Left is comparison of fruit ripening between ‘Tarocco’ blood orange new line(upper) and blood

orange No.8 (lower) on December 19th, 2021; Middle is the colour of peel and flesh of blood orange No.8 in June 3rd, 2020; Right is fruit appearance contrast between 'Tarocco' blood orange new line (left) and Blood orange No.8 (right) on December 19th, 2021)

After the fruit expansion stage from June to September, the peel began to turn yellow in late November (the first turning), orange-yellow in late December (Fig 1 left), orange in late January, orange-red in early February (the second turning) in the next year. And the flesh begins to get rosy from January to February. It comes to maturity from mid-April to early May, and can be kept fresh until the end of May. It had 1-2 months later than 'Tarocco' blood orange new line (Fig 1 middle and right). And the whole growth and development period range from 280d to 300d.

3.3 Fruit Trait of Blood Orange No.8

The fruit weight was about 180g-210g, with an average of 197.1g with the traits of short oval (Fig 1), and fruit shape index was 1.07. The pericarp was smooth and thin which about 3.2mm on average (Table 1). The blood orange No.8 had excellent quality of fruit which was with TSS 11.9%, TA 0.7%, Vc 42mg/100ml, anthocyanin 33.6mg/L, general flavone 831.7mg/kg, juice rate 58.8% on average (Table 2). The fruit was seedless, and had moderate acidity and higher sweetness, and showed more smoothness and plumpness. The juice content was 58.8% and the edible rate was got to 73.6% on average. It had a strong rose aroma in flesh. The fruit are picked in early April and stored at room temperature until the end of May which was still with

good mouthfeel. So, blood orange No.8 was very durable for storage and transportation.

3.4 Production Performance of Blood Orange No.8

Blood orange No. 8 can fruit in the second year after top grafting, and officially put into production in the fourth year. The average yield of the three orchards in 2019 was 17.6kg every tree, and 31.3kg every tree in 2020, 41.3 kg every tree in 2021 (Table 3, Fig 1 right). In addition, there was no need to do anything to promote the flowers. These showed that Blood orange No. 8 had higher and more stable yield.

Table 3: Yield of blood orange No. 8.

Orchard	Average yield of one tree(kg)		
	2019	2020	2021
Ganning	15.1±1.1	31.2±3.1	40.7±4.1
Yongsheng	20.2±1.9	34.3±3.2	41.2±4.2
Heima	17.4±1.4	28.5±2.9	41.9±4.5
Average	17.6±1.7	31.3±3.4	41.3±4.8

4 CONCLUSIONS

Blood orange No.8 was from the *C. Sinensis* 'Tarocco' blood orange, and showed well affinity after grafting. In Wanzhou, Chongqing, *C. Sinensis* 'Tarocco' blood orange had been planted in there for 17 years and 33000 hm². Some of the trees were aged, the variety construction was single, and the maturity was mainly focus on February to April. If we wanted to get larger citrus market and accelerated sustainable

Table 1: Physical properties of blood orange No.8 fruit.

Orchard	Fruit weight (g)	Vertical Diameter (cm)	Horizontal Diameter (cm)	Fruit shape index	Pericarp thickness (mm)
Ganning	181.4±11.5	79.1±8.1	72.7±8.2	1.09±0.1	3.5±0.2
Yongsheng	210.2±18.7	81.4±7.1	76.3±7.4	1.07±0.1	3.2±0.4
Heima	199.8±20.8	79.5±10.2	75.6±6.8	1.05±0.2	2.9±0.2
Average	197.1±18.2	80.0±7.9	74.9±7.1	1.07±0.1	3.2±0.3

Note: Data are mean of three replicates. The same below.

Table 2: Quality of blood orange No.8 fruit.

Orchard	TSS (%)	TA (%)	TSS/TA	VC (mg/100ml)	Anthocyanin (mg/L)	General flavone (mg/kg)	Juice content (%)
Ganning	11.9±0.1	0.64±0.0	18.59±1.1	39.7±3.1	33.5±3.0	825.6±79.8	57.8±5.1
Yongsheng	11.8±2.2	0.68±0.1	17.35±1.2	42.5±3.9	37.8±3.1	848.7±88.3	57.4±5.1
Heima	12.1±1.0	0.71±0.1	17.04±1.9	43.8±4.8	29.5±2.6	820.8±91.5	61.2±6.8
Average	11.9±1.1	0.7±0.0	17.7±1.8	42.0±4.2	33.6±3.4	831.7±84.7	58.8±5.4

development, we must prolong the ripening period and introduce to foster more improved varieties.

Therefore, after several years of introduction experiments, it was found that blood orange No.8 grafted on the 'Tarocco' blood orange new line had higher survival rate, stronger growth and higher yield. And the three major indexes fruit quality, TSS and edible rate all inherited advantages of the 'Tarocco' blood orange new line, coupled with the unique climatic conditions in wanzhou which was in the center of Three Gorges Reservoir Region, ensuring that can form rich anthocyanins and late-mature. These can effectively prolong the time in market, balance variety structure, and alleviate the pressure for sale. So, blood orange No.8 was very suitable for planting on the altitude below 400m in Wanzhou, Chongqing and can be used as a new variety to plant.

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