Comparative Study on Biological Characteristics and Fruit Quality Changes of Two Citrus Varieties

Zhaofang Chen¹, Yuxin Wang¹, Tie Wang¹, Sichen Li¹, Bo Xiong¹, Xia Qiu¹, Guochao Sun² and Zhihui Wang²*

¹College of Horticulture, Sichuan Agricultural University, Chengdu, Sichuan, 611130, China
²Institute of Pomology & Olericulture, Sichuan Agricultural University, Chengdu, Sichuan, 611130, China

*Corresponding author’s e-mail: wangzhihui318@126.com

Abstract. This experiment compared the phenophase, morphological features and fruit quality of the two citrus varieties. The results showed that the whole growth period of Lemon Siranui was about 12 days longer than Siranui. The flowering period, two physiological fruit drop periods and fruit color change period of Lemon Siranui were about 5-7 days later than Siranui. While this study illustrated differences in morphological features that Lemon Siranui tree was stronger than Siranui. And the fruit of Lemon Siranui was heavier than Siranui. It was clear to see that the percentages of soluble solids as well as vitamin C in Lemon Siranui were larger than those in Siranui, which led to better taste qualities. Overall, Lemon Siranui was a new high-quality strain citrus variety with excellent traits which was worth promoting from the analysis of appearance quality and nutritional quality.

1. Introduction
Siranui is a new high-quality hybrid citrus variety selected in Japan. It has excellent characteristics such as high yield, unique-size fruit, palatable favour, high popularity and sales with high price on consumer market in Japan[1].It is a late mature cultivar with wide peel citrus with great comprehensive characters[2].However, in some areas, the tree has premature aging, and the fruit has high acidity. And the citrus varieties have some problems, such as unreasonable variety structure, too many fruits on the market, lacking of excellent quality varieties and so on. At present, most of the citrus varieties cultivated in production have been introduced from abroad, and the same variety often shows different performance under different ecological conditions[3].Therefore, it is of great practical significance and theoretical value to introduce and evaluate the varieties suitable for cultivation in Sichuan and even in southern China[4]. On the basis of related researches, the area promotion of the suspected Siranui budding strain (Lemon Siranui) [5] was found in Pujiang, Danling, Renshou and other places. Compared to Siranui, the peel of Lemon Siranui with a goose-yellow color was paler and the juice color was lighter. This study will compare the differences between Lemon Siranui and Siranui from the perspectives of morphological characteristics, physiological characteristics, phenological changes and fruit quality. The purpose of this study is to provide experimental basis for identifying the excellent characteristics of the strain and theoretical reference to identify the strain.
2. Materials and Methods

2.1 Experimental materials
Two different varieties of *citrus* with red tangerine as rootstock were Siranui and Lemon Siranui (the suspected budding strain). The experimental materials were planted in Chaoyang lake town.

2.2 Experimental design
Fruits were randomly selected from plants with good growth results. Samples were collected evenly from different parts of a fixed single plant with uniform fruit size. Diseased fruits, insect-infested fruits and stunted fruits were removed.

2.3 Test methods

2.3.1 Comparison of phenological survey results. From June 2017 to April 2018, the phenological period of Siranui and Lemon Siranui were investigated in 15 days[6-7].

2.3.2 Determination of the tree’s condition. Trunk height: the length from the ground to the first main branch was measured. Dry perimeter: the maximum straight-line distance between the east-west and north-south directions of the tree body on the ground was measured. Crown diameter: the maximum straight-line distance between east, west and north and south of the tree on the ground was measured. Large branch group: more than 3 times branches within more than 60 cm in length were counted. Medium branch group: 2-3 times branches within 30-60 cm in length were counted.

2.3.3 Comparison of fruit quality characteristics. Single fruit weight: fruit samples with electronic balance were weighed; fruit vertical and horizontal diameters were measured with vernier calipers and the fruit shape index was calculated. Total soluble solids (TSS) were measured with a hand-held sugar meter [8]; vitamin C (Vc) was measured with a 1,10-phenanthroline spectrophotometer [9]; titratable acid was determined by acid-base titration method [9].

3. Results and analysis

3.1 Phenological survey
As shown in Table 1. The full growth period of Lemon Siranui was about 5 days longer than Siranui. From the flowering point, the whole flowering period of Lemon Siranui and Siranui were about 18 days and 20 days, respectively. From the time of physiological fruit drop, the physiological fruit drop period of Siranui was about 5-7 d earlier than Lemon Siranui. The color change period of Siranui was longer than Lemon Siranui by about 5 d in advance. From the maturity stage, Siranui entered maturity after February 5th, and Lemon Siranui entered maturity after February 15th.

Table 1. Phenological record survey.

| Variety      | Full growth period | First flowering period | Fruit bloom | First physiological fruit drop | Second physiological fruit drop | Fruit coloring period | Fruit mature period |
|--------------|-------------------|------------------------|------------|-------------------------------|---------------------------------|-----------------------|---------------------|
| Lemon Siranui| 305 d             | 4.13                   | 5.01       | 5.15-6.05                    | 6.19-7.10                       | 11.10-12.09           | 2.15                |
| Siranui      | 300 d             | 4.04                   | 4.23       | 5.10-5.30                    | 6.13-7.02                       | 11.05-12.01           | 2.05                |

3.2 The tree’s condition survey
As shown in Table 2, there was a significant difference between the trunk height and the dry perimeter length of Lemon Siranui and Siranui. The average trunk of Siranui was 41.40±2.01 cm, which was about 1.4 times than Siranui. The average dry perimeter of Lemon Siranui was 40.31±2.33 cm, which was approximately 2 times than Siranui. There was no obvious difference in crown diameter and the
amounts of large branch groups and medium branch groups between the two citrus varieties. But the numbers of large and medium branches of Lemon Siranui were more than Siranui.

Table 2. Comparison of two citrus varieties' condition.

| Variety  | Trunk height(cm) | Stem circumference (cm) | Crown diameter(cm) | Large branch group(piece) | Medium branch group(piece) |
|----------|------------------|-------------------------|-------------------|--------------------------|---------------------------|
| Lemon Siranui | 41.40±2.01a | 40.31±2.33a | 268.20±7.98a | 5.70±0.33a | 8.00±0.36a |
| Siranui  | 29.72±1.42b | 26.87±1.79b | 258.6±12.22a | 4.67±0.33a | 7.35±0.33a |

Note: Different letters indicate significant differences between different varieties (P<0.05).

3.3 Fruit quality determination

3.3.1 Fruit appearance quality determination. During fruit development, the amount of single fruit generally showed an upward trend (figure 1). After January, the weight of single fruit of Siranui grew slowly, while the weight of single fruit of Lemon Siranui was only gradually stabilized after March. At maturity, the single fruit weight of Lemon Siranui was 262.81±5.77 g, which was higher than Siranui. The overall fruit shape index of the two varieties fruits showed a downward trend (figure 2). The fruit shape index of Siranui started to rise after mid-January, and it was 0.99±0.06 at maturity. The fruit shape index of Lemon Siranui started to rise after mid-March, and it was 0.93±0.02 when mature.

3.3.2 Fruit nutritional quality determination. The TSS content showed an overall upward trend during fruit development (figure 3). The TSS content of Lemon Siranui increased significantly after mid-January and reached 14.90±1.37% until maturity; the TSS content of Siranui increased slowly from January to Marchand then the growth rate increased significantly, its TSS content reached 14.50±0.60% until maturity. The Vc content of the fruits were generally decreasing (figure 4). After mid-January, the Vc content of the two varieties fruits was decreasing similarly. When mature, the Vc
content of Lemon Siranui was higher than Siranui. The titratable acid content of the two varieties fruits was generally decreasing (figure 5). The titratable acid content of the two varieties fruits was decreasing obviously before mid-January, and then the rate of declining was slowing down. The titratable acid content of Siranui was 1.07±0.02 g·mL⁻¹ when mature, which was higher than Lemon Siranui.

4. Discussion and conclusion
According to the analysis of pheno logical observation, the flowering period, physiological fruit-dropping period, fruit turning period, and maturity period of Lemon Siranui were about 5-7 days later than Siranui. Lemon Siranui had a higher trunk and longer perimeter. The crown diameter of Lemon Siranui was larger than Siranui, and the amounts of large branch group and medium-sized branch group were also slightly higher than Siranui. The research results showed that, at maturity, compared to Siranui, the average single fruit weight of Lemon Siranui was larger and the fruit shape index was smaller. During fruit development, the TSS, total sugar contents and sugar-acid ratios of the two varieties fruits were generally higher than those at the earlier stage of development, while the content of titratable acid and Vc were gradually decreasing. In general, the TSS content of Lemon Siranui reached 14.90±1.37% higher than Siranui when mature, the Vc content of Lemon Siranui (30.71±0.75 mg·100mL⁻¹) was significantly higher than Siranui, while the titratable acid content of Lemon Siranui was lower than Siranui (1.07±0.02 g·mL⁻¹).

In summary, there were no significant differences in the phenological stages of the two citrus varieties, but the Lemon Siranui tree was stronger than Siranui. Compared to Siranui, Lemon Siranui was oblate and the fruit was larger, meantime the contents of Vc and TSS of Lemon Siranui were higher and acid content was lower. It was obviously indicated that Lemon Siranui was a new high-quality strain citrus variety with excellent properties.

Acknowledgments
I would like to give my sincere gratitude to professor wang zhihui, my tutor who, with extraordinary patience and consistent encouragement, gave me great help by providing me with necessary materials, advice of great value and inspiration of new ideas. It was his suggestions that draw my attention to a number of deficiencies and made many things clearer. Without his strong support, this thesis could not be the present form. My heartfelt thanks also to the people who have offered me valuable help.

References
[1] Liu J.S., Li H.M., He N.X.C. (2019) Biological characters of ‘Siranui’ Tangor and its cultural technique. Green Science and Technology, (09): 87-91.
[2] Dan Y. (2008) Status, development trends and countermeasures of China’s citrus industry. Chinese Journal of Food Science, 8(1): 1-8.
[3] Li X.L., Hong L., Wang W., et al. (2018) Comprehensive evaluation of fruit quality of new late-maturing hybrid citrus varieties. Journal of Fruit Trees, 35(2): 195-203.
[4] Li J.F., Xiang Z.H., Deng X.X. (2009) Exploring the origin of natural citrus hybrid Zigui Tangor. Journal of Fruit Trees, 26(4): 425-430.
[5] Zhang M., Deng X.X. (2006) Research advances in citrus bud selection and formation mechanism. Journal of Fruit Trees, 23(6): 871-876.
[6] Chen Z.S. (2012) Chinese late-maturing citrus varieties and their characteristics. China Fruit Industry Information, (1): 14-18.
[7] Lado J., Gambetta G., Zacarias L. (2018) Key determinants of citrus fruit quality: Metabolites and main changes during maturation. Scientia Horticulturae, 233: 238-248.
[8] Mitcham B., Cantwell M., Kader A. (1996) Methods for determining quality of fresh commodities. Perishables Handling Newsletter, 85: 1-6
[9] Chen G., Li S. (2016) Plant Physiology Experiment. Beijing: Beijing Higher Education Press.