Study on the Fruit Quality of Different Canopy and Tree Shapes of Huangguogan Citrus

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Abstract. In this paper, Shimian yellow citrus fruit was used as material to study the differences of HuangGuo citrus fruit strains by sampling, measuring and analyzing the fruit quality according to different shapes and canopy. The results showed that: in the yellow fruit citrus plants fruit quality was better than the performance of the lower part of the upper canopy, appearance quality did not change significantly, little difference; intrinsic quality significantly different soluble solids and sugar content than other obvious difference; round tree fruit quality was better than natural growth happy shape and form.

1 Introduction

Huangguogan, belonging to the genus Rutaceae Citrus, is a new hybrid orange variety selected by Sichuan Agricultural University [1]. Originally produced in Xinmian Town, Shimian County, Sichuan Province, it is especially suitable for planting in dry and hot valleys at an altitude of 700~1200 m. Huangguogan has excellent fruit quality, high yield and high yield, late maturity and storability, strong stress resistance, crispy and juicy meat, sweet and sour and delicious, relatively slag, and is deeply loved by the masses in Sichuan and Yunnan [2]. However, in recent years, the research of Huangguogan has found that the fruit shape was very different, the fruit quality was uneven, and the fruit quality difference between and within the plant was obvious.

It was of great significance to explore the fruit quality differences of different canopies and different tree shapes in Huangguogan, and it was of great significance to in-depth study to find out the reasons for its formation, and to further improve the quality of Huangguogan fruit and increase the consistency of its fruit quality. The investigation on the different performance of different canopy fruit quality in Shimian Huangguogan plant and the relationship between different tree shapes and fruit quality are carried out to provide a theoretical basis for further research and promote the development of Shimian Huangguogan industry.

2 Materials and Methods

2.1 Experimental materials

In Shimian County, 9 trees with a row spacing of 3×4 m and an 8-year-old tree were basically uniform and robust. They were 3 round-headed trees, 3 open-hearted trees, and 3 natural-growing trees.

2.2 Sample Collection

The method of Wei Qinping, Wertheim, and Wagenmarkers [3] divided it into three canopies: upper, middle and lower canopy; the fruits were picked in 4 directions of east, south, west, and north on each layer, and 3 fruits were picked at each point, and they were mixed as a layer for sampling; the fruit quality of 12 points was mixed into one fruit quality of the tree.

2.3 Sample determination

Single fruit was measured by electronic balance, measured three times in total, and then averaged; horizontal and vertical diameters were measured with vernier calipers, soluble solids were measured with WYT-4 handheld refractometer [4]; vitamin C content was measured with 2,6-dichloro Phenol indophenol titration method; titratable acid content is measured by NaOH neutralization titration; reducing sugar and invert sugar content are measured by Fehling solution redox titration [5], and the total sugar content is calculated.

2.4 Statistical Analysis

The test data used Office Excel (2003) software and (2013) for statistical analysis, analysis of variance and significance analysis.
3 Results and analysis

3.1 Different canopies of Huangguogan fruit quality

The results of fruit appearance quality measurement (Table 1) showed that the average fruit weight of different canopy fruits was between 132.07-130.15 g. The fruit weight of the upper layer was the largest, and the fruit weight of the lower layer was the smallest. The vertical and horizontal diameters of different canopy fruits were the largest in the upper layer, 6.60 cm and 6.47 cm, respectively; the lower fruit shape index was the largest. However, there was no significant difference in the appearance quality of the fruits in the upper, middle and lower canopies.

The results of the intrinsic quality of the fruit (Table 2) showed that the internal quality of the fruit, soluble solids, vitamin C, titratable acid, and sugar content were the highest in the upper canopy, the middle layer, and the lowest in the lower layer. The sugar-acid ratio of the fruit was the highest in the upper canopy, the lower and the middle layer, the lowest, but the difference was small.

| Table 1. Differences in appearance quality of Huangguogan fruits with different canopies. |
|-----------------------------------------------|
| Different canopy | Single fruit weight/g | Longitudinal diameter/cm | Horizontal diameter/cm | Fruit shape index |
| Upper part | 132.07a | 6.60a | 6.47a | 1.02 |
| Central | 131.98a | 6.58a | 6.46a | 1.02 |
| Lower part | 130.15a | 6.56a | 6.40a | 1.03 |

Note: The LSD method was used to test the significance of differences. The same letters indicated that the difference was not significant, lowercase letters indicate 5% significance level, and uppercase letters indicate 1% significance level. The same below.

| Table 2. Differences in internal quality of Huangguogan fruits with different canopies. |
|-----------------------------------------------|
| Different canopy | TSS /% | Vc /mg·100 mL⁻¹ | Acid /mg·100 mL⁻¹ | Reducing sugar /mg·100 mL⁻¹ | Invert sugar /mg·100 mL⁻¹ | Total sugar /mg·100 mL⁻¹ | Sugar-acid ratio |
| Upper part | 11.24aA | 30.78aA | 0.86aA | 4.75aA | 9.59aA | 9.34aA | 10.96 |
| Central | 10.98abAB | 29.84aAB | 0.85aA | 4.51aA | 9.20abAB | 8.97abAB | 10.43 |
| Lower part | 10.62bB | 28.28bB | 0.82aA | 4.17bB | 9.03bB | 8.79bB | 10.71 |

3.2 Different tree shape Huangguogan fruit quality difference performance

The results of the appearance quality of different tree-shaped fruits (Table 3) showed the appearance quality of the round-headed fruit was slightly better than that of the other two tree shapes, but there was no significant difference in the fruit appearance quality of the three tree shapes.

The results of the internal quality of different tree-shaped fruits (Table 4) showed that the soluble solids, vitamin C, and titratable acid content of different tree-shaped fruits had no significant differences, but there were significant differences in the sugar content of different tree-shaped fruits. Naturally grown fruits had the lowest reducing sugar at 4.32 mg·100 mL⁻¹, which was significantly lower than round-headed and open-hearted fruits; the highest inverted sugar content of round-headed fruits was 9.52 mg·100 mL⁻¹, and the lowest content of natural growth was 8.94 mg·100 mL⁻¹. There were significant differences in sugar content between different tree shapes, and the total sugar content of the natural growth shape (8.71 mg·100 mL⁻¹) was extremely significantly lower than the round head shape and the open shape.

| Table 3. Different tree shapes of Huangguogan fruit appearance quality difference performance. |
|-----------------------------------------------|
| Tree shape | Single fruit weight/g | Longitudinal diameter/cm | Horizontal diameter/cm | Fruit shape index |
| Open heart shape | 129.66a | 6.49a | 6.47a | 1.00 |
| Round head shape | 140.20a | 6.76a | 6.60a | 1.03 |
| Natural growth shape | 122.17a | 6.49a | 6.49a | 1.00 |
4 Discussion and Conclusion

There were many factors that affect the quality of citrus, including fertilization, irrigation, the use of soil wet growth regulators, and the position of the fruit on the tree. From this study, it can be seen that there were significant differences in fruit quality between different levels of Huangguogan canopy, and the difference in appearance quality was small and not significant; the differences in soluble solids, vitamin C, and sugar content are more obvious. The overall performance was that the quality of the upper layer of the canopy was better than the lower layer, which was the same as the results of most people’s research.

The level of soluble solids content had an important impact on the nutritional value, flavor and taste, and actual yield of the fruit. Wang Lihong [6] studied the correlation between different parts of the citrus crown and fruit quality and showed that the content of soluble solids was the highest in the middle and upper part of the crown, while the lower part and the periphery were lower than the inner part of the crown, which was extremely different from each other. In this experiment, the upper layer of the soluble solids canopy was higher than the lower layer.

Fruit quality largely depends on the type and amount of sugar contained in the fruit. The change of total sugar in different canopies of Huangguogan plant was characterized by higher content in the upper canopy, second in the middle, and lowest in the lower part. This was directly related to the position of the fruit and the planting density. If the canopy shades each other and the light transmittance of the tree, adjust the light energy distribution and nutrient distribution of the tree, and help improve the quality of Huangguogan fruit. However, the reasons for these differences and the improvement methods need to be further studied.

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References

1. L.M.M., Liu, W.Q., Luo, H.Y., Wu, (2017) Study on the Whole Green Prevention and Control Model of Huangguogan in Shimian County, Farm Technology. 000(010):93.
2. D.H., Wang, J.T., Li. (1991) The selection and breeding of the fine line of Huangguogan-Guiwankan, Chinese Citrus., 20(3):3.
3. S.J., Wertheim, P.S., Wagenmarkers. (2001) Orchard systems for apple and pear condtions for success. Acta Hort., 557:209-227.
4. C.L., Jiang, L.Z., Peng., L. Cao. (2006) The difference of soluble solid content between individual citrus fruits and different parts of the fruit. South China Fruit Tree., 35(2):3-5.
5. Shanghai Institute of Plant Physiology, (1999) A Guide to Modern Plant Physiology Experiments. Science Press, Shanghai.
6. L.H., Wang, H.L., Zhang, L.Q., Teng. (1997) Investigation on the Correlation between Different Parts of Citrus Crown and Fruit Quality. Zhejiang Citrus., 14(3).
7. S.S., Peng, Z.Y., Peng. (1994) *Study on the Quality of Citrus Fruit*. Hunan Agricultural Sciences, Hunan.

8. S.B., Hong, X.H., Fan, X.P., Wang. (1989) *The Microclimate Characteristics of Wenzhou Tangerine Canopy and Its Effect on Fruit Yield and Quality*. Chinese Agricultural Meteorology., 10(2):16-19.