Effects of Different Organic Fertilizer Treatments on Fruit Quality of a Citrus Cultivar (Huangguogan)

Xu Zhang[1, a], Yi Gao[1, b], Zhihui Wang [2, c]

[1]College of Horticulture, Sichuan Agricultural University, Chengdu, Sichuan, China

[2]Institute of Pomology & Olericulture, Sichuan Agricultural University, Chengdu, Sichuan, China

[a]806174404@qq.com, [b]461154339@qq.com, [c]wangzhihui318@126.com

Keywords: Huangguogan; Organic fertilizer; Fruit external quality; Fruit internal quality.

Abstract. In order to reduce the acid content of Huangguogan and improve the fruit quality, this experiment used Huangguogan as the test material and designed 7 organic manure treatments for its four key fertilization periods. The internal and external quality of each treated fruit was measured and analyzed. The test results are as follows: Different organic fertilizers can improve the internal and external quality of Huangguogan. In addition to no significant effect on the fruit shape index, all indicators are significantly better than the control. The use of bio-organic fertilizer as the base fertilizer treatment 3 and treatment 6 soluble sugar increased by 9.3% and 22%, and the titratable acid (TA) decreased by 30.85% and 26.60%. Meanwhile, the sugar-acid ratio increased by 56.82% and 66.55%. The effects of increasing sugar and reducing acid were most obvious. It can be applied to the actual production industry of Huangguogan.

1. Introduction

Huangguogan is a kind of natural hybrid citrus with independent intellectual property rights in China [1]. It has many excellent economic traits such as late maturity, non-nuclear, high quality, high yield and so on [2]. Increasing the sugar content and reducing the acid content in citrus are hotspots and difficulties of research. Studies have shown that the application of bio-organic fertilizers as base fertilizer can significantly promote citrus growth and increase yield. Organic fertilizer contains a large amount of organic matter, inorganic matter and beneficial microorganism [3]. When applied to soil, it can enhance soil enzyme activity, promote the release of soil insoluble mineral nutrients, and further improve soil nutrient availability [4,5]. As an important management tool, orchard fertilization plays an important role in improving fruit yield and quality. In recent years, because of the unique advantages of Huangguogan, the sales volume of Huangguogan has increased year by year. With the increase of economic benefits, the planting area of Huangguogan has increased correspondingly. But many problems have appeared one after another, for example the difference in the appearance quality of fruits. There are many kinds of fertilizers on the market, and it is difficult for fruit farmers to choose a suitable fertilizer, and the fertilizer pollution is very serious. In this experiment, the effects of different organic fertilizer treatments on the organic acids and fruit quality of Huangguogan were studied, and the organic fertilizer formula with the best influence on fruit quality was obtained. Thereby promoting the development of the Huangguogan industry.

2. Materials and Methods

Test materials. The materials used in this experiment are 24 trees with the same basic tree shape and the same level of management in the previous period. They are provided by the Huangguogan Standardization Demonstration Park in Shimian County, Ya'an City, Sichuan Province.

Test location. It is between 102°23'-102°29' east longitude and 29°17'-29°33' north latitude. The annual average temperature is 13~17 °C, and the average temperature in January is 5-8 °C. The absolute temperature is -1 °C, and the annual effective accumulated temperature is 4000~6500 °C, and the frost-free period is 250-300 d. It belongs to the climate type of the middle and subtropical

  DOI: 10.25236/iczbe.2018.019

dry-hot valley.

Test design. 7 treatments were set up (see Table 1 for details). The fertilization stage of each treatment was: Application of base fertilizer and germination flowering fertilizer in mid-April; blossom fall fertilizer was applied in mid-May; strong fruit fertilizer was applied in mid-July; color-changing fertilizer in mid-September. The plants were treated as single cells, and each treatment was repeated 3 times, and the conventional fertilization treatment was used as a control.

Table 1 Fertilizer selection and dosage (kg)

Fertilization stage	T_1	T_2	T_3	T_4	T_5	T_6	T_7
Base fertilizer and Germination flowering fertilizer	A10.0 B0.5 C1.0 D0.1 E0.15	A10.0 B0.5 C1.0 D0.1 E0.15	A10.0 B0.5 C1.0 D0.1 E0.15	A10.0 I 1.5 D 0.1 E 0.15	L 5.0 A 5.0 I 1.5 D 0.1 E 0.15	A10.0 I 1.5 D 0.1 E 0.15	L10.0 I 1.5 D 0.1 E 0.15
Blossom fall fertilizer	F0.2 C0.75	F0.2 C0.75	F 0.2 C0.75	F0.2 J0.75	F0.2 C0.75	F0.2 J0.75	F0.2 J0.75
Strong fruit fertilizer	F0.2 C0.75	F0.2 C0.75	F0.2 C0.75	F0.2 J0.75	F0.2 C0.75	F0.2 K0.75	F0.2 K0.75
Color-changing fertilizer	G0.1 H0.1 C0.75	G 0.2 C0.75	H 0.2 C0.75	G0.2 K0.75	H0.2 C0.75	H0.2 K0.75	H0.2 K0.75

Note: A represents the bio-organic fertilizer 'hales'; B represents the imported compound fertilizer 'Noteck' (45% pure nitrogen); C represents the imported compound fertilizer 'Micro mass force' (high potassium 12-12-17); D represents the “micro-quality” of trace element fertilizer in the import; E represents alginic acid rooting fertilizer; F represents the imported water soluble fertilizer (balance 20-20-20); G represents the imported water soluble fertilizer (high potassium 15-5-35); H represents the imported water soluble fertilizer (high phosphorus 10-52-10); I represents the domestic high-grade compound fertilizer (high nitrogen 25-5-15); J represents that the domestic high-grade compound fertilizer is (balance 15-15-15); K represents the domestic high-grade compound fertilizer (high potassium 15-5-20); L represents organic fertilizer.

3. Results

Effects of different organic fertilizer treatments on the external quality of Huangguogan. It can be seen from Table 2 that there were no significant differences in the fruit shape index of Huangguogan with the treatment of the seven organic fertilizers. However, it had a significant impact on the weight of single fruit and the longitudinal and transverse diameters. The weight of each treatment was 9.29% higher than that of the control, and the single fruit weight in treatment 6 was 46.87% higher than that of the control single fruit. It showed that organic fertilizer could improve the external quality of Huangguogan.

Table 2 Effects of different organic fertilizer treatments on the external quality of Huangguogan

Treatment	Longitudinal diameter(cm)	Diameter (cm)	per fruit weight (g)	Fruit shape index
CK	6.00 ± 0.20b	6.21 ± 0.15b	125.23 ± 8.21c	0.97 ± 0.05a
1	6.36 ± 0.20b	6.26 ± 0.22ab	144.31 ± 5.04abc	1.02 ± 0.06a
2	6.14 ± 0.19b	6.40 ± 0.17ab	136.87 ± 5.62bc	0.96 ± 0.05a
3	6.38 ± 0.08b	6.38 ± 0.04ab	157.94 ± 4.82abc	1.00 ± 0.02a
4	6.25 ± 0.07b	6.13 ± 0.14b	141.76 ± 4.38abc	1.02 ± 0.04a
5	6.77 ± 0.36b	6.50 ± 0.38ab	166.03 ± 25.46abc	1.04 ± 0.02a
6	7.38 ± 0.44a	6.89 ± 0.20a	183.93 ± 17.58a	1.07 ± 0.03a
7	6.75 ± 0.37ab	6.74 ± 0.10ab	170.31 ± 13.15ab	1.00 ± 0.04a

Note: Different lowercase letters in the same column data indicate significant difference（$P<0.05$）

Effects of different organic fertilizer treatments on the internal quality of Huangguogan. It can be seen from Table 3 that the content of TSS in the Huangguogan increased by 0.33% ~ 2.5% after treatment with 7 organic fertilizers. Treatment 3 had the highest TSS content of 14.00%; The Vc content in the Huangguogan increased by 13.55%~43.07% after treatment with 7 organic fertilizers, and the Vc content of treatment 6 was the highest, reaching 42.02 mg ·100mL^{-1}. The soluble sugar content of each treatment was between 8.04 g · 100mL^{-1} ~ 9.98 g · 100mL^{-1}. Except for treatment 7, the soluble sugar content of it increased by 4% compared with CK after the other six organic fertilizers. The titratable acid(TA) content of each treatment was between 0.65 g · 100mL^{-1} and 0.94 g·100mL^{-1}. The titratable acid(TA) content of it reduced by 9.57%~30.85% after 7 organic fertilizers. Among them, the titratable acid(TA) content of treatment 3 was the most lowest, only 0.65 g ·100 mL^{-1}. The ratio of sugar-acid in the treatment was between 7.70 ~ 14.46. After the combination of 7 organic fertilizers, the CK of the it increased by 17.35% ~ 66.21%, and the ratio of sugar-acid of treatment 6 was the highest, reaching 14.46.

Table 3 Effects of different organic fertilizer treatments on the internal quality of Huangguogan

Treat-ment	Soluble sugar (g·100mL^{-1})	TA (g·100mL^{-1})	Vc (mg·100mL^{-1})	TSS (%)	Sugar - acid ratio
CK	8.18 ± 0.02f	0.94 ± 0.012a	29.37 ± 1.05e	11.50 ± 0.17d	8.70 ± 0.11f
1	9.05 ± 0.04b	0.73 ± 0.007d	34.89 ± 0.5cd	12.73 ± 0.5bc	12.40 ± 0.13c
2	8.68 ± 0.01d	0.85 ± 0.012b	34.96 ± 0.35cd	12.40 ± 0.25bcd	10.21 ± 0.16e
3	8.94 ± 0.05c	0.65 ± 0.007f	39.26 ± 0.73ab	14.00 ± 0.6a	13.75 ± 0.12b
4	8.50 ± 0.02e	0.76 ± 0.015cd	35.17 ± 0.6cd	13.30 ± 0.15ab	11.18 ± 0.37d
5	8.52 ± 0.02e	0.78 ± 0.009c	37.37 ± 1.45bc	13.00 ± 0.12ab	10.92 ± 0.25d
6	9.98 ± 0.05a	0.69 ± 0.009e	42.02 ± 2.17a	13.03 ± 0.18ab	14.46 ± 0.42a
7	8.04 ± 0.05g	0.74 ± 0.003d	33.35 ± 0.32d	11.83 ± 0.35cd	10.86 ± 0.11d

Note: Different lowercase letters in the same column data indicate significant difference（$P<0.05$）

4. Discussion and Conclusion

The weight of single fruit, the content of soluble solids and the ratio of sugar-acid are the basic factors for measuring the quality. The ratio of sugar-acid is an important indicator reflecting the intrinsic quality of the fruit. The higher the ratio of sugar-acid is, the better the quality of the fruit is [6]. Hongwei Wang showed that the application of organic fertilizer could significantly improve the fruit quality of red Fuji apples. It could accumulate soluble solids in fruits, reduce the content of organic acids, and improve fruit flavor [7]. Yuxin Wang showed that seaweed organic fertilizer

could significantly increase the net photosynthetic rate and photosynthetic pigment content of the peach leaf, which could effectively reduce the acidity of the fruit, greatly increase the sugar-acid ratio of the fruit, and play a significant role in improving fruit quality [8]. Meirong Fan studied the effects of organic-inorganic compound fertilizer on citrus yield and quality, and believed that organic and inorganic compound fertilizer could increase citrus yield, improve fruit quality and improve economic benefits. And it could increase the Vc content, soluble total sugar content, sugar acid ratio and soluble solids percentage of citrus fruits, and reduce the titratable acid content [9]. The experimental study showed that compared with the application of a single compound fertilizer, the organic fertilizer significantly improved the fruit quality of Huangguogan. The seven organic fertilizer treatments set in the experiment have significantly improved the single fruit weight and the ratio of sugar-acid of the Huangguogan. The content of soluble solids and soluble sugar in the fruit also increased to some extent, and the content of titratable acid (TA) in the treated fruit also decreased significantly. This is consistent with the results of previous studies. Combine the above results, treatment 3 and treatment 6 are organic fertilizer formulations that have the best effect on fruit quality. This test also provides a theoretical basis for the standardized production of Huangguogan, which can be applied to the development of the industry of Huangguogan.

References

[1] Zhaomin Shen. Chinese citrus division and citrus varieties [M]. Beijing: China Agricultural Science and Technology Press, 1998.

[2] Dahua Wang, Tianxi Li. Breeding of fine fruits of Huangguogan——Guiwan Orange[J]. South China Fruit Tree, 2012(3): 3-5.

[3] Xueqi Pu. Study on the effect of increasing sugar and acid on Huangguogan [D]. Ya'an, Sichuan Agricultural University, 2013.

[4] Katz E, Fon M, Lee Y J, et al. The citrus fruit proteome: Insights into citrus fruit metabolism[J]. Planta, 2015, 226(4): 989-1005.

[5] Cercós M, Soler G, Iglesias D J, et al. Global analysis of gene expression during development and ripening of citrus fruit flesh. A proposed mechanism for citric acid utilization[J]. Plant Molecular Biology, 2006, 62(4): 513-527.

[6] Ying Li. Effects of different organic fertilizers on yield and quality of organic tomatoes and soil nutrients[D]. Beijing, China Agricultural University, 2005.

[7] Hongwei Wang, Lianzhong Zhang, Keguo Lu. Effects of organic fertilizer on the growth and quality of Red Fuji apple[J]. Anhui Agricultural Sciences, 2009, 37(28): 3572-3573.

[8] Yuxin Wang. Effects of organic manure on soil nutrient, tree nutrition and fruit quality of fat peach [D]. Tai'an, Shandong Agricultural University, 2015.

[9] Meirong Fan, Haitao Tang, Yulin Liao, et al. Effects of organic-inorganic compound fertilizer on citrus yield and quality[J]. Chinese Journal of Soil and Fertilizer, 2009(04): 71-73.