

## Effect of different iron preparations on Citrus Cultivar (Kiyomi tangor) iron deficiency chlorosis

Lijuan Xi<sup>1,a</sup>, Qingqing Xi<sup>1,b</sup>, Hongmei Dan<sup>1,c</sup>, Zhihui Wang<sup>2,d</sup>

<sup>1</sup>College of Horticulture, Sichuan Agricultural University, Chengdu, Sichuan, China

<sup>2</sup>Institute of Pomology & Olericulture, Sichuan Agricultural University, Chengdu, Sichuan, China

<sup>a</sup>571077526@qq.com, <sup>b</sup>1273496370@qq.com, <sup>c</sup>9160011884@qq.com,

<sup>d</sup>Wangzhihui318@126.com

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**Abstract.** In this study, Kiyomi tangor fruit tree with iron deficiency xanthation in Jinhua town, Shaohong County, Suining city, Sichuan province was studied. Different iron preparations (ferric citrate, compound amino acid ferric, ferrous sulfate, ferric humate and ferrous lactate) were applied on the surface of the leaves and soil. In contrast to water, the effects of SPAD value (relative content of chlorophyll) and fruit quality of clear fruit were detected. To compare the effect of different iron preparations on the correction of fruit tree ferriosis. The experimental results show that the effects of different iron preparations on the treatment of fe-deficient xanthosis of fruit trees were different, Among several iron preparations tested, compound amino acid iron and ferric citrate have the best treatment effect. Application of iron not only increased the relative content of chlorophyll in the leaves of fruit trees, in addition, the content of vitamin C, soluble solids and total sugar in the clear fruit was increased, and the content of total acid in the clear fruit was reduced. Effectively improve the intrinsic quality of clear fruit.

### 1. Introduction

Kiyomi tangor is a kind of hybrid mandarin bred by the hybridization of wenzhou-mian orange and trovitan-sweet orange in miyagawa<sup>[1]</sup>. It was introduced into China in the late 1980s<sup>[2]</sup>. The flesh of the fruit was clear orange, the slag was easy to be melted, and the flavor was better<sup>[3]</sup>. It has a good comprehensive performance, is popular in the market<sup>[4]</sup>. At the same time, its listing can stagger the sales peak, which can better reduce the pressure brought by the centralized listing and improve the agricultural economic earnings.

Iron deficiency yellowing in fruit trees is a common physiological disease, especially in citrus<sup>[5]</sup>. Because of the plant necessity of iron, the fruit tree plants showed special physiological responses when iron was deficient<sup>[6]</sup>. Severe shortage could lead to death of fruit trees<sup>[7]</sup>, causing great losses. In the calcareous soil area in the northwest of China, one of the major problems troubling fruit production is the iron deficiency of fruit trees<sup>[8]</sup>.

At present, there are many studies on the correlation of iron deficiency in fruit trees. The conventional correction methods include rhizospheric fertilization<sup>[9]</sup>, iron spraying<sup>[10]</sup>. According to studies conducted by Sulu et al.<sup>[11]</sup>, the application of branch stem injection with appropriate concentration of ferrous sulfate or ferric sulfate can effectively correct the iron deficiency of apple. In view of this, in this study, different iron preparations were applied on leaves and soil to explore the effect of different iron preparations on the treatment of xanthellosis. Select the most suitable iron preparation for ferric deficiency yellowing in alkaline purple soil. The aim is to provide scientific basis for the establishment of iron deficiency correction technology.

### 2. Materials and Methods

**Test materials.** The clear-sighted fruit trees with iron deficiency and normal clear-sighted fruit trees without iron deficiency were selected as the test material, with the age of 5a. There are 5 kinds of ferric sulfate, compound amino acid ferric, citric acid ferric, humic acid ferric and ferrous lactate, and the last 4 kinds are prepared by the corresponding organic acid and ferrous sulfate reagent in a certain proportion in the laboratory.

**Test location.** The experimental garden is located in the Kiyomi tangor base of west sanping, Jinhua town, Shaohong county, Suining city, Sichuan province. The experimental park mainly consists of shallow hills, together with dam land, low organic matter content, alkaline purple soil, barren and arid soil, poor water and fertilizer conservation, belonging to subtropical humid climate of Sichuan basin.

**Test design.** In this study, there were 6 treatments: clear water (CK), ferrous sulfate, compound amino acid iron, ferric citrate, ferric humate and ferrous lactate. Normal control was set for the experiment, and the plants of normal control were selected and adjacent to the yellowing plants in the experiment. All application methods of iron preparation were leaf spraying and soil spraying, with single plant as plot, repeated 3 times. The iron preparation was sprayed at the leaf development stage, fruit setting stage and fruit expansion stage. 5l iron preparation with a concentration of 0.25 % was prepared before spraying. The spraying quantity of each tree was about 0.5l, and the amount of soil was 10 times than that of foliar spraying. Spraying time was selected around 9 am. It is advisable to spray the fruit tree leaves in the shape of dripping water on the front and back. After spraying iron preparations on the leaves, a circular groove was dug along the drip line of the tree canopy.

**Sampling.** Collect the leaves of normal and yellow plants, The first sample was taken at the new shoot stage of the plant, the second sample was taken at the leaf spread stage 7 days after applying different iron preparations, the third sample was taken at the fruit set stage 7 days after applying different iron preparations, and the fourth sample was taken at the fruit expansion stage 7 days after applying different iron preparations. After the fruits were ripe, two fruits were picked at random from four different directions of the plant: east, south, west and north, and a total of 8 fruits were taken to the laboratory to determine the fruit quality.

### 3. Results

**Effects of different iron preparations on chlorophyll content in chlorophyll in leaves.** As can be seen from table 1, the relative content of chlorophyll in normal leaves was significantly higher than that in other treatments before the application of iron preparation. As a whole, it could be seen that the relative content of chlorophyll in fruit trees increased from the leaf opening to the mature stage. After iron preparation was applied at the leaf development stage, the relative content of chlorophyll in each treatment of iron preparation was higher than that of the control group, and the content of compound amino acid iron was the highest, reaching 50.15.

Table 1. Effect of different iron preparations on chlorophyll content in leaves

Treatment	Before fertilization	After fertilization		
	New shoots period	Germination-frondesce stage	Fruit period	Fruit swelling period
CK	(40.94±0.58) bc	(41.12±0.55) c	(43.45±0.33) d	(45.31±0.55) c
Ferrous sulfate	(40.35±0.27) bc	(43.96±0.43) c	(49.96±0.35) c	(54.78±0.22) b
Ferric citrate	(42.11±0.19) b	(49.98±0.23) b	(60.93±0.41) b	(70.13±0.34) a
Compound amino acid Chelate iron	(39.98±0.41) d	(50.15±0.77) b	(61.28±0.70) b	(71.22±0.87) a
Fenous lactate	(41.51±0.21) b	(45.81±0.43) bc	(53.41±0.31) c	(61.58±0.57) b
Ferric humate	(41.98±0.22) b	(45.92±0.65) bc	(53.25 ±0.43) c	(61.26±0.63) b
The normal plants	(70.15±0.09) a	(71.61±0.34) a	(73.54±0.25) a	(75.89±0.32) a

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

**Effects of different iron preparations on the external quality of fruit.** According to table 2, the weight per fruit of the fruits treated with different iron preparations was higher than that of the control treatment, among which the weight per fruit of the fruits treated with compound iron amino acid and ferric citrate was significantly higher than that of the other treatments, among which the content of compound iron amino acid was the highest, up to 221.43 g; The longitudinal and transverse diameters of the fruit were significantly higher than those of the other treatments. The

pericarp of each treatment was 0.91-0.99, and the pericarp of compound ferric acid and ferric citrate was significantly higher than that of other treatments.

Table 2 Effects of different iron preparations on the external quality of clear fruits

Treatment	Per fruit weight (g)	Longitudinal diameter(cm)	Diameter (cm)	Fruit shape index
CK	(201.24±0.42) d	(6.96±0.05) d	(7.28±0.15) b	(0.95±0.005) b
Ferrous sulfate	(208.28±0.43) c	(7.18±0.11) c	(7.43±0.09) c	(0.96±0.002) b
Ferric citrate	(219.50±0.39) ab	(7.51±0.12) b	(7.53±0.07) bc	(0.99±0.005) a
Compound amino acid	(221.43±0.44) a	(7.77±0.11) a	(7.91±0.02) a	(0.98±0.013) a
Chelate iron	(214.99±0.13) b	(7.18±0.12) c	(7.61±0.08) b	(0.94±0.008) bc
Fenous lactate	(2019.83±0.31) c	(6.78±0.13) d	(7.45±0.11) c	(0.91±0.005) c
Ferric humate	(225.20±0.37) a	(7.91±0.08) a	(7.99±0.03) a	(0.99±0.001) a
The normal plants				

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

**Effects of different iron preparations on the internal quality of fruit.** It can be seen from table 3 that the soluble solids content in fruits after the application of compound iron amino acid was significantly higher than that in other treatments, and there was no significant difference from that in normal plants. After the application of different iron preparations, the content of vitamin C treated with ferric citrate and compound amino acid iron was significantly higher than that treated with the rest, up to 32.45mg /100ml. Compared with the control group, the content of total sugar in the fruit was significantly increased after the application of compound amino acid iron, reaching 9.15g/100ml. Compared with the control group, the total acid content in the fruits decreased after the application of different iron preparations, especially after the application of ferric citrate, followed by the compound amino acid iron.

Table 3 Influence of iron preparation on the internal quality of clear fruits

Treatment	TSS (%)	V <sub>C</sub> (mg·100mL <sup>-1</sup> )	Total sugar (g·100mL <sup>-1</sup> )	Titrateable acid (g·100mL <sup>-1</sup> )
CK	(11.07±0.09) d	(30.76±0.08)c	(8.19±0.05) d	(0.81±0.04)a
Ferrous sulfate	(11.56±0.10) c	(31.74±0.33) b	(8.89±0.02)b	(0.76±0.03)a
Ferric citrate	(12.42±0.09) b	(32.25±0.51) ab	(8.99±0.08) b	(0.62±0.05)b
Compound amino acid	(13.08±0.14) a	(32.45±0.17) ab	(9.15±0.02) a	(0.69±0.07)ab
Chelate iron	(12.32±0.16)b	(31.79±0.07) b	(8.89±0.17) b	(0.72±0.11)ab
Fenous lactate	(11.19±0.03) d	(31.84±0.72) b	(8.84±0.12) c	(0.75±0.07)a
Ferric humate				
The normal plants	(13.13±0.02) a	(33.46±0.27) a	(9.16±0.11) a	(0.77±0.02)a

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

#### 4. Discussion and Conclusion

Because iron is an essential element for chlorophyll synthesis, the xanthation caused by the decrease in chlorophyll content in the new leaves of fruit trees is a typical symptom of iron deficiency in fruit trees<sup>[12]</sup>. The results showed that the relative content of chlorophyll in normal leaves was significantly higher than that in other treatments before iron preparation was applied. After three times of iron preparation, the relative content of chlorophyll in the leaves of fruit trees was increased, and the chlorophyll content in leaves was obvious. Among them, the total content of chlorophyll in each treatment was the highest, which was ferric citrate and compound amino acid iron, significantly higher than other treatments.

Compared with the control of water spraying, the application of iron not only corrected the

yellowing of clear leaves, but also improved the single fruit weight, fruit diameter, soluble solid content, total sugar and vitamin C content of clear fruits, reduced the total acid content of clear fruits, and effectively improved the fruit quality. This indicated that after the application of iron preparation, its effectiveness increased obviously, and promoted the ability of plants to absorb iron to synthesize chlorophyll for photosynthesis, the photosynthetic efficiency of leaves increased, and the production and accumulation of organic materials increased, which would surely lay a foundation for fruit tree yield and improve fruit quality.

Through this test, it was found that the compound ferric acid and ferric citrate were more effective in all the iron preparations applied, and basically restored to the level of normal and normal fruit trees after application. This test result is consistent with the research conclusion of Chen Jinxin<sup>[13]</sup> on the kiwi fruit. Therefore, the ferric citrate and compound amino acid iron can effectively correct the ferriosis of fruit trees and improve the fruit quality of fruit trees.

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