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Dynamic trends of soil chemical properties in citrus planting soil

Tingyu Gou¹, Jinqiu Huang², Zhihui Wang² and Xun Wang^{2*}

¹College of Horticulture, Sichuan Agricultural University, Chengdu, Sichuan, 611130, China

²Institute of Pomology and Olericulture, Sichuan Agricultural University, Chengdu, Sichuan, 611130, China

*Corresponding author's e-mail: wangxun0104@hotmail.com

Abstract. In this experiment, potassium sulfate and monopotassium phosphate were used as the potassium source. Three potassium amount levels (31.96 g, 37.36 g and 48.16 g) were set. The urea and monopotassium phosphate were applied respectively as nitrogen and phosphate sources. The fertilizers were applied from March to July, and soil samples were collected before, during and after fertilization. Three-year-old of hybrid citrus variety 'Kiyomi' trees were the plant materials. The results showed that 48.16 g potassium was the optimum amount to improve the soil fertility by enhancing the content of alkaline nitrogen, available potassium and organic matter.

1. Introduction

Citrus is cultivated widely all over the world, and it has over-4000-year long cultivation history in China [1]. The citrus industry in China is mainly distributed in Zhejiang, Fujian, Jiangxi, Hubei, Guangdong, Guangxi, Chongqing and Sichuan province and the citrus orchards' area in these provinces account for 93.5 % of the country [2]. As the world's largest fruit, it has excellent fruit value, which contains quantity of Nutrients such as vitamin [3]. Fertilization is one of the significant technical measures in citrus cultivation. Reasonable fertilization can make citrus to obtain high quality and high yield, and reduce soil pollution [4]. For citrus growth, the demand for nitrogen fertilizer is the largest, followed by potash, while the demand for phosphate fertilizer is smaller [5]. In the cultivation of citrus, potassium, one of the large number of elements essential for plants' life activities, is especially important. Potassium can promote photosynthesis and increase the number of carbohydrates. At the same time, potassium can promote not only protein activity and increase protein content in trees and fruits as well as increase fruit yield, but also the conversion of starch into sugar in the fruit, which is beneficial to the increase of sugar content in fruit and mature earlier [6]. The surplus of potassium ions can affect the physiological processes such as photosynthesis, transpiration and metabolism of plants, and also affect the pest resistance, drought resistance and product quality of crops [7]. Potassium plays an important role in the life activities of plants, especially the available potassium. The content of available potassium and slow-acting potassium are used to measure the potassium fertility in the soil [8]. The hybrid citrus variety 'Kiyomi' was rapidly expanded in Sichuan province. The fertilization schemes are varied in various regions. We performed the experiment in Renshou county, which was developed to a promising citrus planting region. The research results are expected to provide a reference fertilization schemes to citrus planting in Renshou and the peripheral areas.



2. Materials and Methods

2.1. Materials

The hybrid citrus variety ‘Kiyomi’, which is widely expanded in Sichuan province, was tested in this research. The three-year-old trees growing in the Renshou county Sichuan province were the experimental materials. The base soil at the experimental site is sandy loam; pH was 7.23, organic matter was $5.34 \text{ g}\cdot\text{kg}^{-1}$, alkaline nitrogen was $27.35 \text{ mg}\cdot\text{kg}^{-1}$, available potassium was $45.23 \text{ mg}\cdot\text{kg}^{-1}$, available phosphorus was $11.37 \text{ mg}\cdot\text{kg}^{-1}$.

2.2. Fertilizer application

Potassium sulfate ($\text{K}_2\text{O} \geq 54 \%$) and monopotassium phosphate ($\text{P}_2\text{O}_5 \geq 52 \%$, $\text{K}_2\text{O} \geq 34 \%$) were the potassium sources. Potassium sulfate 0 g, 5 g and 10 g per tree were applied in both June and July. Monopotassium phosphate was applied in same amount on all treatments. It was applied monthly from March to July, totally five times. In May, April and May, monopotassium phosphate 14.8 g/tree was used in each month, and in June and July, improved amount 24.8 g/tree was used. Urea ($\text{N} \geq 46 \%$) was used to balance nitrogen. Urea 30 g/tree was applied monthly from March to June, and 15 g/tree was applied in July. The final potassium amount in the three treatments was 31.96 g, 37.36 g and 48.16 g respectively. The fertilizers were dissolved and applied along the dripline of trees. Each experimental treatment was performed on six trees, which were regarded as six experimental replicates.

2.3. Soil chemical properties determination

Soil samples were collected three times. The first time was in December 2017, before fertilization. The second time was during the citrus tree rapid growing period, May 2017. The last time was in August 2017, one month after total fertilization. The soil samples were collected at 0–30 cm depth along the dripline in three directions of each plant and mixed to form one replicate. Grind the soil sample to a powder size of less than 1 mm. Soil pH, organic matter content, and alkaline nitrogen content, available potassium and available phosphorus were determined. Soil pH was measured by pH meter [9]. Organic matter content was determined by using $\text{K}_2\text{CrO}_7\text{-H}_2\text{SO}_4$ oxidation method [9]. Alkaline nitrogen content was determined by using alkaline solution diffusion method [9]. Available potassium content was determined by using flame spectrophotometer method [9]. Available phosphorus content was determined by using molybdenum antimony anti-spectrophotometer method [9].

2.4. Statistical analysis

One-way analysis of variance (ANOVA) and the Student–Newman–Keuls q test were performed at the 5% significance level with SPSS Statistics 19.0 software. Contrast analyses were used to separate the interactions.

3. Results

3.1 Soil pH and organic matter content

The content of organic matter content in soil in the experimental groups was improved comparing with the CK (Fig. 1). Furthermore, the experimental treatment of K-2 was the most effect application, which increased by 88.64% ($P < 0.05$) comparing to the CK. However, the pH of the soil almost wasn't affected by applying potassium sulfate (Fig. 2). In conclusion, the fertilization of potassium sulfate can effectively enhance the content of organic matter of soil, while it has no effect on soil pH.

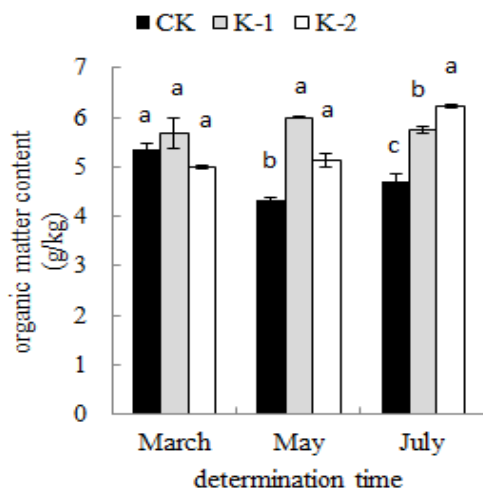


Figure 1. Organic matter content in soil.

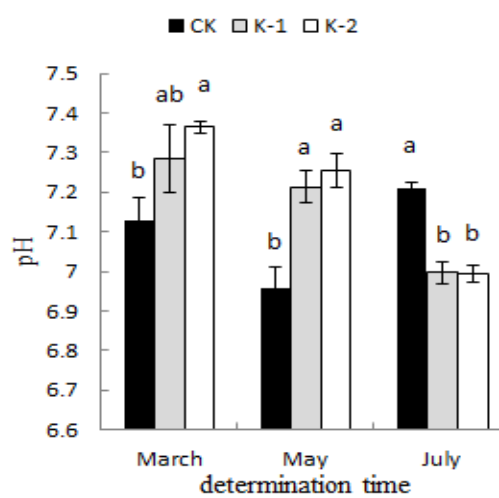


Figure2. pH in soil

3.2 Dynamic trends of N, P and K content in citrus planting soil

Comparing with the CK, the content of alkaline nitrogen content and available potassium content in citrus planting soil were improved after fertilization (Fig. 3, Fig. 4). Furthermore, with the level of potassium sulfate increasing, the content of alkaline nitrogen and available potassium contents in soil improved more efficiently. In the experimental treatment of K-2, the content of alkaline nitrogen content and available potassium content of the soil achieved the peak, which increased by 46.16% ($P<0.05$) and 47.87% ($P<0.05$) respectively to the CK. Nevertheless, the content of available phosphorus content in soil almost maintains the same level as the CK. In conclusion, the experimental treatment of K-2 is the best treatment to improve the content of the alkaline nitrogen and available potassium contents in soil.

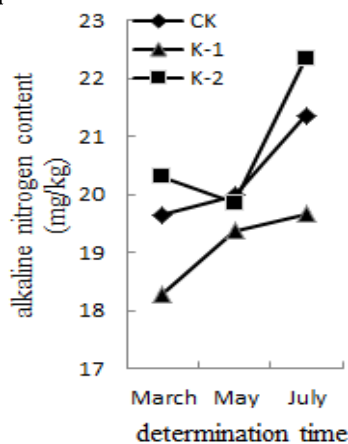


Figure 3. Alkaline nitrogen content.

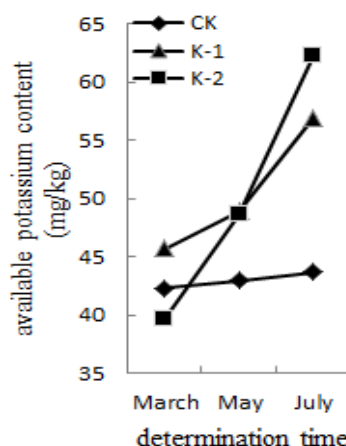


Figure 4. Available potassium content.

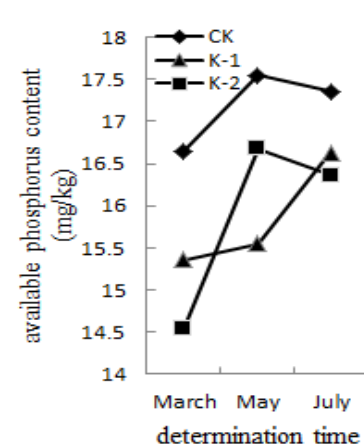


Figure5. Available phosphorus content.

4. Conclusions

From the results, the experimental treatment of K-2 was showed the most beneficial to the improvement of soil fertility by means of improving the content of alkaline nitrogen, available potassium and organic matter in soil. This plays a role in amelioration of soil, so that would make for the citrus trees growth and the improvement of citrus fruit's quality and yield. This experiment provides the theoretical basis for the fertilization of citrus in production. At the same time, it also provides assistance in further researches on the application of potash fertilizer to citrus.

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