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Effects of nitrogen fertilizer on soil chemical property in citrus orchard

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Abstract. The present research investigated the soil chemical properties applied nitrogen different amounts in Citrus orchard. The available nitrogen, available potassium and available phosphorus, as well as soil pH value and organic matter contents were determined. The results showed that the available nitrogen, available potassium, available phosphorus and organic matter in the soil were higher than the control.

1. Introduction

Fertilization is an important technical measure in citrus cultivation, and rational fertilization is the guarantee of high yield and high quality [1]. All the high citrus producing areas abroad are studying citrus, especially in the aspect of rational fertilization; each producing area has different experience and technology. However, due to different natural environment, citrus varieties and cultivation management in different areas, the results of fertilization research are not universal, and it is difficult to use for reference in production. Nitrogen is an essential element to maintain the normal life activities of plants. Nitrogen is not only the basic element of plants, but also the nutrient needed for plant growth. Adequate nitrogen is a necessary condition for cell division, and whether the nitrogen supply is sufficient or not is directly related to organ differentiation, formation and tree structure formation [3]. Rational application of nitrogen fertilizer is a key measure to achieve a higher target yield in crop production in the world today [4]. Unreasonable of nitrogen fertilizer would result in low yield and soil residues, bringing up the environment pressure [5,6]. This experiment studied the application of nitrogen fertilizer on the young trees of 'Kiyomi' in south of China, and determined the optimal application level, aiming to explore the application amount suitable for the growth of local citrus saplings and provide theoretical basis for large-scale cultivation and promotion of citrus in local areas.

2. Materials and methods

2.1. Plant materials

The heterozygous citrus 'Kiyomi', planted for 3 years, were researched. The experimental site was in Renshou, Sichuan province, China. In the experimental site, the annual mean air temperature is 17.4 °C, rainfall is 1009.4 mm, sunshine is 1196.6 h, and the annual frost zone is 312 days.

2.2. Experimental design

Urea (N≥46%) was the nitrogen source, which was applied monthly from March to June 2018, and totally four times. There were 3 levels of urea amount in each application: 50 g, 100 g and 150 g per plant, and totally 200 g, 400 g and 600 g nitrogen were supplied. In the control treatment, no urea was applied. The design was randomized block. Each treatment contains 6 repetitions, and one tree was regarded as one replication. In order to balance phosphate (P) and potassium (K) elements, monopotassium phosphate (P_2O_5≥52%, K_2O≥34%) and potassium sulfate (K_2O≥54%) were applied. Monopotassium phosphate was applied from March to July monthly, totally five times. In March, April and May, the amount of monopotassium phosphate applied was 14.8 g every time, and 24.8 g was applied respectively in June and July. Two grams of potassium sulfate were applied in both March and April, and the increased amount (4 g) was applied in both May and June. Therefore, the final K content and P content of each treatment were 38.44 g and 48.88 g.

2.3. Assay of soil chemical properties

Soil pH value, organic matter content, available nitrogen, available phosphate and available potassium were determined. The soil samples were collected before fertilizing (December 2017), and during plant growing, when were by the end of March, May and July in 2018. The methods to assay soil chemical properties were according to Ruihe Shi's methods [7]. In brief, the alkaline solution diffusion method was used to analyze the alkaline nitrogen content. A spectrophotometer method was used to exam the available potassium content, and the available phosphorus content was determined by using molybdenum antimony anti-spectrophotometer method. The soil pH value was determined by a pH matter. Organic matter content was determined using K_2CrO_7-H_2SO_4 oxidation method.

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. The nitrogen, potassium and phosphorus contents in the soil

In March, the control group had the highest nitrogen level, and in May and July, the treatment of 600g alkaloidal nitrogen had the highest available nitrogen level (Table 1). In March, the N content of soil in the control group was 1.2, 1.3 and 1.1 times that in the N-1, N-2 and N-3 treatment groups, respectively. In May, the N-3 treatment group with the highest N content was 2.6 times higher than the N-2 treatment group with the lowest N content, and nearly 2 times higher than the control group. In July, compared with the control group, the nitrogen content in the N-3 treatment group was 3.3 times.

Table 1. Available nitrogen content in soil

Number	Months		
	March	May	July
N-CK	17.854±0.210a	26.989±2.664b	19.584±0.615c
N-1	15.234±0.510b	19.397±0.384c	21.674±1.313c
N-2	14.226±0.101b	29.984±1.549b	35.358±1.521b
N-3	16.657±0.794a	49.332±3.386a	64.367±4.361a

In March, the N-3 group had the highest available K content, about 1.1 times that of the control group, and about 1.2 times that of the N-2 group, which had the lowest available K content of soil (Table 2). In May, the N-3 group had the highest available K content, about 1.1 times that of the control group, and about 1.2 times that of the N-2 group, which had the lowest available K content of soil. In July, the N-3 group had the highest available K content, about 1.2 times that of the control group, and about 1.3 times that of the N-2 group, which had the lowest available K content of soil.

Table 2. Available potassium content in soil

Number	Months		
	March	May	July
N-CK	41.367±1.683a	43.552±2.548a	43.234±1.963a
N-1	42.237±2.987a	41.965±0.385a	43.845±0.371b
N-2	37.685±1.011a	40.232±0.684a	39.668±1.184a
N-3	42.689±2.662a	45.396±1.191a	51.588±2.753a

In the three months, the control group had the lowest available P content (Table 3). In March, the N-3 group had the highest available P content, about 1.2 times that of the control group. In May and in July, the N-3 group had the highest available P content, about 1.1 times that of the control group.

Table 3. Available phosphorus content in soil

Number	Months		
	March	May	July
N-CK	13.247±0.305b	14.558±0.606a	15.216±0.184b
N-1	14.465±0.623ab	15.558±0.516a	15.684±0.163b
N-2	14.399±0.309ab	15.659±0.499a	15.745±0.221ab
N-3	15.647±0.104a	15.668±0.298a	16.345±0.134a

3.2. The pH value and organic matter content in soil

With the passage of months, the pH value determination shows a trend of increasing first and then decreasing (Table 4). In March, N-2 group had the highest pH value, while N-1had the highest pH value in May and July. According to the figures, N-2 group shows the most apparent change in the soil pH value determination. In July, the groups which were applied N fertilization had a higher pH value. As a result, it is clearly that N fertilization has an apparent effect to increase the soil pH value determination.

Table 4. The pH value in Soil

Number	Months		
	March	May	July
N-CK	6.754±0.011d	6.897±0.086c	6.725±0.073c
N-1	7.254±0.034b	7.169±0.041a	7.288±0.019a
N-2	7.486±0.321a	6.889±0.043b	7.231±0.046a
N-3	6.988±0.036c	6.845±0.076b	7.124±0.054b

The organic matter content in the soil of citrus sapling treated with nitrogen fertilizer increased, and increased with the increase of nitrogen fertilizer content (Table 5). When urea content in nitrogen fertilizer was 150 g, the soil organic matter content reached the maximum value, which increased by 27.94% ($P < 0.05$). Thus, the application of nitrogen fertilizer can enhance soil fertility. Moreover, the nitrogen fertilizer ratio of 150 g urea was the most significant. As time goes on, the organic matter content in the soil of citrus increased gradually, and the growth rate is nearly 50%.

Table 5. Organic matter content in soil

Number	Months		
	March	May	July
N-CK	3.543±0.043a	4.188±0.057a	4.897±0.076b
N-1	3.688±0.323a	3.642±0.021b	4.956±0.018a
N-2	2.944±0.025b	3.578±0.041b	3.375±0.032b
N-3	2.544±0.064b	3.774±0.014b	4.986±0.011a

4. Discussion and conclusion

The experiment shows that physical and chemical indexes of soil are changed obviously. It can be concluded from this experiment that during the growth period of spring shoots of citrus sapling, the optimal fertilization formula is 150g urea, 24.8g potassium dihydrogen phosphate and 15g potassium sulfate. Relevant studies show that the nutrient resource management of most orchards in China is not reasonable, and the fertilizer utilization rate is relatively low compared with developed agricultural countries. It is generally believed that the seasonal utilization rate of nitrogen fertilizer is 30%-40%,

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that of phosphate fertilizer is 10%-25%, and that of potash fertilizer is 50%-60%.

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