Fruit Growth and Yield of Jujubes Affected by Nitrogen, Phosphorus and Potassium Fertilization in Yellow Brown Soil

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Abstract

Jujube is one of the best-selling fruits in China. When after harvest, the quality of the fruits cannot be improved. Since, it is necessary to improve fruit quality before harvesting. And orchard nutrition is a pre-harvest factor that affects productivity and fruit quality. Plants can cause lack of trace elements under adverse conditions during the growing season. Such as drought, excessive soil moisture and cold weather. And different fertilizers have different effects on different plants. This mainly depends on the variety of plants and the variety of soil. The objective in this part of the research was to study the effects of different nitrogen, phosphorus and potassium fertilizers on the yield and growth of jujube. The research experiment was conducted between august and October 2019.The basic conditions for the experimental design were drip irrigation conditions. Trials were designed for 10 treatments, and each treatment was repeated 3 times. In the treatment of Nitrogen, Phosphorus and Potassium Combined Fertilization, Different varieties show different effects. For different varieties, the variety "lv liang" has the highest yield and good fruit growth in the N3P1K3 treatment. The variety "ji shan" has the highest yield and good fruit growth in the N3P3K1 treatment. The variety "jiaocheng" had the highest yield and good fruit growth in the N1P3K3 treatment.

Keywords

Jujube, Nitrogen, Phosphorus, Potassium, Yield, Fruit growth.

1. Introduction

Jujube is one of the important kind of fruits in China [1-3].It is deeply favored by people, because of its good taste and abundant nutrition. The main nutrition includes vitamin C, amino acids, cyclic AMP, carbohydrate, and minerals, etc. [4-5]. Vitamin C content is 70 times that of apple and 3 times of kiwifruit. It has the title of "vitamins pills", and the nutritional value ranks the highest among all fruits. Its extracts can also be used as food additives such as analeptic, palliative and antibacterial materials [6]. The international market has reached 36 US dollars / kg, which is of high economic value and vastness. The prospects of domestic and foreign market development.

It is necessary to improve fruit quality before harvesting. And orchard nutrition is a pre-harvest factor that affects productivity and fruit quality[7-9]. Plants can cause lack of trace elements under adverse conditions during the growing season. Such as drought, excessive soil moisture and cold weather [10]. And different fertilizers have different effects on different plants. This mainly depends on the variety of plants and the variety of soil[11].

The objective in this part of the research was to study the effects of different nitrogen, phosphorus and potassium fertilizers on the yield and growth of jujube.

2. Materials and Methods

2.1 Experiment preparation

The research experiment was conducted between august and October 2019 in a jujube orchard in Jiangsu province of China in Zhenjiang city (119.45 longitude, 32.20 latitude). A pH meter and soil suspension were used to measure the soil pH. The soil main physicochemical characteristics are given in Table 1. The jujube trees of"lv liang","ji shan","jiaocheng" were selected because these cultivar

are elite varities of jujube. The trees were planted 1m apart in rows that were 2m apart. The orchard is managed according to standard cultivation methods and standard pest control measures. The average tree height is 3 meters and the average trunk diameter is 7.05 centimeters.

Table 1. The soil main physicochemical characteristics

Texture	Organic matter (g/kg)	Available nitrogen (mg/kg)	Available phosphorus (mg/kg)	Available Potassium (mg/kg)	pH
Yellow brown soil	20	109	19	128	6.7

2.2 Experiment design.

The basic conditions for the experimental design were drip irrigation conditions. The fertilization design scheme is shown in Table 2. Trials were designed for 10 treatments, and each treatment was repeated 3 times. Drip irrigation method and irrigation quantity: The irrigation method is drip irrigation and irrigation for three times, respectively before germination, before flowering and during fruit setting period. The total irrigation quota is 450m3/hectare. Fertilization method: Dig 25 cm deep, 35 cm wide and 35 cm long in the horizontal trenches on both sides of the canopy and on the outside. Sprinkle the fertilizer and mix it with the soil. In May 2016, all phosphate and potash fertilizers and 50% nitrogen fertilizer were applied as base fertilizers. In July, the remaining 50% nitrogen fertilizer was applied. The type of fertilizer used is urea (N content is 46%), phosphate fertilizer is superphosphate (P_2O_5 content is greater than or equal to 12%), and potassium fertilizer is potassium sulfate (K_2O content is greater than or equal to 50%).

Table 2 Three factors D-saturation optimal design of N,P and K

Treatment	X1	X2	X3
CK	-1	-1	-1
N_3	1	-1	-1
P_3	-1	1	-1
K_3	-1	-1	1
P_2K_2	-1	0.2	0.2
N_2K_2	0.2	-1	0.2
N_2P_2	0.2	0.2	-1
$N_1P_3K_3$	-0.3	1	1
$N_3P_1K_3$	1	-0.3	1
$N_3P_3K_1$	1	1	-0.3

2.3 Sample and pre-treatment.

2.3.1 Sample collection and processing

After ripening, the fruit was picked in different positions of different varieties of jujube trees without scars and dead spots. The smooth skin of the fruit was selected. 20 jujube trees were selected from each variety, 10-15 jujube fruits were collected from each jujube tree, and the duplicate processing was incorporated into the plastic seals. Bags, while placing an appropriate amount of toilet paper to absorb the moisture produced by the respiration of jujube fruit, cold storage, storage and spare.

2.3.2 Test methods

(1) Determination of growth physiological indicators

Fruit setting rate: In the different directions of each tree, the number of jujube fruits was recorded in the flowering and fruiting stages of the jujube tree, and the mean value was obtained. Fruit setting rate = fruit number/flowering number *100%.

Change in leaf length: Each tree selects four leaves in different directions. Every 15 days, measure the length of the blade with a vernier caliper.

Growth trend: After fruiting, 4 jujube fruits of equal size were taken in different positions of each tree, and their vertical and horizontal diameters were measured and marked with vernier calipers. After that, the horizontal and vertical diameters were measured every 7 days, and the growth curves of the lateral and longitudinal diameters were plotted.

⑵ Determination of yield

After ripening jujube fruit, single-plant single-income method was adopted, and the fruit was picked every time for detailed records until the fruit was harvested, the yield of the individual plants was calculated, and the total yield was calculated later.

2.4 Sample and pre-treatment.

The SPSS ver.10.0(SPSS Inc.,Chicago, Illinois, USA) was used to process and plot data, sigmaplot and matlab 7 were used for statistical analysis.

3. Result and discussion

3.1 Effect of Nitrogen, Phosphorus and Potassium on Fruit Setting Rate.

Jujube flowers are large, but the fruit setting rate is very low. Increasing the fruit setting rate is an important way to increase the yield. The low output rate of leaf photosynthetic products and the intense competition of nutrients are one of the important reasons for the low fruit setting rate of jujube trees. Therefore, providing sufficient nutrients for fertilization is a controllable way to improve the fruit setting rate of jujube trees. Fertilization has a significant effect on improving the fruit setting rate of jujube trees. As shown in Figure 1, red is the fruit set rate for each fertilization treatment of variety “lv liang”, blue is the fruit setting rate for each fertilization treatment of “ji shan”, and green is the fruit setting rate for each fertilization treatment of variety “jiaocheng”. The fruit setting rate of each fertilization treatment was significantly higher than that of the control treatment. The fruit setting rate were higher of Nitrogen, Phosphorus and Potassium Combined Fertilization than N, P and K fertilization alone or two kinds of combined fertilization.

In the treatment of Nitrogen, Phosphorus and Potassium Combined Fertilization, Different varieties show different effects. In the $N_3P_1K_3$ fertilization treatment, the cultivar “lv liang” had the highest fruit setting rate. The cultivar “jiaocheng” had the highest fruit setting rate in the $N_3P_3K_1$ fertilization treatment. The cultivar “jiaocheng” had the highest fruit setting rate in the $N_1P_3K_3$ fertilization treatment.

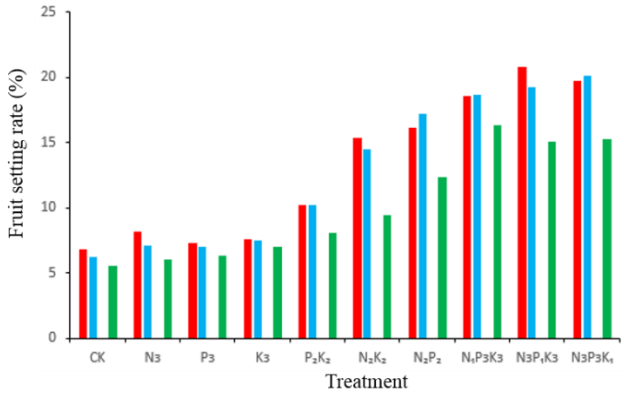

Fig.1 The fruit setting rate of different varieties under different treatments

3.2 Effects of Nitrogen, Phosphorus and Potassium on Leaf Growth.

The leaves are the main sites for plants to carry out photosynthesis. One of the main ways to increase the utilization of light energy is to increase the photosynthesis of the leaves. Fig. 2 shows the leaf length growth trend of the variety “lv liang” under different fertilization treatments. Fig. 3 shows the leaf length growth trend of varieties “ji shan” under different fertilization treatments. Fig. 4 shows the growth trend of leaf length under different fertilization treatments for “jiaocheng” variety. From the overall growth trend, there was no significant difference between each fertilization treatment. In

0-20 days, the leaves are in a rapid growth period, and after 40 days, the leaf growth rate is slowed down. According to the growth characteristics of the plant, after fruiting, the main photosynthetic product of the plant is mainly used for the growth of the fruit, and the leaf grows slowly and stops vegetative growth.

As can be seen from Fig.2, in the variety "lv liang", the smallest blade length is CK treatment, and the largest blade length is $N_3P_1K_3$ treatment. As can be seen from Fig.3, in the variety “ji shan”, the smallest blade length is N_3 treatment, and the largest blade length is $N_3P_3K_1$. Figure 4 shows that in the “jiaocheng” variety, the smallest leaf length is P_3 treatment, and the longest leaf length is $N_1P_3K_3$.

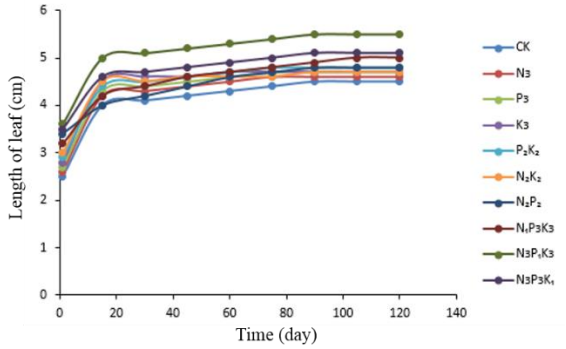

Fig.2 The leaf length growth trend of the variety “lv liang”

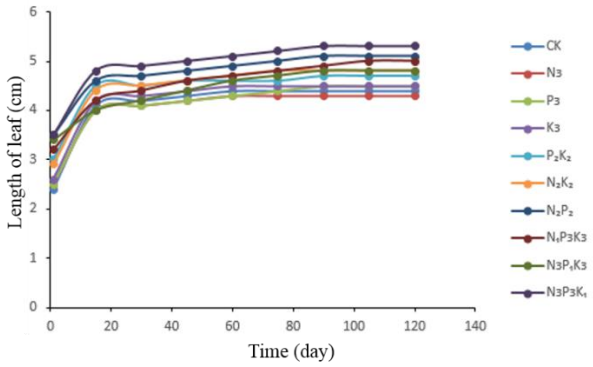

Fig.3 The leaf length growth trend of varieties “ji shan”

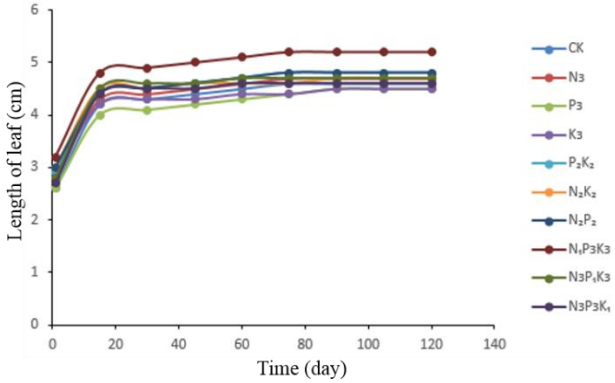

Fig.4 The leaf length growth trend of varieties “jiaocheng”

3.3 Effect of Nitrogen, Phosphorus and Potassium on the vertical diameters.

The growth period of jujube fruit is divided into flowering fruit set, fruit enlargement and fruit ripening. As jujube is too small, the measurement error is large. Moreover, due to the serious fruit drop of the jujube tree, the determination will have a certain impact on it. Therefore, one week after the fruit selection, the normal growing fruit was selected for marking and measurement. Fig.5 shows the variation trend of fruit vertical diameter under different fertilization treatments for variety “lv liang”. Fig.6 shows the trend of the vertical diameter of the fruit under the different fertilization

treatments for the variety “ji shan”. Fig.7 shows the trend of the vertical diameter of the fruit of the “jiaocheng” variety under different fertilization treatments. It can be seen from the figure that the vertical diameter of fruits were higher of Nitrogen, Phosphorus and Potassium Combined Fertilization than N, P and K fertilization alone or two kinds of combined fertilization. In the treatment of Nitrogen, Phosphorus and Potassium Combined Fertilization, Different varieties show different effects. From Fig.5, it can be seen that the variety "lv liang" has the greatest vertical growth when treated with $N_3P_1K_3$. As can be seen from Fig.6, the variety "jishan" has the greatest vertical growth in $N_3P_3K_1$ treatment. As can be seen from Fig.7, the variety “jiaocheng” has the largest vertical growth of fruit in $N_1P_3K_3$ treatment.

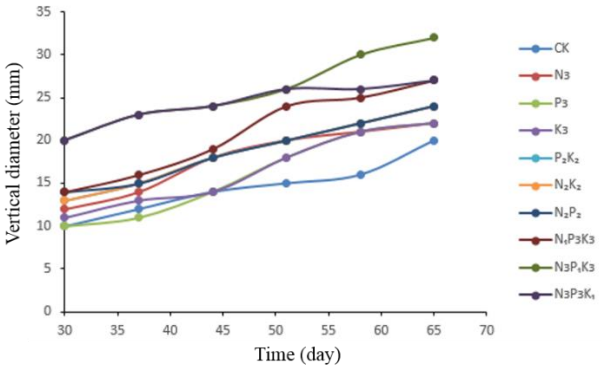

Fig.5 The variation trend of fruit vertical diameter for variety “lv liang”

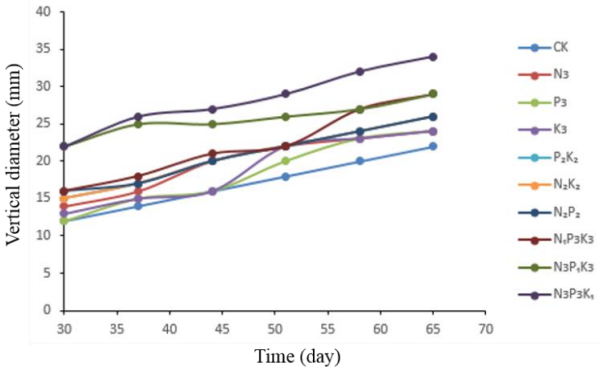

Fig.6 The variation trend of fruit vertical diameter for variety “ji shan”

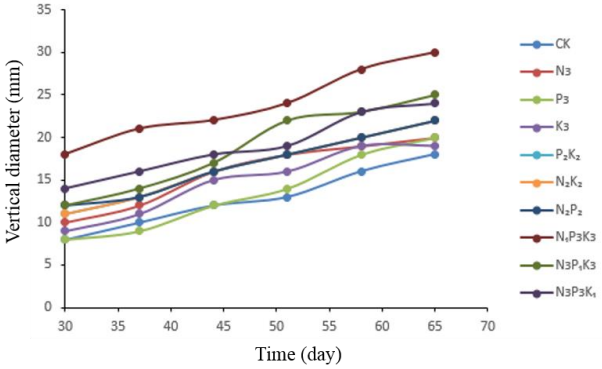

Fig.7 The variation trend of fruit vertical diameter for variety “jiaocheng”

3.4 Effect of Nitrogen, Phosphorus and Potassium on the horizontal diameters.

Fig.8 shows the trend of the horizontal diameter of the fruit under different fertilization treatments for the variety“lv liang”. Fig.9 shows the trend of the horizontal diameter of the fruit under the different fertilization treatments for the variety“ji shan”. Fig.10 shows the trend of the horizontal diameter of the fruit under the different fertilization treatments of the “jiaocheng” variety. It can be seen from the figure that the horizontal diameter of fruits were higher of Nitrogen, Phosphorus and Potassium Combined Fertilization than N, P and K fertilization alone or two kinds of combined

fertilization. In the treatment of Nitrogen, Phosphorus and Potassium Combined Fertilization, Different varieties show different effects.

Fig.8 shows that the variety "lv liang" has the greatest horizontal diameter growth in the $N_3P_1K_3$ treatment. As can be seen from Fig.9, the variety "ji shan" has the greatest horizontal diameter growth in the $N_3P_3K_1$ treatment. From Fig.10, it can be seen that the variety “jiaocheng” has the greatest horizontal diameter growth in $N_1P_3K_3$ treatment.

Based on the data of the horizontal and vertical diameters of the fruits, the increase in horizontal and vertical diameter of most fertilization treatments was higher than that of the control treatment, but under some fertilization treatments, the increase in horizontal and vertical diameter was lower than the control treatment. Comprehensive analysis of the reasons for the following points: 1.There is a difference in the growth schedule of the selected fruit samples. 2. The fruit samples were affected by the disease and affected the measurement. There was no change in appearance but the growth did not stop. From the overall data, fertilization treatment can promote fruit growth, thereby increasing the rate of large fruit.

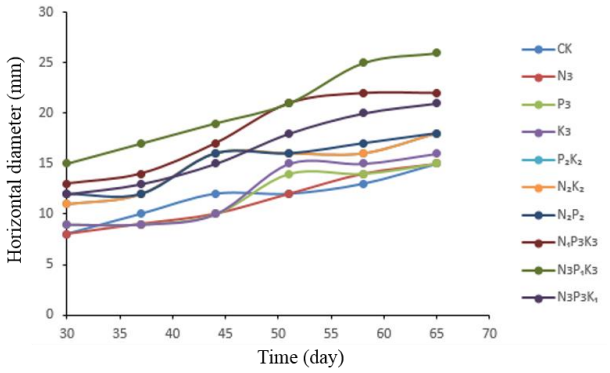

Fig.8 The variation trend of fruit horizontal diameter for variety “jiaocheng”

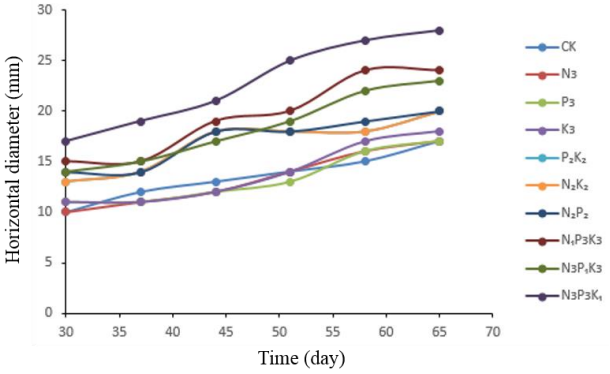

Fig.9 The variation trend of fruit horizontal diameter for variety “jiaocheng”

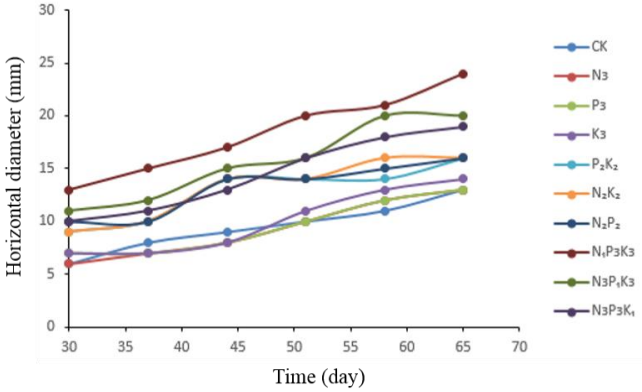

Fig.10 The variation trend of fruit horizontal diameter for variety “jiaocheng”

3.5 Effect of Nitrogen, Phosphorus and Potassium on Yield.

The effects of different fertilization treatments on the yield of jujube fruit in the same variety are shown in Fig.11. It can be seen from the figure that the yield of fertilization treatment is higher than the control treatment. For different varieties, the variety "lv liang" has the highest yield in the $N_3P_1K_3$ treatment. The variety "ji shan" has the highest yield in the $N_3P_3K_1$ treatment. The variety "jiaocheng" had the highest yield in the $N_1P_3K_3$ treatment. The data shows that fertilization treatment can improve the yield of jujube fruit. Moreover that the yield of fruits were higher of Nitrogen, Phosphorus and Potassium Combined Fertilization than N, P and K fertilization alone or two kinds of combined fertilization.

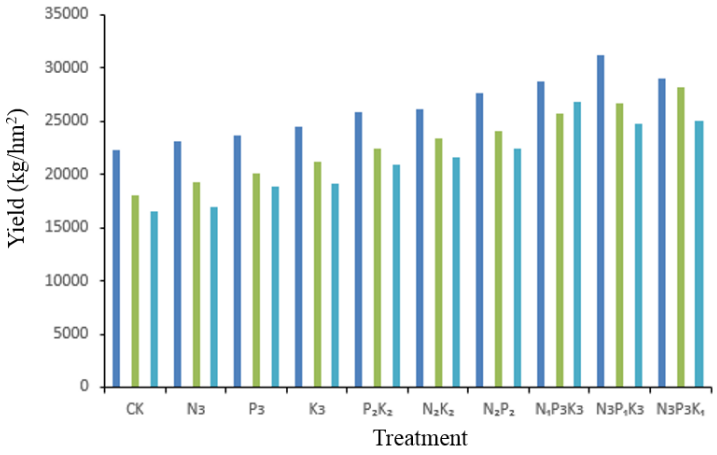

Fig.11 The yield of different varieties under different treatments

4. Conclusion

The application of N, P and K fertilizers has a significant effect on the vegetative growth of jujube and the yield of jujube fruit. The low fruit setting rate has always been the bottleneck of increasing the output of jujube trees. Providing sufficient water and fertilizer will improve the fruit setting rate of jujube trees. Therefore, a reasonable supply of nutrients is of great importance for improving the biomass of plants.

The results showed that different jujube tree varieties were adapted to different fertilization treatments, and the combination of N, P, and K could significantly improve the fruit setting rate, leaf growth, and fruit production of jujube.

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