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Effects of Different Irrigation Quotas on the Growth Index and Yield of Jujube Trees under the Condition of Spring Root Irrigation

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Abstract

Field experiments were used to study the effects of different irrigation quotas on the growth and yield of pear jujube trees under the condition of spring root irrigation. The results showed that different irrigation quotas can significantly improve the physiological growth of Shaanbei Lizao and increase the yield of Lizao. The growth of new shoots in the irrigation treatment was significantly higher than that in the CK treatment. Compared with CK, the relative growth rate of new shoots increased by 0.04, 0.04, and 0.05 in the irrigation quota treatments of 180 $m^3 \cdot hm^{-2}$, 135 $m^3 \cdot hm^{-2}$, and 100 $m^3 \cdot hm^{-2}$, respectively. The high irrigation treatment of 180 $m^3 \cdot hm^{-2}$ The fixed pear and jujube fruit setting rate reached the highest value of 2.84%, but compared with the medium irrigation quota, the fruit setting rate between the two did not reach a significant difference. The yield of pear jujube in the four different treatments was as follows: high irrigation quota>medium irrigation quota>low irrigation quota>CK, and the yields of each treatment were 16772.8 $kg \cdot hm^{-2}$, 16658.2 $kg \cdot hm^{-2}$ and 16514.5 $kg \cdot hm^{-2}$ Compared with CK (15822.3 $kg \cdot hm^{-2}$), increased by 6.0%, 5.3% and 4.4% respectively, and reached significant differences from CK ($P<0.05$), but the difference between the three was not significant. Considering the drought and water shortage in northern Shaanxi and the growth and yield of jujube trees, it is better to use a low irrigation quota of 100 $m^3 \cdot hm^{-2}$.

Keywords

Irrigation quota; Pear jujube; Yield.

1. Research Background

Yongquan root irrigation technology is a new type of irrigation technology suitable for fruit trees in China. The advantage of this technology is that it can directly transport water to the root system of the fruit tree and directly use the fruit tree, thereby reducing the large amount of water evaporation on the ground and the possibility of water dispensers. The problem of clogging [1-2]. Studies [3] have shown that compared with drip irrigation and pipe irrigation, it can significantly increase the net income of this technology, and the net income will increase by 2500-6000 yuan·hm^{-2}. At the same time, the cost of this technology is greatly controlled, and the annual cost is reduced by 2030 yuan·hm^{-2} compared with drip irrigation. Therefore, it is recommended that this irrigation technology be popularized and applied in a large area of mountain economic forests. Relevant experts conducted a large number of irrigation experiments in the pear and jujube forestland in northern Shaanxi, including different irrigation volumes and spring root irrigation, drip irrigation, surface irrigation and other different irrigation methods to analyze the physiological growth indicators, fruit yield, and water use of the pear and jujube trees in northern Shaanxi Differences in efficiency, etc., found that compared with ground flood irrigation and other technologies, spring root irrigation and drip irrigation can significantly increase the yield of jujube trees. The yield first increases and then

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decreases with the irrigation quota, but the water use efficiency varies with irrigation. The increase in the quota decreases [4-5]. Therefore, the spring root irrigation technology is used to directly supply the water needed by the fruit tree to the roots of the fruit tree, which effectively solves the shortcomings of easy clogging of the irrigator, easy aging of the capillary, and low irrigation efficiency. Its high efficiency and practical advantages can alleviate the shortage of water resources in the Loess Plateau [6-7]. The question is of great significance. In this paper, combining the characteristics of water consumption of jujube trees in mountainous areas, drawing on the results of drip irrigation experiments on jujube trees, setting up different irrigation volume experiments for spring root irrigation, and studying the effects of different irrigation quotas on pear under the conditions of spring root irrigation. The research results on the physiological growth and yield of jujube provide a basis for the pear and jujube planting industry in northern Shaanxi.

2. Test Setup

2.1. Test Plan

The test site was a seven-year-old pear and jujube forest in Mizhi County, Yulin. The jujube trees in the test were of uniform shape and geographical location. The crown radius of the pear and jujube trees in this experiment was about 150 cm and the height was about 200 cm, Yongquan root irrigation is set as the irrigation form of double drippers. The drippers are placed 20 cm from the left and right of the tree trunk near the ground, and the water volume of the drippers is set to 4 $L \cdot h^{-1}$. Three different irrigation quotas were set up in the experiment, as shown in Table 1, and each treatment was repeated in three groups.

Table 1. Test plan

Treatment	irrigation quota($m^3 \cdot hm^{-2}$)	Irrigation frequency	Bud development	Flowering and fruit-bearing period	Swelling period	Maturity
Different	100	4	1	2	1	0
irrigation	135	4	1	2	1	0
quota	180	4	1	2	1	0
CK	0					

2.2. Measurement Indicators and Methods

New shoot length: measured with a steel ruler, with an accuracy of 0.1cm; specific measurement method: select 3 fixed shoots from each of the four directions of the jujube tree, measure the length, and finally take the average value; June 1 to June 26 A total of 7 measurements per day, once every 3 days, the interval time is appropriately extended as the growth rate of new shoots and leaves slows down.

Number of flowers and fruits: Count the number of flowers and fruits of the whole jujube tree during the flowering and fruit setting period.

Yield: First, count the number of jujubes in the whole plant, and then randomly sample 30 and weigh them to get the average single fruit weight, thereby obtaining the yield. The measurement time is September 29, 2018.

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3. Results

3.1. The Effect of Irrigation Quota on the Growth and Fruit Setting of Jujube Trees

Figure 1 shows the dynamic changes of jujube trees from the period of vigorous growth of the new shoots to the period of slow and stable growth under different irrigation quotas and no irrigation (control) conditions. It can be seen from the figure that the growth change trend of the new shoots is characterized by rapid growth in the early stage, slower growth rate in the later stage, and finally a stable state; the growth rate of the new shoots of the jujube trees with different irrigation amounts is significantly faster than that of CK. In the early stage of growth, the new shoots of jujube trees with a high irrigation amount of 180 $m^3 \cdot hm^{-2}$ grew slowly, and the growth rate was faster than other irrigation amounts in the later stage. This may be affected by temperature. In the early growth of new shoots, in addition to the unfavorable factors of low soil moisture caused by continuous drought in early spring, slow temperature rises also greatly inhibited the growth of jujube trees; CK caused new shoots due to continuous drought. The relative growth rate of shoots is the lowest, while the growth rate of jujube trees treated with high irrigation water quota is slower in the early stage and medium and low irrigation water quota treatments due to the lower temperature. The shoot growth rate tends to be the fastest. Due to the interactive effects of temperature and moisture, the growth rate of shoots among the three irrigation treatments was not significantly different during the entire monitoring period, but they were all significantly higher than the average shoot growth rate of CK, 180, 135, and 100 $m^3 \cdot hm^{-2}$ irrigation quota treatments. Compared with CK, it increased by 0.04, 0.04, and 0.05, respectively. It shows that with the increase of irrigation amount, the relative growth rate of the new shoots of Lizao increased, but the growth rate of the new shoots of different irrigation quota treatments is not significantly different. Considering the water shortage in northern Shaanxi, the middle irrigation quota is 135 ($m^3 \cdot hm^{-2}$) or the low irrigation quota is 100 ($m^3 \cdot hm^{-2}$) for jujube garden irrigation.

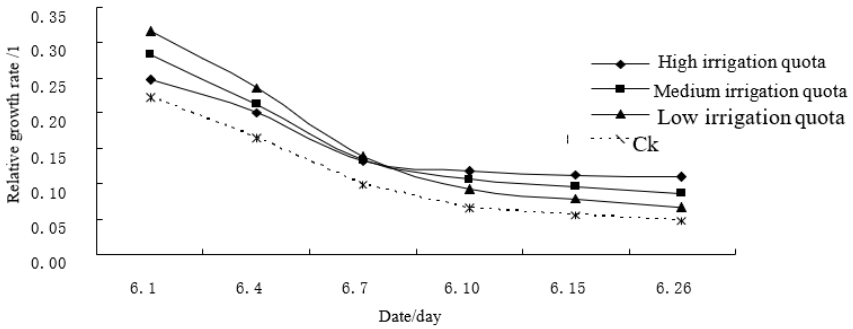

Figure 1. Changes in the relative growth rate of jujube tree shoots with different irrigation quotas

3.2. The Effect of Different Irrigation Quotas on the Fruit Setting Rate of Jujube Trees

Table 2 reflects the fruit setting of individual jujube trees under different irrigation quotas. It can be seen that a significant feature of the physiological reproductive growth of jujube trees is the large number of flowering and extremely low fruit setting rate. The fruit setting rate of jujube trees under different treatments is only It is 1.38~2.84. The order of fruit setting rate among different treatments is: high irrigation quota treatment>medium irrigation quota treatment>low irrigation quota treatment>CK. The fruit setting rates of the three treatments are 1.46%, 1.23%, and 0.79% higher than CK respectively. In addition, it can be seen that the

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drought and water shortage of CK has greatly promoted the increase in flower volume, but its soil moisture is low, and the tree has a poor ability to absorb water and reduce its own temperature, resulting in a large loss of fruit set. Therefore, During the fruit setting period, moisture is a key factor that affects the fruit setting and even the final yield. Among them, the fruit setting rate with high irrigation quota is the highest at 2.84%, but there is no significant difference from the fruit setting rate with medium irrigation quota. Therefore, considering the lack of water in northern Shaanxi, the medium irrigation quota is 135 ($m^3 \cdot hm^{-2}$). Irrigate the jujube garden.

Table 2. Flowering and fruit setting rate of jujube trees with different irrigation quotas

Irrigation quota /(m^3/hm^2)	Flowers	Number of fruit set/piece	Fruit setting rate /%
180	30563	868	2.84 a
135	32567	850	2.61 a
100	32488	705	2.17 b
CK	39130	540	1.38 c

3.3. The Impact of Irrigation Quota on the Yield of Jujube Trees

It can be seen from Figure 2 that different irrigation quotas significantly increased the yield of Lizao. The output performance of each treatment was: high irrigation quota>medium irrigation quota>low irrigation quota>CK, and the yields of each treatment were 16772.8 $kg \cdot hm^{-2}$, 16658.2 $kg \cdot hm^{-2}$ and 16514.5 $kg \cdot hm^{-2}$, respectively. CK (15822.3 $kg \cdot hm^{-2}$) increased by 6.0%, 5.3% and 4.4%, and was significantly different from CK ($P<0.05$), but the difference between the three was not significant. In terms of economy and efficiency, a low irrigation quota of 100 $m3 \cdot hm^{-2}$ is better.

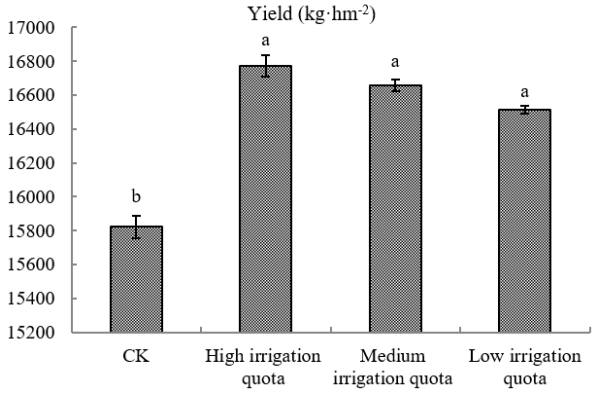

Figure 2. Yield and water use efficiency of jujube trees with different irrigation quotas

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