

The study of KNO_3 on breaking forced dormancy of *Ziziphus Jujuba* 'Zhanshanmizao' and the effects on fruit quality

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Abstract. The trial *Ziziphus jujuba* 'Zhanshanmizao' as test materials, test its dormant stage breaking dormancy select different concentrations of potassium nitrate (3%, 6%, 9%), the control of water treatment, study the changes of water, organic substances (starch, soluble sugar, soluble protein, free amino acid). Then, measure the fruit quality, the effect of potassium nitrate (KNO_3) with different concentrations on breaking forced dormancy of *Ziziphus jujuba* 'Zhanshanmizao' trees were compared. The results showed that in the forced dormancy period (from 30 th January to 14 th February) the effect on potassium nitrate at 6 % breaking forced dormancy were better than others, they can improve the ratio of the free water and the bound water significantly. Change the content of organic substances composition rapidly. KNO_3 (9%) was largely ineffective or even inhibited in breaking dormancy. By analysis the fruit quality, we think the effects of KNO_3 at 6% on breaking forced dormancy of *Ziziphus jujuba* 'Zhanshanmizao' was the best.

Introduction

The main production areas is Mianyang City. It have high-quality, because of high-quality taste and rich nutrition value, it is welcomed by the vast number of consumers [1]. In recent years, study on the dormancy of deciduous fruit trees by chemical was more than others way [2]. A large number of experiments showed that in different periods of dormancy of deciduous fruit trees, a series of material metabolism occurs, such as the change of water forms [3], carbohydrate metabolism [4,5], protein metabolism [6], etc. However, there are few reports on the dormancy of the *Ziziphus jujuba* 'Zhanshanmizao'. In this experiment, the changes of water and organic substances in the branches of KNO_3 were studied with 7-year-old *Ziziphus jujuba* 'Zhanshanmizao' as the material, and the quality of the fruit was analyzed. The aim of this paper is to find out the most effective concentration of KNO_3 to break the forced dormancy of the *Ziziphus jujuba* 'Zhanshanmizao', and to prolong the harvest period and increase the income of jujube farmers.

Materials and Methods

Materials. The test base is located in Yonglian Village, Yongxin Town, Santai County, Mianyang City. The test material is 7 year old *Ziziphus jujuba* 'Zhanshanmizao' (tiller propagation seedling). The plant was processed on January 30 th, 2017. KNO_3 was set up at 3 levels(3%,6%,9%), 3% KNO_3 was written as T1, 6% KNO_3 was written as T2, 9% KNO_3 was written as T3, with the treatment of clear water as control(CK). A single plant is a small community, each treatment repeat

3 times, a total of 36 strains, random district group arrangement. Taking the first sample after two days of treatment, each interval 7d sampling. At each sampling time, the 2~3 of two representative branches in the upper and middle part of the canopy of jujube tree were cut. After wrapping the plastic wrap, put the ice tape back to the Sichuan Agricultural University. The samples were brought back to the laboratory with a sampling box, and stored in a -10°C refrigerator for use. After fruit trees were ripe, 30 of treated fruits were used for the analysis of fruit quality.

Determination index and method. The content of starch and soluble sugar was determined by anthrone colorimetry [7]. Determination of amino acid content used ninhydrin colorimetry [8]. Determination of soluble protein content using coomassie brilliant blue G-250 method [8]. Determination of the acid content of titration by acid-base titration [7]. Determination of Vc content using 2,6-dichlorophenol phenol titration [7]. Determination of soluble solids content using hand-held refractometer method [7].

Statistical Analyses. Data analysis using Excel.

Results

Change of water content during dormancy about *Ziziphus jujuba* ‘Zhanshanmizao’. The total water content in *Ziziphus jujuba* ‘Zhanshanmizao’ was stable after the experiment, and there was a small upward trend (Fig. 1), and the total content changed at different concentrations was always higher than the control. The change of total water content in the branch which treated with 3% KNO₃ showed a trend of "first decreased then increased", the total water content with 6% KNO₃ showed a trend of "increase-decrease-increase-decrease", 9% concentration of KNO₃ treatment and CK of the total water content in *Ziziphus jujuba* ‘Zhanshanmizao’, Showed an upward trend. The change of total water content in the branch which treated with water showed a trend of "decrease-increase".

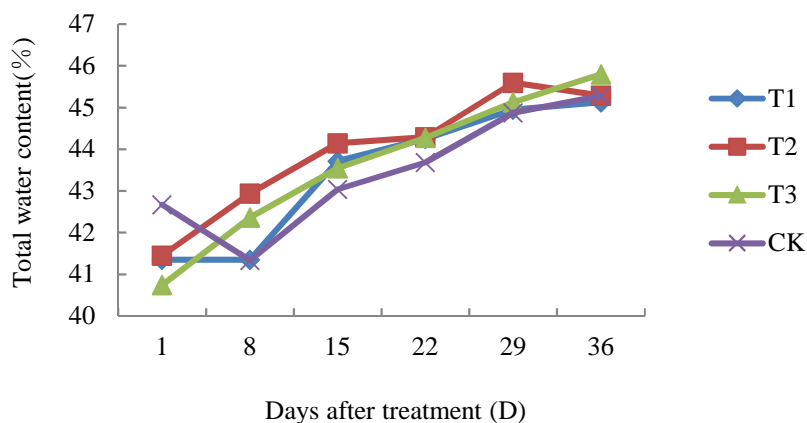


Fig.1 Change of total water content

The free water content of the intradermal rose in the dormant period of the *Ziziphus jujuba* ‘Zhanshanmizao’ (Fig. 2). The change of free water treated by the KNO₃ was higher than the CK. The difference is particularly pronounced after 15 days of processing. The content of free water in the branches of 6% potassium nitrate was significantly higher than that of other concentration treatment.

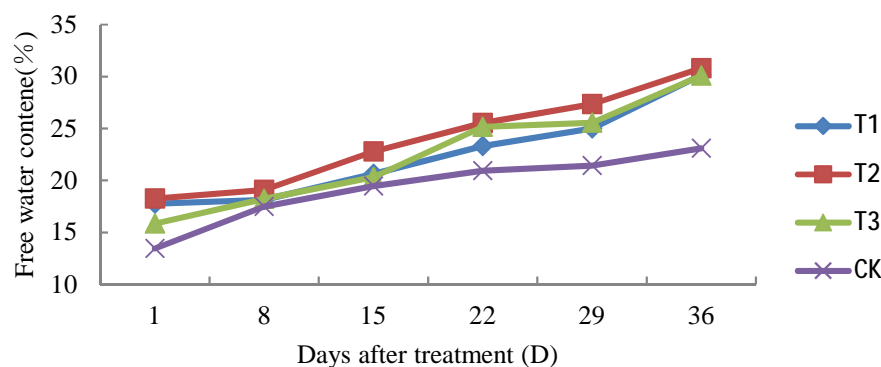


Fig.2 Change of free water content

In contrast to free water content, the content of bound water in the branches of *Ziziphus jujuba* 'Zhanshanmizao' was decreased (Fig. 3), and 9% of potassium nitrate was treated, the water content decreased slightly slowly with 3% and 6% potassium nitrate.

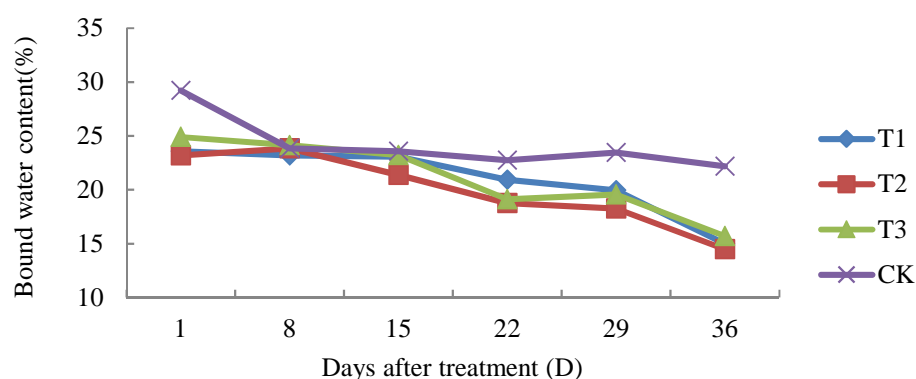


Fig.3 Change of bound water content

It was found that the change trend of total water content, free water content and bound water content of all the different concentrations of potassium nitrate treated by 15 days after the experiment was obviously better than that of the control, which may be related to the enhancement of the metabolism activity of the tree.

Changes of organic substances content in the dormancy process of the *Ziziphus jujuba* 'Zhanshanmizao'. The soluble sugar content showed a tendency to decline first and then rise (Fig. 4). In the treatment 15 days, the experimental group's soluble sugar content is higher than the control, and the rate of decline is slower than the control, after 15 days, the experimental group's soluble sugar content rise trend is better than control. It can be seen from the figure that all the treatment and control of the soluble sugar content at the lowest level in 15 days, indicating that the dormancy ended. The increase of soluble sugar content may be related to the gradual strengthening of respiration, and soluble sugars act as energy-supplying substances.

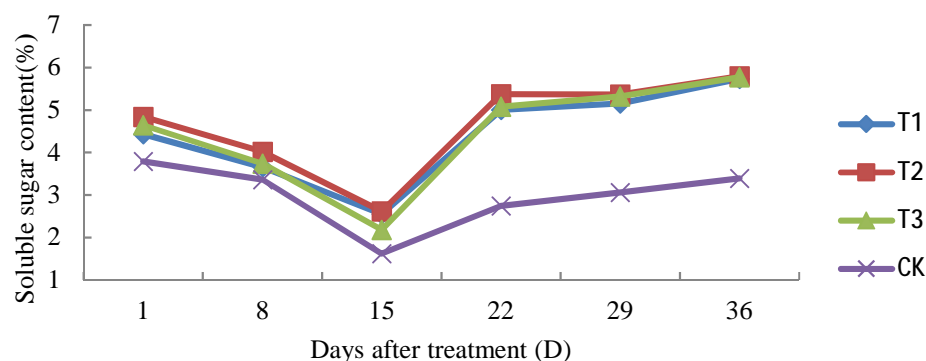


Fig.4 Change of soluble sugar content

Starch content appears first rise and then decline trend, in the treatment after 15 days peak, from the overall effect, the treatment of starch content is always lower than the control. The starch content in the branches of 6% potassium nitrate was lower than that of other concentrations.

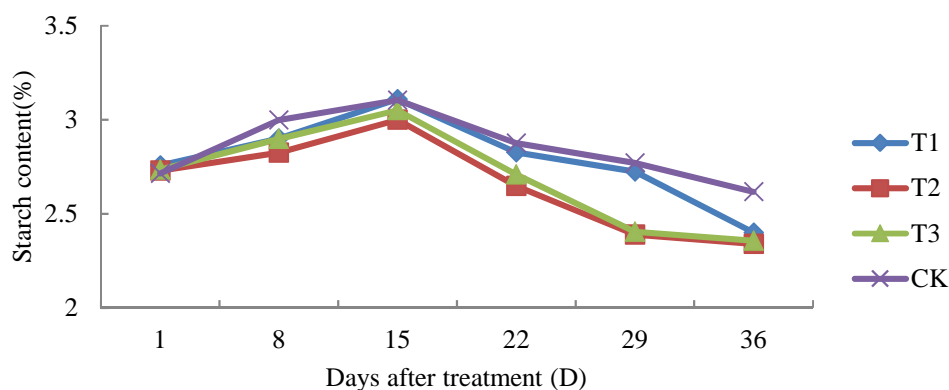


Fig.5 Change of starch content

In the experiment, the content of soluble protein in the branches showed a trend of ascending and descending, the maximum value was 15 days after, the soluble protein content of each experiment group was always lower than that of the control, it may be that the treatment of the sleep inhibitor can deter the synthesis of protein or accelerate the hydrolysis of protein, The most significant change of soluble protein content was 6% KNO_3 .

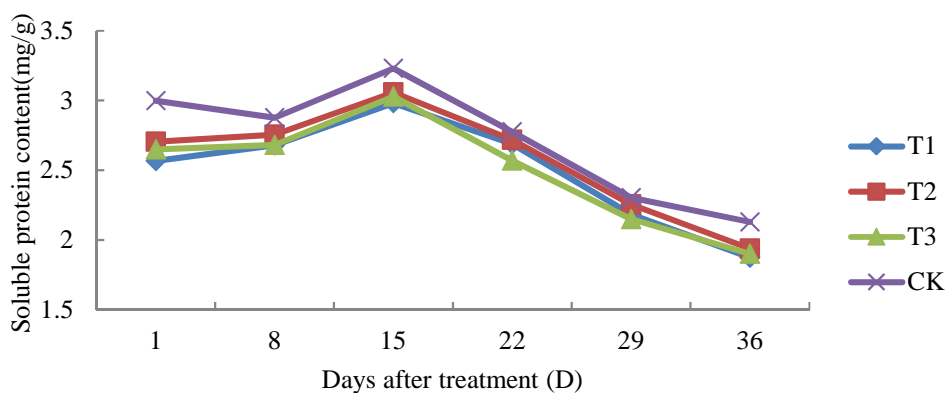


Fig.6 Change of soluble protein content

The content of free amino acid showed the tendency of decreasing first and then rising. The minimum value was reached 15 days after treatment, and the free amino acid content treatment Group was higher than the control group. The content of free amino acid showed that the activity of

cell metabolism was very strong, and free amino acid could be the basis of macromolecular material synthesis, which promoted germination of *Ziziphus jujuba* 'Zhanshanmizao'. 6% KNO_3 promotes free amino acid content to increase at the fastest rate.

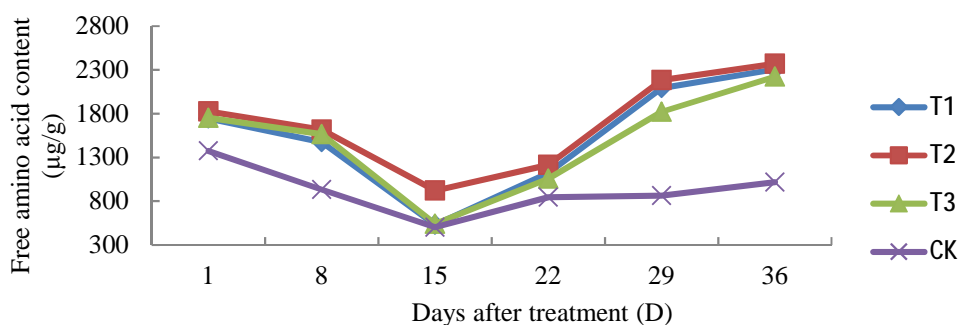


Fig.7 Change of free amino acid content

Effect of different concentrations of KNO_3 on fruit quality of *Ziziphus jujuba* 'Zhanshanmizao'. The content of VC in different concentration of potassium nitrate was higher than that of control.

Effect of different concentration of KNO_3 on soluble solids (TSS) content of *Ziziphus jujuba* 'Zhanshanmizao'. The TSS content of the 3% KNO_3 treated branches was slightly lower than that of the control, and the TSS content of the 9% KNO_3 treated branches was slightly higher than that of the control, and the TSS content of the branches treated by 6% KNO_3 was basically and controlled.

Effect of different concentration of KNO_3 on the content of soluble sugar and titration acid in the fruit of the *Ziziphus jujuba* 'Zhanshanmizao'. The total soluble sugar content of all the cuttings treated by the treatment was slightly higher than that of the control. Among them, the 6% KNO_3 concentration increased the titration acid content of the fruit.

Effect of different concentration of KNO_3 on single fruit weight of the *Ziziphus jujuba* 'Zhanshanmizao'. The results of the 3% KNO_3 treated branches were slightly lower than the controls, however, the difference is not significant, in all treatment, the 6% KNO_3 treated by the branches of the results of the largest single fruit weight, but because the fruit single fruit weight by the tree potential, the load of large impact, in the treatment of small impact on the situation is difficult to evaluate the treatment effect.

Table 1 Effects of different concentration of KNO_3 on fruit quality of *Ziziphus Jujuba* 'Zhanshanmizao'

Treatment	Vc(mg/100g)	TSS(%)	Soluble sugar(%)	Single fruit weight(g)	Titration acid(%)
3% KNO_3	379.05	19.0	25.67	4.59	0.56
6% KNO_3	428.22	19.5	24.55	5.22	0.63
9% KNO_3	428.22	20.5	22.43	4.73	0.61
CK	340.99	19.7	19.70	4.63	0.61

Conclusions and Discussion

Effect of KNO_3 on dormancy of *Ziziphus jujuba* ‘Zhanshanmizao’. Dormancy is a biological adaptation of plants to the environment and seasonal climatic changes formed during the evolution process [9]. Dormancy can be divided into several stages, and different scholars have inconsistent interpretations [10], among them, water and organic substances (starch, soluble sugar, soluble protein, free amino acid) are important to the dormancy of the *Ziziphus jujuba* ‘Zhanshanmizao’, and this experiment finds that during the dormancy of the *Ziziphus jujuba* ‘Zhanshanmizao’, Contrast to the change trend of free water and bound water, the change tendency of soluble sugar and starch, the free water content rise may be from the bound water conversion, the soluble sugar content rise may be from starch hydrolysis, free water/bound water ratio increase and starch hydrolysis may be related to dormancy release. KNO_3 processing of the *Ziziphus jujuba* ‘Zhanshanmizao’, the total water and free water content in the branches were higher than the control, and the bound water content was less than the control, and He [11] in the dormant physiology of jujube tree, the water change is similar, this may be the KNO_3 treatment of the *Ziziphus jujuba* ‘Zhanshanmizao’ dormancy is shallow, and the control of dormancy is deep. In this experiment, the content of free amino acid and soluble sugar showed the tendency of decreasing first and then rising. The starch and protein showed a trend of ascending and descending, which may be due to the increase of soluble protein synthesis ability and the decrease of free amino acid content in the dormancy period, when dormancy is relieved, soluble protein content decreases, The content of free amino acid increased and the metabolic activity of bud body increased, and the dormancy of the *Ziziphus jujuba* ‘Zhanshanmizao’ was relieved 15 days after the experiment began.

Effect of different concentrations of KNO_3 treatment on fruit quality of the *Ziziphus jujuba* ‘Zhanshanmizao’. During the dormancy of the *Ziziphus jujuba* ‘Zhanshanmizao’, the effects of different concentrations of KNO_3 on the fruit quality of the *Ziziphus jujuba* ‘Zhanshanmizao’ were not particularly great, and the different treatments increased the sugar-acid ratio of the fruit to a certain extent, and the fruit sugar-acid ratio was increased to some extent by the fruit of 3% treated branches. The Vc content of the branches was improved to a certain extent, but the single fruit weight and TSS content were not significantly different from the control group.

To sum up, 6% concentration of KNO_3 processing in improving the fruit quality of the *Ziziphus jujuba* ‘Zhanshanmizao’ due to other treatment of the fruit quality, and the different concentrations of KNO_3 treatment of the *Ziziphus jujuba* ‘Zhanshanmizao’, the effect of the release of dormancy is different, 6% KNO_3 treatment, total water content, free water content, The content of soluble sugar and free amino acid were higher than other treatments, and the effect was better.

Acknowledgements

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