ATLANTIS PRESS

Advances in Engineering Research, volume 170

7th International Conference on Energy and Environmental Protection (ICEEP 2018)

Effect of GA_3 on breaking dormancy of *Zizyphus jujuba* 'Zhanshanmizao' and its effect on antioxidants

Xingyu Long[1, a], Mengwei Chen[1,b], Yan Zhou[1,c], Jie Zhou[1,d] and Qunxian Deng[1,e*]

[1]College of Horticulture, Sichuan Agricultural University, Chengdu, Sichuan, China

[a]1296110496@qq.com, [b]912468236@qq.com, [c]zhouyan6213500@qq.com, [d]493137598@qq.com, [e]1324856299@qq.com

*Corresponding author.

Keywords: GA_3; *Zizyphus jujuba* 'Zhanshanmizao'; antioxidants; forced dormancy

Abstract. We used the 7-year-old *Zizyphus jujuba* 'Zhanshanmizao' as a test material, and sprayed three different concentrations of GA_3(50 mg/L, 100 mg/L and 200 mg/L) to it on January 30, 2017. The dynamic changes of antioxidant substances (SOD, POD, O_2^- and MDA) were measured after the management in order to compare the effects of different concentrations of GA_3 on antioxidant substances of the jujube trees. The results showed that spraying GA_3 increased the activity of SOD and POD, while decreasing the content of O_2^- and MDA. After different concentrations of GA_3 treatment during forced dormancy (January 30 to February 14) of jujube trees, it turns out that 200 mg/L GA_3 could significantly activate the antioxidant system while 50mg/L GA_3 had basically no use in breaking the forced dormancy and even has the inhibition. Therefore, 200mg/L GA3 is thought to be its the most effective concentration of breaking the forced dormancy of *Zizyphus jujuba* 'Zhanshanmizao'.

Introduction

Zizyphus jujuba 'Zhanshanmizao', a plant of *Rhanmaceae*.R.Br, is mainly produced in Santai County, Mianyang, Sichuan Province, China. It was deeply loved by the majority of consumers because of its beautiful appearance, regional characteristics of fruit, good taste and rich nutrition[3]. The dormancy of deciduous fruit tree bud is a very complicated life phenomenon, which involves a series of complex physiological and biochemical reactions, and bud dormancy is a beneficial biological characteristic, and it is a kind of biological adaptability to environmental conditions and seasonal changes obtained by deciduous fruit trees after a long period of evolution [2]. In recent years, the study of using chemical agents instead of cold demand to break the dormancy of deciduous fruit trees is a hot spot[3]. It is generally believed that GA_3 is the substance that promotes dormancy release. In the study of Whitelam[4] *et al.* on poplar mutant, GA_3 plays an important role in bud dormancy induction, and the decrease of GA_3 synthesis guides the plant into dormancy. So far, the study on GA_3 breaking the forced dormancy physiology of the *Zizyphus jujuba* 'Zhanshanmizao' is rarely reported. In this experiment, the changes of antioxidant substances in the branches treated with three different concentrations of GA_3 were studied with 7-year-old *Zizyphus jujuba* 'Zhanshanmizao' as material. The aim is to find out the most effective concentration of GA_3 to break the forced dormancy of the *Zizyphus jujuba* 'Zhanshanmizao', make the maturity period of jujube earlier, increase the income of farmers and to provide some guidance for the regulation of the maturity period of the *Zizyphus jujuba* 'Zhanshanmizao'.

Materials and Methods

Materials. The test base is located in Yong Lian Village of Yongxin town of Mianyang Santai County. The tested material was 7-year-old *Zizyphus jujuba* 'Zhanshanmizao' (tillering propagation seedling), spaced at 2 m×3 m. The plant was processed on January 30, 2017 and 4 levels were set: the GA_3 treated with the concentration of 50, 150, 200mg/L was used to treat the plants and clear water treatment was used as control. Single plant area, each treatment repeat 3 times, a total of 36 strains, random District group arrangement. The first time sampling was on the second day of processing,

each sampling time interval seven days. At each sampling time, two to three of the representative secondary branch on the upper and middle part of tree canopy was cut. After wrapping the plastic wrap, put the ice cassette back into the comprehensive Laboratory of Horticulture Department of Sichuan Agricultural University. Using the blade to remove the bud branch skin, placed it in the -10℃ refrigerator for testing to analyze the change trend of antioxidant substances.

Methods. Both SOD and POD were measured using the method which Nimir[5] et al. refered to in the paper. Determination of O_2^- content by reference to the method of Lei. Bi[6]. The content of MDA is determined by reference to the method of Si. Liu[7].

Statistical Analyses. The data were processed using SPSS Statistics 20.0 and Excel software to analyze variance (Duncan new Repolarization method).

Results and Discussion

Effect on the change of SOD content. SOD is an important enzyme in the antioxidant system of plants[8]. As shown in Fig. 1, the GA_3 treatment greatly promoted the activity of SOD, and its content was gradually increasing, which was consistent with the research results of Dengwen. Chen in shoots of apricot[9]. The increase of SOD content helps to remove the free radicals accumulated by the trees under low temperature stress and break the forced dormancy. On the 15th and 22nd days after treatment, the content of SOD in the 100 mg/L and 200 mg/L GA_3 treated was decreased, and increased to the highest in the whole treatment cycle by the 36th day after treatment, in which the content of SOD in 200 mg/L GA_3 was reached to 159.242 OD/ g·Fw.This indicates that these two processes have strong ability to process activated antioxidant systems.

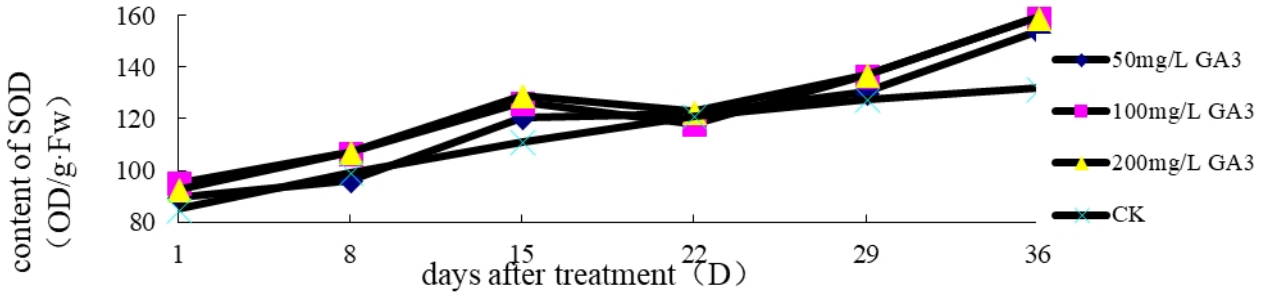

Fig. 1 Effect of GA_3 treatment with different concentrations on content of SOD in dormant period of the *Zizyphus jujuba* 'Zhanshanmizao'

Effect on the change of POD content. POD, like SOD, is also an enzyme that protects against reactive oxygen species in plants [8]. As shown in Fig. 2, the POD content in the sprout of the *Zizyphus jujuba* 'Zhanshanmizao' shoots decreased first and then rose. After applying GA_3, the activity of POD was always higher than that in the control period, and the content of POD increased gradually after 15 days of treatment, which may be related to the germination of the sprout of *Zizyphus jujuba* 'Zhanshanmizao'.When the content of POD was at the bottom, it indicates that forced dormancy release. There was no significant difference in content of POD between GA_3 treatment of the three concentrations, among which 200 mg/L GA_3 had the highest POD content in 36 days after treatment, which was up to 153 od/g Fw.

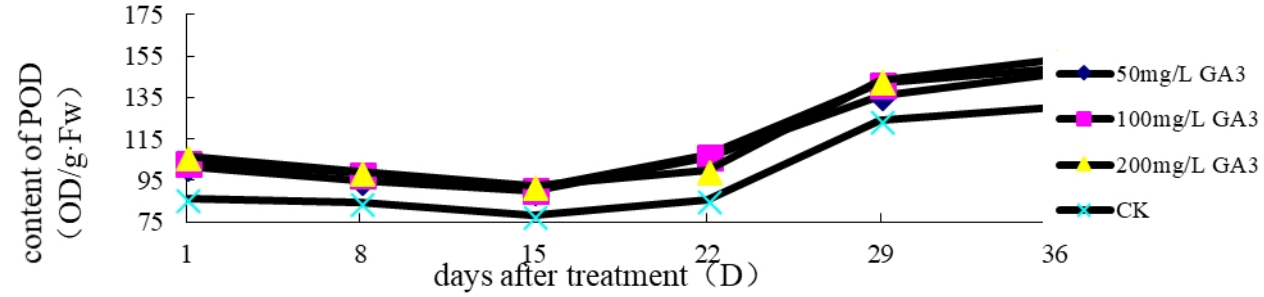

Fig. 2 Effect of GA_3 treatment with different concentrations on content of POD in dormant period of the *Zizyphus jujuba* 'Zhanshanmizao'

Effect on the change of O_2^- content. As shown in Fig. 3, the content of O_2^- in the bud of the *Zizyphus jujuba* 'Zhanshanmizao' with different concentration of GA_3 was significantly lower than that in the control, and the whole showed a decreasing trend, which was contrary to the content of SOD. Among these, O_2^- content in branch intradermal of *Zizyphus jujuba* 'Zhanshanmizao' with the 100 mg/L and 200 mg/L concentrations of GA_3 decreased faster than the 50 mg/L concentration of the treatment of GA_3, and O_2^- content on the 36th day after the treatment achieved the lowest, reaching to 26.657 umol/ g·Fw.

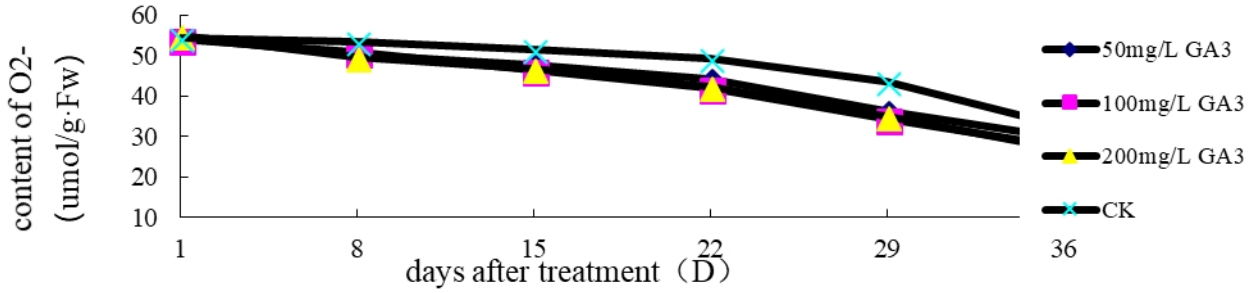

Fig. 3 Effect of GA_3 treatment with different concentrations on content of O_2^- in dormant period of the *Zizyphus jujuba* 'Zhanshanmizao'

Effect on the change of MDA content. The change of membrane permeability is one of dormancy phenomena, and MDA is the final decomposition product of membrane lipid peroxidation[10]. Its content can reflect the degree of lipid peroxide [11]. It is shown from Fig. 4 that the change trend of MDA content decreased first and then stabled after three concentration of GA_3 treatments. Among these, 200 mg/L GA_3 had the lowest content of MDA in 22 days after treatment, and was significantly lower than other treatments, for a number of 0.549 umol/ g·Fw, then the change of the treatment was smooth, this change may have nothing to do with the influence of forced dormancy, and the reason may be related to the germination of the branch of *Zizyphus jujuba* 'Zhanshanmizao'.

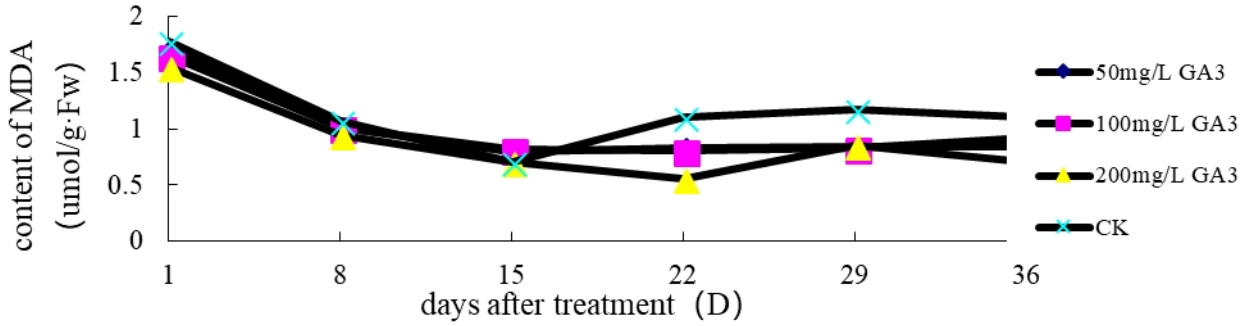

Fig. 4 Effect of GA_3 treatment with different concentrations on content of MDA in dormant period of the *Zizyphus jujuba* 'Zhanshanmizao'

Conclusions

The dormancy of deciduous fruit trees is divided into related dormancy, internal dormancy and forced body sleep [12]. The forced dormancy is satisfied with the internal factors such as cold quantity, but environmental stress (such as water stress, nutrient deficiency, etc.) leads to the phenomenon of not sprouting. The results showed that the activity of SOD was lower in the early period of forced dormancy during the forced dormancy of the jujube bud, and the content of SOD increased gradually with the change of external temperature, and the POD content decreased gradually. The POD content gradually increased when the budding jujube shoots were ready to be released after the forced dormancy. SOD is the first enzyme of superoxide radical degradation, and its rise can be regarded as an adaptive response to low temperature stress. The higher the activity of SOD, the stronger the role of low temperature in the dissolution, and the content of O_2^- will gradually decrease, when forced dormancy begins, POD activity is reduced rapidly. POD activity increases gradually after dormancy is released, the changes of antioxidant enzyme activity in the bud of the dormancy period of apricot

tree is consistent with the study of Junjie. Du[13] et al.. The results showed that 200 mg/LGA_3 had the strongest ability to activate the enzyme activity of antioxidant system during the period of forced dormancy of the jujube bud. Plant organs suffer damage under adversity, often have membrane lipid peroxidation, MDA is one of the main products of membrane lipid peroxidation, its content can reflect the degree of membrane lipid peroxidation [14]. The higher the MDA content in the dormant period, the greater the damage of the cold to the bud [10]. At the end of forced dormancy, the content of MDA in the branches of 200 mg/L GA_3 was the lowest. The results showed that the sleep effect was better. To sum up, 200 mg/L GA_3 can significantly activate the antioxidant system of ***Zizyphus jujuba*** 'Zhanshanmizao' bud, has better effect in breaking the ***Zizyphus jujuba*** 'Zhanshanmizao' bud forced dormancy than other concentration treatment. It is considered that 200 mg/L GA_3 is the most effective sleep-breaking agent during the forced dormancy period of the ***Zizyphus jujuba*** 'Zhanshanmizao'.

Acknowledgements

This work was financially supported by the Double subject construction plan of Sichuan Agricultural University and Special action plan project of science and technology rich people and strong county of Sichuan Province “Integration and demonstration of key Technologies for industrialized Development of Zizyphus jujuba ‘Zhanshangmizao’of Santai County”.

References

[1] L. Wang, A. M. Min, Z. G. Qin, Y. Wang, C. G. Li, H. X. Li and Z. Xiong: Journal of West China Forestry Science Vol. 5(2014), p. 48-52.

[2] G. Q. Liu, P. H. Zhen and Y. W. Teng: Journal of Fruit Science Vol. 5(2012), p. 911-917.

[3] P. Q. Sun, J. Liu, J. M. Jia, X. H. Wang, Z. A. Shi and X. L. Li: China Agricultural Science Bulletin Vol. 8(2011), p. 222-225.

[4] G. C. Whitelam and P. Devlin: Plant Cell Env Vol. 20(1997), p. 752-756.

[5] N.E.A. Nimir, S. Lu, G. Zhou, W. Guo, B.L. Ma and Y. Wang: Crop & Pasture Science Vol. 2(2015), p. 145-157.

[6] L. Bi: Study on changes of inclusions and metabolism during dormant period of Qiyuesu Pear(thesis of doctor’s degree, Agricultural University Of Hebei, Hebei, China 2009).

[7] S. Liu: The Function and Associated Mechanism of Gibberellin on Bud Dormancy Release in Blueberry(thesis of master’s degree, Dalian University of Technology, Dalian, China 2017).

[8] Q. T. Wang, X. Q. Liu and T. Xu: Plant physiology communications Vol. 5(1996), p. 321-327.

[9] D. W. Chen, F. Wang and A. Q. Gao: Journal of Northwest plants Vol. 2(2000), p. 212-217.

[10] Z. H. Li and D. S. Gao: Anhui agricultural science Vol. 24(2008), p. 10339-10340.

[11] L. X. Wang, Z. X. Wu and J. B. Wang: Journal of Tropical crops Vol. 1(2005), p. 60 - 62.

[12] L. H. Fuchigami and C. C. Nee: Hort science Vol.22(1987), p. 836-845.

[13] F. H. Pang, J. J. Du and F. Liu: Journal of Hubei institute for nationalities(Natural science edition) Vol. 4(2004).