Effect of pruning on endogenous hormone content associated with differentiation of blueberry flower buds

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Abstract--In this study, the relationship between pruning methods and endogenous hormone contents related to flower bud differentiation of Brigitta blueberries cultivated in Southwest China was studied. We performed the top pruning in June. The contents of endogenous hormones related to flower bud differentiation of blueberry were measured and analyzed. After top pruning, there was no significant change in the content of ethylene among the five endogenous hormones, but top pruning had a significant effect on the content of the other four hormones, which indicated that top pruning could affect flower bud differentiation by regulating the content of endogenous hormones.

1. INTRODUCTION
In recent years, with the development of economy and the improvement of people's living standards, the planting scale of blueberry in China is also growing. Blueberry has high economic benefits, but there are also many problems, such as many diseases, difficult disease control, harsh growth conditions, low yield\textsuperscript{4,5}. It is found that pruning blueberry branches can effectively improve the tree vigor and shape of blueberry fruit trees, affect the growth of new branches and the formation of flower buds, and improve the quality and yield of fruit. Endogenous hormones have an irreplaceable regulatory effect in the process of flower bud differentiation of fruit trees, which can greatly affect the growth of blueberry\textsuperscript{4,5}. In theory, the flower bud differentiation of blueberry can promote the growth and development of blueberry and improve the quality of blueberry\textsuperscript{6}. There are obvious differences in pruning methods and pruning responses in different regions. At present, there is still a lack of research on the effect of Pruning on Blueberry quality in Sichuan Province. Through this experiment, we can...
explore the internal relationship between the pruning methods and the changes of endogenous hormone content of blueberry, and provide a reference for the fine pruning of blueberry, which is conducive to improving the quality and planting efficiency of blueberry[7].

2. MATERIALS AND METHODS

2.1 Research sites and plant materials.
This experiment was carried out in Pujiang blueberry Valley in Chengdu, Sichuan Province. It is located at 103° 19' E and 30° 20' N with an altitude of 594-609 m, an average annual temperature of 16℃ and an average annual rainfall of 1266 mm. In this study, three-year-old northern high bush blueberry variety Brigitta was used as material.

2.2 Experimental design
The early maturing Brigitta was used as the blueberry variety in the experiment. The blueberry seedlings with normal development, healthy growth and consistent management level were selected. The top branches were pruned after the fruit picking period (June). The area to be pruned is the base of the fruiting branch. The control group was not pruned at the same time. Three trees were selected in each treatment, and ten branches of each tree were pruned as three biological repetitions.

2.3 Endogenous hormone detection
During the flower bud morphological differentiation, a certain number of flower buds were taken from the control group and the experimental group every seven days. The flower buds were picked for the first time from June 19. A total of four times were collected as test materials. Paraffin sections of blueberry flower buds were made, and the contents of gibberellin (GA), abscisic acid (ABA), ethylene (ETH), auxin (IAA) and zeaxanthin (ZT) were determined by HPLC. The number of flower buds and new branches in the experimental group and the control group were recorded.

3. RESULT
Effects of top pruning on endogenous hormone contents of GA, ABA, ETH, IAA and ZT in fruits were showed in Figure 1 and Figure 2. In both treatment group and control group, during the process of flower bud differentiation of blueberry, the contents of endogenous hormone were constantly changing. It showed that the contents of various hormones gradually increased in the process of flower bud differentiation, and the content of endogenous hormones were closely related to the flower bud differentiation of blueberry.

The average values of all five endogenous hormones were showed in Figure 1. Among all the five endogenous hormones, IAA content was the highest, with the average 640.34 ng/g of pruning treatment from all stages, and 775.48 ng/g of average CK treatment. The lowest contents were in ETH, with the average 2.04 ng/g of pruning treatment from all stages, and the average of CK treatment was 2.03 ng/g.

|          | IAA (ng/g) | GA3 (ng/g) | ZT (ng/g) | ABA (ng/g) | ETH (ng/g) |
|----------|------------|------------|-----------|------------|------------|
| CK       | 775.48     | 421.37     | 55.36     | 186.36     | 2.03       |
| Pruning  | 640.33     | 347.43     | 53.28     | 220.85     | 2.04       |

The IAA contents in both pruning treatment and CK treatment were gradually increased during flower developing stages (Figure 2 A). The amplifications were 21.31% in CK treatment and 26.64% in pruning treatment. The IAA content in CK treatment were always higher than pruning treatment
during. It was increased by 15.93%-19.20% comparing with CK. It implied that low concentration of auxin can promote the differentiation of blueberry flower buds.

Same case was in GA (Figure 2 B). GA increased along with flower developing, and the GA content in CK treatment were always higher than pruning treatment during all stages. The amplifications were 17.49% in CK treatment and 22.67% in pruning treatment. The GA contents in pruning treatment increased by 15.89%-19.44% comparing with CK.

In the same way, ZT increased along with flower developing (Figure 2 C). The amplifications were 15.69% in CK treatment and 13.89% in pruning treatment. Its contents in CK treatment were always higher than pruning treatment during all stages, whereas the amplification was different. The ZT contents in pruning treatment increased by 3.15%-4.65% comparing with CK. It indicated that low concentration of ZT can promote the transformation of leaf buds into flower buds and thus promote the differentiation of flower buds in blueberry.

The opposite changing trend were in ABA and ETH. The contents of ABA and ETH in pruning treatment were generally higher than the CK treatments. The content of ABA increased significantly (Figure 2 D). Its contents in pruning treatment decreased by 17.66%-19.68% comparing with CK. The result indicated that the accumulation of ABA could promote the dormancy of blueberry flower bud differentiation.

The ETH content in pruning treatment was a little lower than in CK treatment in the first flower developing stage, and it decreased by 1.60% in pruning treatment at the first flower developing stage (Figure 2 E). However, during the rest three flower developing stages, it increased by 0.45%-1.53% in in pruning treatment comparing with the CK.
4. DISCUSSION

The effects of pruning methods on endogenous hormone contents in flower bud differentiation of blueberry were studied. The results provide a basis for the selection and optimal management of pruning methods of high bush blueberry in the north of Southwest China, which is conducive to the standardization of pruning. It was confirmed that top pruning in June played an important role in flower bud growth and differentiation of blueberry plants.

The effect of auxin in flower bud differentiation is undefined. Werizilov found auxin decreased in flower buds of apple, while Gil thought auxin increased in peel flower buds [8]. GA was generally confirmed to depress flower bud formation, whereas CTK, ABA and ETH are endogenous hormones promoting flower buds formation [8]. In apple trees, compared with the control, the integrated method of bud-notching, in twisting shoot and removing terminal shoot together with shoot-bending treatment, the endogenous IAA, GA in lateral buds treated with the integrated method decreased, while ZR, ABA content increased at flower bud differentiation stage [9]. The experiment in *Xanthoceras sorbifolium*
fruits showed that the contents of GA, IAA and ZT of middle and basal buds increased with the increase pruning cut length [10].

In this experiment, we compared the effects of no-pruning and June-pruning on endogenous hormones related to flower bud differentiation of blueberry. Compared with normal pruning, top pruning had a greater effect on endogenous hormone content of blueberry. The flower bud differentiation of blueberry is a process promoted by many factors, through this experiment, it is shown that apex pruning can promote the differentiation of blueberry flower buds, and it is also shown that daily management is important to the growth of blueberry.

5. CONCLUSION
The effect of pruning methods on endogenous hormone contents related to flower bud differentiation of blueberries was studied in this study. We used Brigitta blueberry as the plant material. The contents of endogenous hormones related to flower bud differentiation showed that there was no significant change in the content of ethylene among the five endogenous hormones, but top pruning had a significant effect on the content of the other four hormones, which indicated that top pruning could affect flower bud differentiation by regulating the content of endogenous hormones.

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