Comparison of Physiological and Biochemical Characteristics of Grafting ‘Lingfengnuo’ and ‘Guan litchi’

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Abstract. In this experiment, the optimal grafting combination was obtained by comparing the physiological and biochemical characteristics of the rootstock ‘Dahongpao’ with scion ‘Lingfengnuo’ and ‘Guan litchi’. The results showed that the soluble protein content and the enzyme activity of POD in the rootstock-scion combination of ‘Dahongpao’ and ‘Lingfengnuo’ were higher than those of ‘Dahongpao’ and ‘Guan litchi’, with higher affinity and better adaptability to the environmental and climatic conditions in Leshan area.

1. Introduction
Litchi chinensis Sonn belongs to Sapindaceae. Litchi is popular with consumers for nutrition and delicious. Yuelai township, Leshan, Litchi Bay and Daohua Village are the northernmost litchi producing areas in China, which can be traced back to the history of litchi cultivation over 2,000 years ago. However, the single variety of litchi and the same ripening period of the fruits in Leshan area lead to the concentrated litchi production period. When it is difficult to sell the fruit and the sale is not in time, litchi will rot and deteriorate, causing economic losses. The problem of concentrated litchi fruit period can be improved by introducing early, middle and late varieties.

Therefore, this experiment mainly observed and studied the survival status and physiological and biochemical indexes of two rootstock-scion combinations with ‘Dahongpao’ as rootstock, ‘Lingfengnuo’ and ‘Guan litchi’ as scion. The affinity of the two groups of litchi grafting combinations was preliminarily tested, and the better litchi grafting combinations were obtained. It provides a theoretical basis for screening the grafting combinations of litchi which are more suitable for planting and promotion in Leshan area.

2. Materials and methods

2.1 Testing material
The experimental site was the litchi bay, Yuelai township, Leshan. The rootstock was ‘Dahongpao’. The scion was ‘Lingfengnuo’ and ‘Guan litchi’.

2.2 Overview of the test ground
Leshan litchi bay is located at 29°39’ n and 103°45’ e, with an average elevation of about 380~450m, being adjacent to Minjiang river, with an average annual rainfall of about 1400 mm. From November
to January of the following year, the average temperature is 7.1℃, being 11 ℃ in March. What’s more, the average temperature is 25.9 ℃ in July, and the highest temperature is 38.1 ℃, which is characterized by warm winter and hot summer. Litchi bay is generally purple sandy loamy soil with high organic matter content and soil pH value of about 5.5~7. The environmental climate conditions are very suitable for the survival and growth of litchi [1].

2.3 Main measurement indexes and methods

2.3.1 Determination of chlorophyll. Chlorophyll content was determined by spectrophotometer [2].

2.3.2 Determination of soluble protein content. Protein content was determined by coomassie blue staining g-250 [3].

2.3.3 Determination of malondialdehyde (MDA) activity. The content of malondialdehyde (MDA) was determined by thio-barbituric acid [4].

2.3.4 Determination of peroxidase (POD) activity. POD activity was determined by guaiacol method [5].

3. Result analysis

3.1 Comparison of chlorophyll content in leaves of different litchi varieties

According to tab.1, the chlorophyll a+b content of the rootstock 'Dahongpao1' in the two rootstock-scion combinations was 38.377 mg/L, while the chlorophyll a+b content of 'Dahongpao2' was 34.841 mg/L, with little difference in content. The content of chlorophyll a+b in scion 'Guanlitchi' was significantly higher than that in 'Lingfengnuo', with a difference of 12.029 mg/L. The chlorophyll a+b content of rootstock 'Dahongpao' was higher than that of scion 'Lingfengnuo' and 'Guanlitchi'.

| Varieties         | Chlorophyll a (mg/L) | Chlorophyll b (mg/L) | Chlorophyll a+b (mg/L) |
|-------------------|----------------------|----------------------|------------------------|
| Dahongpao1        | 26.750               | 11.416               | 38.377                 |
| Lengfengnuo (scion1) | 6.991               | 2.134               | 9.188                  |
| Dahongpao2        | 24.333               | 9.239               | 34.841                 |
| Guanlitchi (scion2) | 14.695               | 6.262               | 21.262                 |

Table 1. Chlorophyll content in leaves of different litchi varieties

Scion 'Lingfengnuo' and rootstock 'Dahongpao1' are rootstock-scion combination 1; Scion 'Guanlitchi' and rootstock 'Dahongpao2' are rootstock-scion combination 2.

3.2 Comparison of soluble protein content in leaves of different litchi varieties

The soluble protein content is directly proportional to the healing speed of the graft union, which improves the survival rate of the grafted plants [6]. According to tab.2, the soluble protein content of 'Dahongpao1' and 'Lingfengnuo' in rootstock-scion combination 1 was 31.814 mg/g and 14.874 mg/g respectively, with a difference of 16.940 mg/g. The soluble protein content of 'Dahongpao2' and 'Guanlitchi' in rootstock-scion combination 2 was 27.661 mg/g and 3.617 mg/g respectively, with a difference of 24.044 mg/g. According to the analysis, the graft union of 'Dahongpao1' and 'Lingfengnuo' had better healing, higher affinity, and higher survival rate of grafted plants.

| Varieties         | Soluble protein content (mg/g) |
|-------------------|-------------------------------|
| Dahongpao1 (rootstock1) | 31.814                       |
| Lengfengnuo (scion1)   | 14.874                       |
| Dahongpao2 (rootstock2) | 27.661                       |
| Guanlitchi (scion2)   | 3.617                        |

Table 2. Soluble protein content in leaves of different litchi varieties
3.3 Comparison of MDA content in leaves of different litchi varieties

According to fig.1, the MDA content of 'Dahongpao1' in rootstock-scion combination 1 was 8.351mol/g, and that of 'Lingfengnuo' was 8.599mol/g. The MDA content of 'Dahongpao2' in rootstock-scion combination 2 was 4.755mol/g, and that of 'Guanlitchi' was 4.183mol/g. There was no significant difference in MDA content between rootstock and scion in the two rootstock-scion combinations, but the MDA content of rootstock and scion in rootstock-scion combination 1 was higher than that in rootstock-scion combination 2.

![Figure 1. Comparison of MDA content in leaves of different litchi varieties](image)

3.4 Comparison of POD activity in leaves of different litchi varieties

According to fig.2, POD activity of rootstock in both rootstock-scion combinations was significantly higher than that of scion, and POD activity of rootstock-scion combination 1 was higher than that of rootstock-scion combination 2. POD activity of 'Dahongpao1' was 31.920mol/g, and significantly higher than that of 'Dahongpao2', with a difference of 10.910mol/g. The POD activity of 'Lingfengnuo' was 8.400mol/g, which was higher than that of 'Guanlitchi', with a difference of 5.200mol/g.

![Figure 2. Comparison of POD activities in leaves of different litchi varieties](image)
4. Discuss

Factors influencing survival of grafting on litchi include temperature, air humidity, light and other environmental factors, as well as internal factors such as the quality and state of rootstock and scion and the affinity between rootstock and scion. The affinity between rootstock and scion is an important factor that directly affects the survival rate of grafting and the growth of grafted seedlings. The tissue structure of rootstock and scion of litchi showed convergent changes after the graft union healing, and the variety of rootstock was an important factor influencing the growth of litchi trees[7,8]. In this experiment, the chlorophyll content, soluble protein content and POD activity of rootstock 'Dahongpao' were all higher than that of scion 'Lingfengnuo' and 'Guanlitchi', which were similar to the results of Liu haiyan et al[9]. Therefore, 'Dahongpao' can be used as a good rootstock for grafting litchi in Leshan area.

After grafting, many physiological and biochemical changes will occur between the rootstock and scion of the grafted plant. Chlorophyll, an organic material which was produced through photosynthesis, provided the energy needed for life activities such as the healing of the graft union. The increase of soluble protein content can promote the cell division and accelerate the formation of callus at the graft union, promoting the healing of the graft union, and improve the survival rate of the grafted plant[6]. The increase of POD activity had positive effects on callus formation of grafted plants, enhancing the affinity between anvil and spike, and improved the survival rate of plants[10]. The amount of MDA accumulated is proportional to the degree of damage to plant cells[11-12]. In this experiment, soluble protein content and POD activity of the rootstock-scion combination of 'Dahongpao' and 'Lingfengnuo' were all higher than that of the rootstock-scion combination of 'Dahongpao' and 'Guanlitchi', while the chlorophyll content was lower than that of the rootstock-scion combination of 'Dahongpao' and 'Guanlitchi'. Therefore, it can be inferred that the rootstock-scion combination of 'Dahongpao' and 'Lingfengnuo' had higher affinity, higher resistance and stronger tree. However, the MDA content was higher than that of the combination of 'Dahongpao2' and 'Guanlitchi', which would produce higher toxic effect. From the comprehensive comparison of physiological and biochemical data of leaves of different litchi varieties, after grafting the rootstock-scion combination of 'Dahongpao1' and 'Lingfengnuo', the enzyme activity in the plant was higher than the rootstock-scion combination of 'Dahongpao1' and 'Guanlitchi' showing higher affinity, higher stress resistance, stronger tree potential and better adaptation to the climate conditions in Leshan area.

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