Research on Grafting Propagation of Feijoa

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Abstract
An $L_9(3^4)$ orthogonal experimental design was employed to investigate the effects of Feijoa cultivars (Unique, Coolidge, and Mammoth), grafting methods (cleft grafting, whip grafting, and side-veneer grafting), and grafting seasons (summer, autumn, and spring) on grafting survival rates. The results showed no significant differences in survival rates among cultivars, while the grafting season was identified as the primary influencing factor, followed by grafting methods. The optimal grafting season was spring, with a survival rate of 49.63%; the best grafting method was cleft grafting, achieving a survival rate of 38.52%; and the optimal experimental combination was Mammoth grafted in spring using the cleft grafting method, which yielded a survival rate of 84.47%.

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1. Introduction

Feijoa sellowiana Berg., an evergreen shrub or small tree of the *Myrtaceae* family and *Feijoa* genus, is native to southeastern Brazil and Uruguay [1]. It exhibits broad adaptability, thriving primarily in temperate and subtropical climates, with an average annual temperature above 12°C and a minimum extreme temperature no lower than -10°C. Currently, it is cultivated in countries such as New Zealand, the United States, France, Spain, Russia, Australia, and Japan. As an emerging fruit tree valued for its ornamental, edible, and medicinal properties, Feijoa holds promising applications in food, pharmaceuticals, cosmetics, and other fields [2–3]. Propagation studies indicate that Feijoa is most easily propagated by seed, but seed reproduction results in significant trait variability. Compared to other fruit trees, Feijoa presents greater challenges in vegetative propagation [4–5]. Layering is slow and has a low multiplication rate, while considerable research has been conducted on cutting propagation [5-7]. For commercial Feijoa production, maintaining the superior traits of elite cultivars while enhancing adaptability and stress resistance makes grafting the optimal propagation method. To accelerate the cultivation of high-quality grafted Feijoa seedlings and promote its fruit production, this study investigated the effects of cultivar, grafting method, and grafting season on graft survival rates.

2. Materials and Methods

The experiment was conducted at the Facility Agriculture Experimental Station of Jingchu University of Technology (Jingmen), where the annual average temperature is 16.3°C, with January and July averages of 5.2°C and 26°C, respectively. The area receives 1,298.1 hours of annual sunshine, has a frost-free period of 272 days, and an average annual precipitation of 963.2 mm. Feijoa seedlings propagated from seeds in spring 2022 were used as rootstocks. Scions were collected from healthy branches of six-year-old Feijoa trees of three cultivars: Unique, Coolidge, and Mammoth.

An $L_9(3^4)$ orthogonal experimental design was adopted, with three factors: cultivar, grafting method, and grafting season. The levels for each factor were:

- **Cultivar:** Unique, Coolidge, Mammoth
- **Grafting method:** Cleft grafting, whip grafting, side-veneer grafting
- **Grafting season:** Summer (early July 2023), autumn (late September 2023), and spring (early March 2024)

The experimental combinations are presented in Table 1. Each treatment included 30 plants, replicated three times. Scions were freshly collected and grafted immediately. Graft survival rates were recorded on May 8, 2024, and the data were statistically analyzed. Prior to ANOVA, data underwent arcsine transformation, followed by F-tests.

Table 1: Design Scheme and Test Results of $L_9(3^4)$ Orthogonal Experiment for Feijoa Grafting

Number	Factor A Variety	Empty Column	Factor B Grafting Method	Factor C Grafting season	Survival Rate（%）	Sin-1√p
1	A1	1	B1	C1	11.10	0.34
2	A1	2	B2	C2	12.20	0.36
3	A1	3	B3	C3	21.13	0.48
4	A2	1	B2	C3	43.30	0.72
5	A2	2	B3	C1	0.00	0.00
6	A2	3	B1	C2	20.00	0.46
7	A3	1	B3	C2	6.67	0.26
8	A3	2	B1	C3	84.47	1.17
9	A3	3	B2	C1	6.67	0.26
K1	44.77	61.07	115.57	17.77	∑205.53	
K2	63.30	96.67	62.17	32.20		
K3	97.80	47.80	27.80	148.90		
k1	14.92	20.36	38.52	5.92		
k2	21.10	32.22	20.72	10.73		
k3	32.60	15.93	9.27	49.63		
Range	17.68	16.29	29.26	43.71		
Primary and Secondary Factors			C B A			

3. Results and Analysis

3.1. Primary and Secondary Factors Affecting Grafting Survival Rate

The experimental results revealed that grafting season had the most significant impact on grafting survival rates. Spring demonstrated the highest survival rate, while summer showed the lowest, with an extreme difference (range) of 43.71 percentage points between the two seasons. The grafting method was the second most influential factor. Cleft grafting achieved the highest survival rate, whereas side-veneer grafting yielded the lowest, with an extreme difference of 29.26 percentage points. The effects of cultivar and experimental error (null column) were relatively minor, with extreme differences of 17.68 and 16.29 percentage points, respectively (see Table 1). These findings indicate that the primary factors influencing Feijoa grafting survival rates are, in order: Grafting season, Grafting method. The cultivar was identified as a secondary factor.

3.2 Grafting Success Rate and Its Relationship with the Season of Grafting

The results of the experiment show that the season of grafting has a significant impact on the success rate of Feijoa fruit grafting, with a significance level reaching 0.05%. The success rate in spring was 49.63%, while it was only 10.73% in autumn and 5.92% in summer (see Table 2). The former is significantly higher than the latter two because the spring temperature is suitable and gradually increases, which is conducive to the formation of callus tissue and the generation of new conductive tissues. Therefore, for Feijoa fruits, the best season for grafting is spring.

3.3 The Relationship between Grafting Success Rate and Grafting Methods

The results of the experiment show that the grafting method also has a relatively significant impact on the success rate of Feijoa fruit grafting, with a significance level reaching 0.01%. Among them, the survival rate of the cut grafting method is the highest, reaching 38.52%; followed by the split grafting method at 20.72%; and the branch abdominal grafting method is only 9.27% (see Table 2), which indicates that the cut grafting method is the best grafting method suitable for Feijoa fruits.

3.4 The Relationship between Grafting Success Rate and Varieties

The results of the experiment show that there is no significant difference in the grafting success rate among different varieties, that is, varieties have no significant effect on the grafting success rate (see Table 2).

Table 2: Analysis of Variance for Each Treatment of Feijoa Grafting Test

Source of variation	Degree of freedom	Sum of squares of deviation	Mean square	Mean square ratio F	F_a
Grafting season	2	0.5522	0.2761	31.5739**	$F_{0.05}(2,2)$ =19.00
Grafting method	2	0.2523	0.1261	14.4260*	$F_{0.10}(2,2)$ =9.00
Variety	2	0.0578	0.0289	3.3057	
Test error	2	0.0175	0.0087		
Total	8	0.8798			

Note: ** means the difference reaches 0.05% significance level, * means the difference reaches 0.10% significance level

4. Summary

The success rate of Feijoa grafting is significantly related to the season and method of grafting, but not significantly related to varieties. The best season for grafting is spring, with a survival rate of 49.63%; the best grafting method is the cut grafting method, with a survival rate of 38.52%; in the orthogonal experiment, the best combination is A3B1C3, that is, the survival rate of Mammoth grafted by the cut grafting

method in spring is the highest. This experiment also shows that the grafting survival rate of Feijoa is lower than that of other fruit trees, and has higher requirements for factors affecting grafting survival; it is recommended to strictly master the best grafting season and method in actual production to improve the grafting survival rate. The reasons for the difficulties in grafting Feijoa fruits need further study.

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