

Research Article

A Preliminary Study on Introduction and Cultivation of *Feijoa sellowiana* in China

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Abstract: *Feijoa sellowiana* is cultivated as a food crop in New Zealand, Colombia and France and is well known for its high dietary value fruit. *F. sellowiana* was firstly introduced into Shanghai Botanical Garden during the 1980s. Four varieties of *F. sellowiana* ('Mammoth', 'Triumph', 'Unique', 'Coolidge') were introduced to Hunan in 2007. However, little is known about their biological characteristics and phenology reaction in our climate. Through the introduction and cultivation test of *F. sellowiana* in Hunan, the biological characteristics about phenological phase, shoots, leaves and fruits growth were determined from 2008 to 2010. The results are showed that the budding and leafing of 'Mammoth' were earlier than the other three varieties. The time of shoots start growing of four varieties were relatively concentrated in early April, while the time of shoots stop growing were inconsistent. 'Mammoth' has the strongest growth potential, followed by 'Triumph', 'Unique', 'Coolidge'. There was only one rapid growth stage in the whole leaf area growth process and in the order of mature leaf area size was 'Triumph' > 'Mammoth' > 'Coolidge' > 'Unique'. Four varieties growth dynamics of leaf thickness were similar, from early May to mid-June and the growth rates of leaf thickness were nearly the same. Initial bloom stages of four varieties were in early May, fallen flower stages were from late May to early June. There were two rapid growth periods during the whole fruit growths, which were after the fallen flower to early July and early September to early October, respectively. 'Mammoth', 'Triumph' and 'Unique' took 170 days to ripe, while 'Coolidge' took nearly 180 days. Based our results, four varieties of *F. sellowiana* acclimatize to Hunan province.

Keywords: Biological characteristics, *Feijoa sellowiana*, introduction, phenological phase

INTRODUCTION

Acca sellowiana (Berg) Burret, syn. *Feijoa sellowiana* (Berg) is a fruit tree in the Myrtaceae family (Yu *et al.*, 2012; Li *et al.*, 2014). The feijoa is an evergreen shrub or small tree, which originates from Brazil, Uruguay and Argentina and Paraguay (Sharpe *et al.*, 1993; Franzon *et al.*, 2005). It occurs at altitudes >800 m in Southern Brazil and is often part of a sub-canopy alongside stands of *Araucaria angustifolia* (Bertol). O. Kuntze, which dominates the Ombrophilous Mixed Forest, an ecosystem in the Atlantic Forest biome (Finatto *et al.*, 2011). This species is cultivated in several countries, such as New Zealand, Colombia, France, Italy, USA, Japan and China (Mingjie, 2010a). Researchers at Shanghai Botanical Garden first brought *F. sellowiana* from Europe to China in the 1980s (Yujie *et al.*, 2009). Thereafter, it was introduced to Jiangsu, Sichuan and Hunan provinces. In 2007, we planted 3-year-old *F. sellowiana* on the Central South University of Forestry and Technology campus in Hunan (Xiang *et al.*, 2009; Ming-jie *et al.*, 2010b). The *Feijoa* fruit is a good source of vitamin C, low in calories and high in minerals and fibre (Weston, 2010). *Feijoa* also contains

many phenolic compounds, such as catechins, leucoanthocyanins, proanthocyanidins and flavonols (Tuncel and Yilmaz, 2015). Its unique flavor makes it a potentially attractive fruit crop for small farmers while providing an opportunity for a non-timber forest product to contribute to forest conservation (Karine *et al.*, 2009).

At present, *F. sellowiana* has received considerable attention in recent years, most studies of this species focused on the photosynthetic characteristics (Xiang *et al.*, 2009), fruit nutritional components (De-yi *et al.*, 2011), seed germination (Chao *et al.*, 2011), rooting (Wen-tao *et al.*, 2011), rapid propagation in vitro of *F. sellowiana* (Yan-ling *et al.*, 2012). Unfortunately, little was known about their phenological characteristics in our climate. The aim of this study was to investigate whether four varieties of *Feijoa sellowiana* ('Mammoth', 'Triumph', 'Unique', 'Coolidge') could acclimatize to Hunan province.

MATERIALS AND METHODS

Plant materials: Four varieties of 4-year-old *Feijoa sellowiana* trees were used as materials, they were 'Mammoth', 'Coolidge', 'Triumph', 'Unique',

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respectively. Plant spacing was 2×3 m and the average height was about 1.5 m (Mingjie, 2010a).

Experimental field: The plant materials were cultivated at Central South University of Forestry and Technology in Hunan province, southern China (longitude: east 112°59'32"; and latitude: north 28°8'14"). The field is hilly red soil and the thickness of the soil is 50~80 cm, mean annual air temperature is 17.5°C, ranging from -8°C to 39.5°C, with 286 frost-free days. Average annual precipitation is 1392 mm and ≥10°C years of accumulated temperature is 5300°C (Li *et al.*, 2014).

Observation and measurements: From December 2008 to January 2010, 120 healthy trees were randomly chosen (each variety 30 trees) as research collections. Four varieties of phenological phase Leaf area (MSD-971 Leaf area analyzer, China) and leaf thickness (Electronic vernier caliper, Japan) were measured every 4 days from 10th May to 28th June, ten leaves per plant from the central part of the stem were used for these measurements. In which, measuring ten leaves at once, took the average as the leaf thickness of each leaf. Shoots length (Tape measure, China) and diameter (Electronic vernier caliper, Japan) were measured every

4 days from 13th April to 14th June, ten shoots per plant from the central part of the stem were used for these measurements. Fruit diameter and vertical (Electronic vernier caliper, Japan) were measured every 15 days from 8th June to 22th October, ten fruits per plant from the central part of the stem were used for these measurements. Recorded the phenological changes every day.

RESULTS

Phenological phase: Table 1 shows the different phenological phase of four varieties *Feijoa sellowiana*. Compared to the other varieties, ‘Mammoth’ budding and leafing were the earliest, 30th March and 5th April, respectively. The time of shoots start growing of four varieties were relatively concentrated, both on 3th April and 5th April. However, the time of shoots stop growing were inconsistent, ‘Coolidge’ shoots growth period was the shortest, which lasted about 2 months, from 3th April to 3th June, while ‘Triumph’ shoots growth period was the longest, which lasted about two and a half months, from 3th April to 14th June. Fruit growth periods of four varieties were in the early September to mid-October. ‘Mammoth’, ‘Triumph’ and ‘Unique’ took about 170 days to ripe, while ‘Coolidge’ took nearly 180 days.

Table 1: The phenological phase of *Feijoa sellowiana* (month/day)

Variety	Budding	Leafing	Shoots start growing	Shoots stop growing	Initial bloom	Full bloom	Fallen flower	Fruit growth	Fruit ripe
‘Mammoth’	3/30	4/5	4/3	6/8	5/6	5/9~5/15	5/25~6/9	Early September ~mid-October	Late October
‘Coolidge’	4/1	4/7	4/3	6/3	5/7	5/7~5/14	5/26~6/9	Early September ~mid-October	Early November
‘Triumph’	4/2	4/7	4/3	6/14	5/8	5/11~5/17	5/28~6/10	Early September ~mid-October	Late October
‘Unique’	4/4	4/9	4/5	6/12	5/8	5/11~5/16	5/27~6/9	Early September ~mid-October	Late October

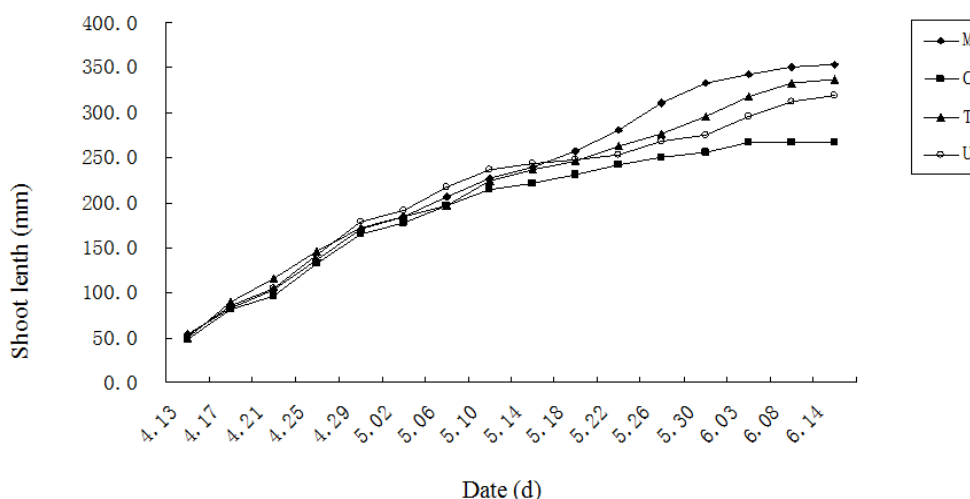


Fig. 1: The growth dynamic curve of shoots length

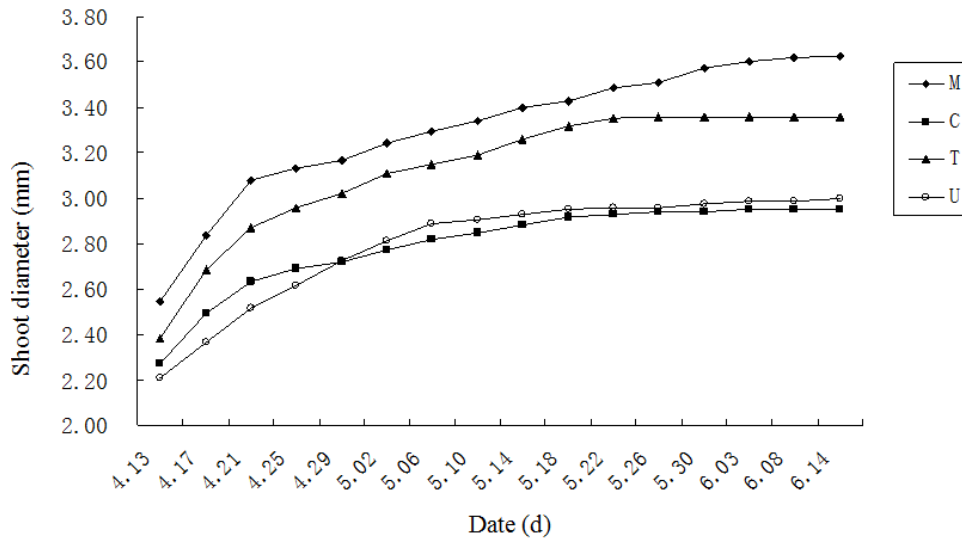


Fig. 2: The growth dynamic curve of shoots diameter

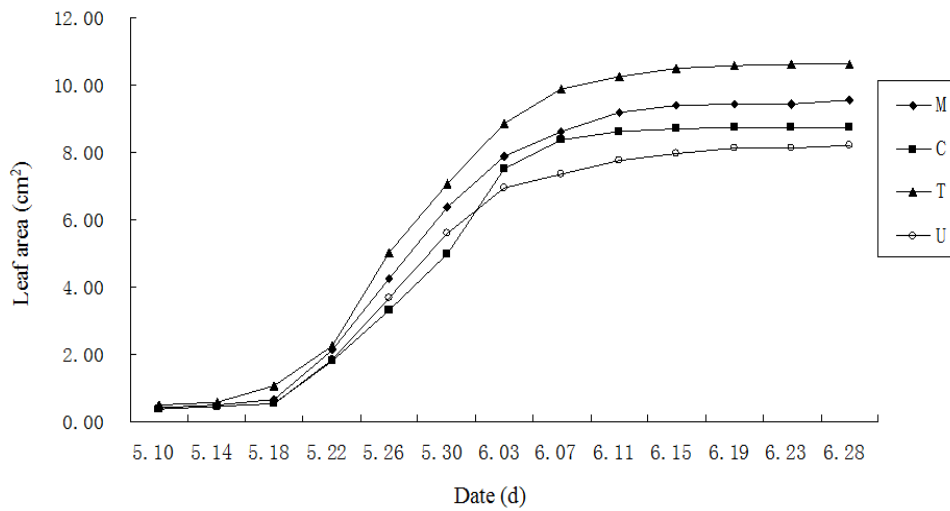


Fig. 3: The growth dynamic curve of leaf area

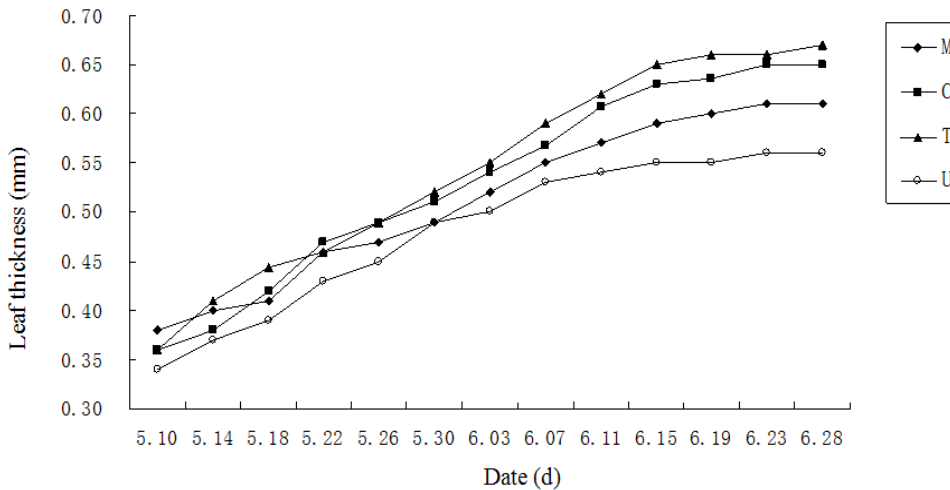


Fig. 4: The growth dynamic curve of leaf thickness

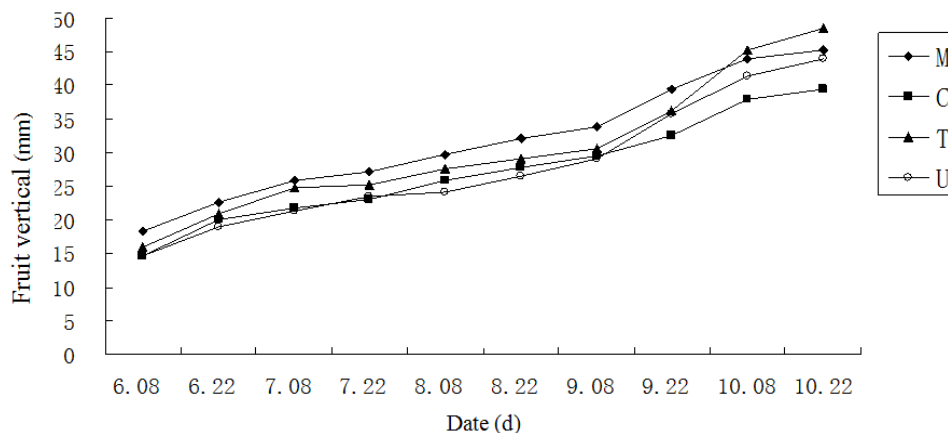


Fig. 5: The growth dynamic curve of fruit vertical

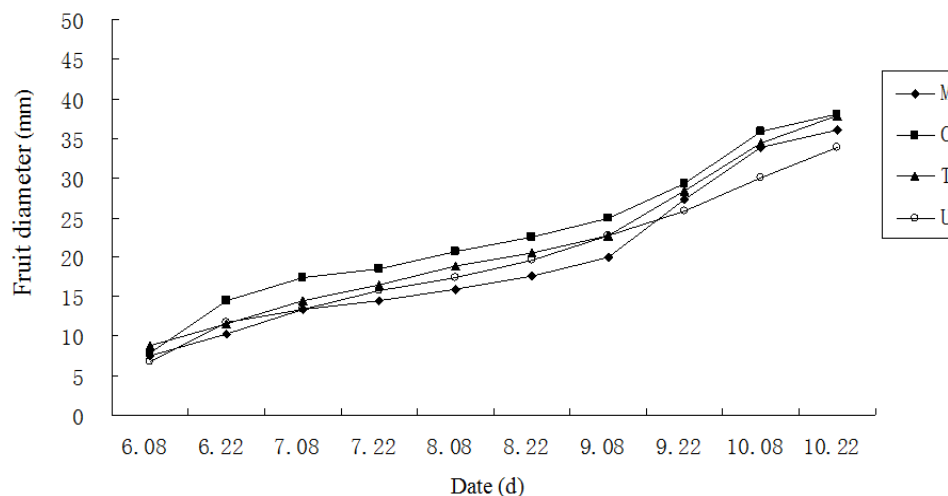


Fig. 6: The growth dynamic curve of fruit diameter

Shoots growth: There were two rapid growth stages during the growth process of shoots length of four varieties (Fig. 1). The first rapid growth stage was from 13th April to 29th April, since then till 14th May shoots length grew slowly, from 14th May to 8th June ('Coolidge' was 3th June) was the second rapid growth stage. What's more, the growth rate of 'Mammoth' was significantly higher than the other three varieties during the second rapid growth stage. Untill shoots stop growing, the mean shoots length of four varieties were 352.96 mm ('Mammoth'), 336.43 mm ('Triumph'), 318.43mm ('Unique') and 267.13mm ('Coolidge'), respectively.

The shoots diameter of four varieties grew fast at first, then gradually slow down (Fig. 2). Till shoots stop growing, the mean shoots diameter of four varieties were 3.63mm ('Mammoth'), 3.36mm ('Triumph'), 3.01mm ('Unique') and 2.95mm ('Coolidge'), respectively.

Leaves growth: Four varieties of *Feijoa sellowiana* have the same leaf area growth tendency (Fig. 3). There

was one rapid growth period in the whole leaf area growth process. At the first days, from 10th May to 18th May, leaf area grew slowly. Yet, after then till 7th June was the rapid growth period, during this period, the average daily growth of leaf area of four varieties were 0.517 cm² ('Triumph'), 0.468 cm² ('Mammoth'), 0.462 cm² ('Coolidge') and 0.401 cm² ('Unique'), respectively. Till 15th June, four varieties of leaves area almost stop growing and the average size order of mature leaf area was 'Triumph' > 'Mammoth' > 'Coolidge' > 'Unique'.

Four varieties of *Feijoa sellowiana* have nearly the same leaf thickness growth tendency (Fig. 4). From 10th May to 15th June, the leaf thickness was in a state of equilibrium rapid growth. After 15th June, four varieties almost stop thickening growth and the average thickness of mature leaf were 0.67 mm ('Triumph'), 0.65 mm ('Mammoth'), 0.61 mm ('Coolidge') and 0.56 mm ('Unique'), respectively.

Fruit growth: Four varieties of *Feijoa sellowiana* have nearly the same fruit vertical growth tendency and there were two rapid growth periods during the whole fruit

vertical growth process (Fig. 5). The first rapid growth period was from 8th June (after fallen flower) to early July, which was called the young fruit rapid growth period, the average daily growth was about 0.25 mm. After then was the slow growth period, which last almost 60 days and the average daily growth was 0.122 mm. The second rapid growth period was from 8th September to 8th October, the average daily growth was 0.378 mm. Then the fruit ripen and the growth rate slowed down.

Fruit diameter growth tendency of the four varieties were almost the same (Fig. 6). There was a significant rapid growth period during the whole fruit diameter growth process, which was from 8th September to 8th October and the average daily growth was 0.365 mm. Then the fruit ripen and the growth rate slowed down.

DISCUSSION

In this study, four varieties of *Feijoa sellowiana* ('Mammoth', 'Triumph', 'Unique', 'Coolidge') were introduced to Hunan, biological characteristics about phenological phase, shoots, leaves and fruits growth were observed. The results showed that the budding and leafing of 'Mammoth' were earlier than the other three varieties. The time of shoots start growing of four varieties were relatively concentrated in early April, while the time of shoots stop growing were inconsistent. 'Mammoth' has the strongest growth potential, followed by 'Triumph', 'Unique', 'Coolidge'. There was only one rapid growth stage in the whole leaf area growth process, in the order of mature leaf area was 'Triumph' > 'Mammoth' > 'Coolidge' > 'Unique'. Four varieties growth dynamics of leaf thickness were similar, from early May to mid-June and the growth rates of leaf thickness were nearly the same.

Initial bloom stages of four varieties were in early May. However, it was different that from which introduced to Shanghai. In which, the initial bloom stages of four varieties were 15 days later than in Changsha of Hunan province, which might caused by the slowly rise temperature in spring (Yujie *et al.*, 2009). Only take flower synchronization into consideration, the four varieties could be pollinations to each other. There were two rapid growth periods during the whole fruit growths, which were after the fallen flower to early July and early September to early October, respectively. 'Mammoth', 'Triumph' and 'Unique' took 170 days to ripe, while 'Coolidge' took nearly 180 days. The whole fruit development stage was earlier than in Shanghai, but consistent with in Mianyang city, Sichuan province (Zhang, 2009).

CONCLUSION

The introduction of 'Mammoth', 'Triumph', 'Unique' and 'Coolidge' cultivates maintained a high economic and ornamental value for the biology

characteristics have no significantly change and all varieties can blossom and bear fruit. Which means that *F. sellowiana* ('Mammoth', 'Triumph', 'Unique' and 'Coolidge') can acclimation to Hunan and ought to be application widen in South China.

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