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The Correlation between Different Fruiting Branch Diameters of *Actinidia chinensis* and Fruit Quality Change in Post-ripening Period

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Abstract he research aimed to explore the correlation between fruiting branch diameter of *A. chinensis* and fruit quality change during the post-ripening period and the mechanism, which could provide theoretical basis for making scientific management measures during *A. chinensis* fruit post-ripening period. In this paper, correlation analysis between fruiting branch diameter of *A. chinensis* and fruit quality change during post-ripening period during 2013 – 2015 was conducted. Results were as below: (i) correlation coefficient analysis showed that fruiting branch diameter was highly positive correlation with number of fruit ventricle, significantly positive correlation with single fruit weight when picking and the indexes after the fruit ripening single (single fruit weight, loss rate of single fruit weight, longitudinal diameter of fruit and width of fruit core), lowly positive correlation with sugar content of fruit juice, and positive correlation with thick transverse diameter of fruit after ripening. (ii) Standard errors of regression analysis between fruiting branch diameter and single fruit weight, longitudinal diameter of fruit, wide transverse diameter of fruit, thick transverse diameter of fruit, fruit core length and sugar content of fruit juice were 12.4248, 4.2731, 2.6452, 2.0260, 0.1337 and 1.0035 respectively; significance F values of variance analysis were 0.0743, 0.0658, 0.1950, 0.5733, 0.2600 and 0.1517 respectively. It showed that fruiting branch diameter had a significant difference with thick transverse diameter of fruit and insignificant differences with other indicators; quadratic curve regression equation and linear regression equation of residual curve, observed value curve, forecast value curve and normal probability curve of were analyzed, and the results were all in line with the law of quadratic curve. (iii) The larger the fruiting branch diameter, the greater the indexes after post-ripening (single fruit weight, longitudinal diameter of fruit, wide transverse diameter of fruit, thick transverse diameter of fruit and sugar content of fruit juice), the better the fruit quality. It was clear that fruiting branch diameter could be as one of important bases of fruit quality change during post-ripening period. Through investigating fruiting branch diameter and the regression equation, it could predict single fruit weight, longitudinal and transverse diameters of fruit, and sugar content of fruit juice index after the ripening.

Key words *A. chinensis*, Fruiting branch, Diameter, Fruit, Quality, Correlation

1 Introduction

Actinidia chinensis belongs to Actinidiaceae, has more than 54 species, and is originally from Wuduhe Town, Yiling District, Yichang City, Hubei Province. It distributes to East Asia and Southeast Asia, and China is main production area of *A. chinensis*, which has more than 52 species. *A. chinensis* in China distributes from Northeast to Hainan Island and from Tibet to Taiwan, and mainly distributes in the south of Qinling and the east of Hengduan Mountain. The fruit could be eaten, and has unique flavor and abundant vitamine C. In Guizhou, fruit garden area in 2011 reached 112680 hm^2, and fruit yield reached 1.2803 million tons, in which *A. chinensis* yield reached 1700 thousand tons, which increased by 30.7% than 2010[1]. *A. chinensis* industry developed fast and has become one pillar industry of agricultural economy in Guizhou fruit tree main production region, which made active contribution to promoting farmer income increase and enlarging employment of urban and rural residents, and improving eco-environment. Guizhou Plateau is in the south of Yangtze River and is a beautiful and magical place, with green mountain, clean water, white cloud, moderate latitude and height[2]. Such eco-environment advantage and natural resource advantage provide good condition for deciduous fruit tree growth, including *A. chinensis*tree. In latter period of the 1990s, with optimization and adjustment of agricultural industry structure, *A. chinensis* industry of Guizhou developed fast. But Guizhou *A. chinensis* industry had many problems, such as unreasonable variety structure, uneven fruit quality, low management level, and low fruit yield and quality, which seriously inhibited the development of *A. chinensis* production in Guizhou Province[3]. Although Jin Fanglun *et al.* reported introduction cultivation test and cultivation technology of *A. chinensis*[4 – 8], and Zeng Rong *et al.* studied fruit quality change of *A. chinensis* during storage period[9 – 14], there was no report about the correlation between different fruit branch diameters of *A. chinensis* and its fruit quality change during post-ripening period. Hence, we studied the correlation between different fruit branch diameters of "Guichang *A. chinensis*" and its fruit quality change during post-ripening period during 2013 – 2015, which aimed to understand the influence factors of *A. chinensis* fruit quality change during post-ripening period and mechanism. The research could provide accurate theoretic basis for improving management level of *A. chinensis* fruit in post-ripening period and *A. chinensis* fruit quality, and reference for making scientific management technology and measure of *A. chinensis* fruit during post-ripening period.

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2 Test materials and methods

2.1 Test variety Test *A. chinensis* variety was "Guichang *A. chinensis*", which was introduced by original Guizhou Fruit Tree Research Institute.

2.2 Basic situation of test garden Test site was in fruit garden of Guizhou Institute of Sericulture Pepper, and test variety was "Guichang *A. chinensis*". The altitude is 880 m, and annual average temperature is 14.9 ℃. Summer maximum temperature is 38.4 ℃, and average temperature in the hottest month (July) is 25.8 ℃. Winter minimum temperature is −3.0 ℃, and average temperature in the coldest month (January) is 3.0 ℃, and ≥10 ℃ of effective accumulative temperature is 4938 ℃. Annual rainfall is 1040 mm, which mainly distributes in summer. Test site is south typical yellow soil, with insufficient fertility, deep soil layer (generally more than 1.0 m) and pH of 5.5 − 6.5. Irrigation mainly depends on rainwater. Test variety was planted in spring of 2001, with plant spacing of 3.0 m × 3.0 m. There were 75 plants in 667 m^2, and the ratio of male and female plants was 8 − 9∶1. High-standard garden construction method was used to rationally plant seedlings, that is, digging planting ditch and fertilizing base fertilizer. In 1 − 2 months before plantation, planting ditch was dug, with 0.8 m deep and 0.8 m wide. The dug surface and deep-layer soils are stacked respectively. When backfilling, surface soil was firstly filled at bottom layer, then the mixed middle-layer soil and base fertilizer, finally deep-layer soil was filled on the surface, which was 25 cm higher than ground surface. All varieties were managed according to high-level cultivation management technology of *A. chinensis* tree, and the key was enhancing soil, fertilizer and water management, using sector tree shape, and rational flower and fruit thinning management. *A. chinensis* tree started to fruit in 2003, and was just at full bearing period now.

2.3 Test method Test design and data investigation: representative tree was selected, and there were three repeats. Fruiting branch of each tree was selected according to test requirement, which was marked. According to test requirement, top fruit was left. During 2013 − 2015, fruiting branch diameter was investigated when picking fruit. During 15 − 20 days of fruit post-ripening, single fruit weight, longitudinal diameter of fruit, wide transverse diameter of fruit, thick transverse diameter of fruit, fruit core width and sugar content of fruit juice were investigated.

2.4 Statistical analysis method Microsoft Office software was used for statistics and analysis of the measured data, mainly containing correlation analysis, regression analysis and the establishment of regression equation.

3 Results and analyses

3.1 Correlation coefficient analysis

3.1.1 Correlation level. When picking *A. chinensis* fruit, fruiting branch diameter was highly positive correlation with number of fruit ventricle, significantly positive correlation with single fruit weight when picking fruit and the indexes after fruit post-ripening (single fruit weight, loss rate of single fruit weight, longitudinal diameter of fruit and fruit core width), lowly positive correlation with sugar content of fruit juice, and positive correlation with thick transverse diameter of fruit after fruit post-ripening. When picking fruit, single fruit weight was highly positive correlation with the indexes after fruit post-ripening (single fruit weight, longitudinal diameter of fruit, wide transverse diameter of fruit and fruit core width), and significantly positive correlation with loss rate of single fruit weight, thick transverse diameter of fruit, fruit core width, number of fruit ventricle and sugar content of fruit juice after fruit post-ripening. Single fruit weight after fruit post-ripening was highly positive correlation with other indexes. Loss rate of single fruit weight after fruit post-ripening was significantly positive correlation with longitudinal diameter of fruit, thick transverse diameter of fruit, fruit core length and number of fruit ventricle fruit post-ripening, lowly positive correlation with fruit core width, and significantly positive correlation with sugar content of fruit juice. Longitudinal diameter of fruit after fruit post-ripening was highly positive correlation with thick transverse diameter of fruit after fruit post-ripening, significantly positive correlation with thick transverse diameter of fruit, fruit core length, fruit core width and number of fruit ventricle after fruit post-ripening, and lowly positive correlation with sugar content of fruit juice. Wide transverse diameter of fruit after post-ripening was significantly positive correlation with fruit core length, fruit core width and number of fruit ventricle, and lowly positive correlation with thick transverse diameter of fruit and sugar content of fruit juice. Thick transverse diameter of fruit after fruit post-ripening was significantly positive correlated with fruit core length, lowly positive correlation with number of fruit ventricle and sugar content of fruit juice, and positive correlation with fruit core width. Fruit core length was significantly positive correlation with fruit core width and number of fruit ventricle, and lowly positive correlation with sugar content of fruit juice. Fruit core width was highly positive correlation with number of fruit ventricle and sugar content of fruit juice. Number of fruit ventricle was significantly positive correlation with sugar content of fruit juice (Table 1).

3.1.2 Significant difference level. When picking *A. chinensis* fruit, fruiting branch diameter had extremely significant difference with number of fruit ventricle, significant difference with width of fruit core and insignificant difference with other indexes.

3.2 Regression analysis Regression analysis between fruiting branch diameter when picking fruit and single fruit weight, longitudinal diameter of fruit, wide transverse diameter of fruit, thick transverse diameter of fruit, fruit core length and sugar content of fruit juice after fruit post-ripening was conducted.

3.2.1 The relationship between fruiting branch diameter and single fruit weight after fruit post-ripening.

(i) Regression statistics: standard error was 12.4248.

(ii) Variance analysis: residual of SS was 1543.7510, residual of MS was 154.3751, Significance F value was 0.0743 (Table 2).

Table 1 The correlation coefficient

Content	Fruiting branch diameter	Single fruit weight when picking	Fruit after post-ripening					Fruit core			Sugar content of fruif juice
			Single fruit weigth	Loss rate of single fruit	Longitudinal diameter	Wide transverse diameter	Thick transverse diameter	Length	Width	Ventricle number	
Fruiting branch diameter	1	0.5563**	0.5332**	0.5492**	0.5468**	0.4021*	0.1811	0.3532*	0.7294**	0.8137**	0.4406*
Single fruit weight when picking	0.5563**	1	0.9936***	0.7196**	0.8924***	0.8604***	0.5979**	0.9267***	0.7203**	0.7907**	0.5634**
Single fruit weight	0.5332**	0.9936***	1	0.6385**	0.8985***	0.8736***	0.5449**	0.9237***	0.7307**	0.7876**	0.5784**
Loss rate of single fruit	0.5492**	0.7196**	0.6385**	1	0.5875**	0.5006**	0.7323**	0.6368**	0.4110*	0.5647**	0.2506
Longitudinal diameter of fruit	0.5468**	0.8924***	0.8985***	0.5875**	1	0.8824***	0.5841**	0.8753***	0.6311**	0.7783**	0.3556*
Wide transverse diameter of fruit	0.4021*	0.8604***	0.8736***	0.5006**	0.8824***	1	0.4382*	0.7771**	0.5440**	0.7157**	0.3173*
Thick transverse diameter of fruit	0.1811	0.5979**	0.5449**	0.7323**	0.5841**	0.4382*	1	0.5764**	0.2732	0.4848*	0.3173*
Length of fruit core	0.3532*	0.9267***	0.9237***	0.6368**	0.8753**	0.7771**	0.5764**	1	0.5663**	0.5786**	0.3966*
Width of fruit core	0.7294**	0.7203**	0.7307**	0.4110*	0.6311**	0.5440**	0.2732	0.5663**	1	0.8843***	0.8167***
Ventricle number	0.8137***	0.7907**	0.7876**	0.5647**	0.7783**	0.7157**	0.4848*	0.5786**	0.8843***	1	0.6700**
Sugar content of fruit juice	0.4406*	0.5634**	0.5784**	0.2506	0.3556*	0.3172*	0.3173*	0.3966*	0.8167***	0.6700**	1

Note: ***, ** and * respectively showed the high, significant and low correlation levels.

Table 2 Variance analysis between fruiting branch diameter and single fruit weight after fruit post-ripening

Item	df	SS	MS	*F* value	Significance *F*
Regression analysis	1	613.1177	613.1177	3.9716	0.0743
Residual	10	1543.7510	154.3751		
Total	11	2156.8690			

(iii) Analysis on residual curve, curve of observed value, curve of predicted value and normal probability chart.

Residual curve, observed value curve, predicted value curve and normal probability chart between fruiting branch diameter and single fruit weight were shown as Fig. 1 – Fig. 3. Quadratic curve regression equation and linear regression equation were used for comparative analysis. R of quadratic curve regression equation was bigger than that of linear regression equation, and its results all corresponded with quadratic curve rule. Correlation coefficients of residual curve, observed value curve, predicted value curve and normal probability chart respectively showed significantly positive correlation, significantly positive correlation, highly significant positive correlation and highly positive correlation, and significant difference levels were respectively insignificant difference, significant difference, significant difference and significant difference (Table 3).

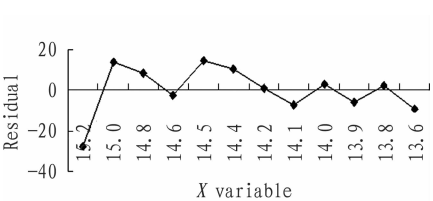

Fig. 1 Residual

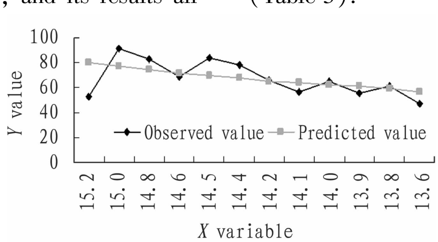

Fig. 2 Curves of observation and predictive values

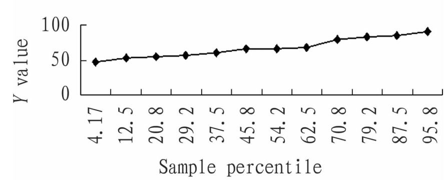

Fig. 3 Normal probability plot

Table 3 Straight line and quadratic curve analysis

Item	Fitting way	Regression equation	Determination coefficient	Correlation index (R)
Residual	Straight line	$y = -0.1563x + 1.0157$	0.0023	0.4780
	Quadratic curve	$y = -0.559x^2 + 7.111x - 15.941$	0.2724	0.5219**
Observed value	Straight line	$y = -2.2129x + 81.892$	0.3247	0.5696
	Quadratic curve	$y = -0.4985x^2 + 4.2679x + 66.77$	0.4785	0.6917**
Predictive value	Straight line	$y = -2.0567x + 80.877$	0.9866	0.9933
	Quadratic curve	$y = 0.0605x^2 - 2.843x + 82.712$	0.9945	0.9972***
Normal probability plot	Straight line	$y = 3.836x + 42.574$	0.9756	0.9877
	Quadratic curve	$y = 0.1265x^2 + 2.1915 + 46.411$	0.9855	0.9927***

Note: ***, ** and * respectively showed the high, significant and low correlation levels.

3.2.2 The relationship between fruiting branch diameter and longitudinal diameter of fruit after fruit post-ripening.

(i) Regression statistics: standard error was 4.2731.

(ii) Variance analysis: residual of SS was 182.5941, residual of MS was 18.2594, Significance *F* value was 0.0658 (Table 4).

Table 4 Variance analysis between fruiting branch diameter and longitudinal diameter of fruit after fruit post-ripening

Item	df	SS	MS	F value	Significance F
Regression analysis	1	77.8926	77.8926	4.2659	0.0658
Residual	10	182.5941	18.2594		
Total	11	260.4867			

(iii) Analysis on residual curve, curve of observed value, curve of predicted value and normal probability chart.

Residual curve, observed value curve, predicted value curve and normal probability chart between fruiting branch diameter and longitudinal diameter of fruit were shown as Fig. 4 – Fig. 6. Quadratic curve regression equation and linear regression equation were used for comparative analysis. R of quadratic curve regression equation was bigger than that of linear regression equation, and its results all corresponded with quadratic curve rule. Correlation coefficients of residual curve, observed value curve, predicted value curve and normal probability chart respectively showed significantly positive correlation, significantly positive correlation, highly positive correlation and highly positive correlation, and significant difference levels were all significant difference, significant difference, significant difference and significant difference (Table 5).

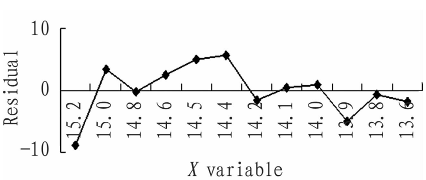

Fig. 4 Residual

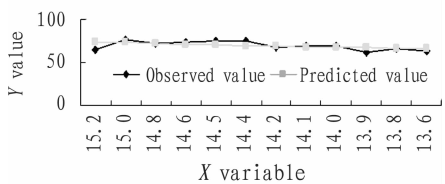

Fig. 5 Observation and predictive values

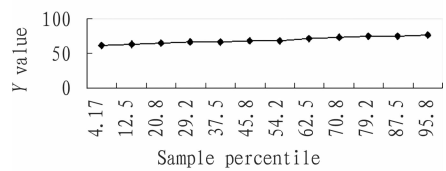

Fig. 6 Normal probability plot

Table 5 Straight line and quadratic curve analysis

Item	Fitting way	Regression equation	Determination coefficient	Correlation index (R)
Residual	Straight line	$y = -0.0732x + 0.476$	0.0042	0.06481
	Quadratic curve	$y = -0.2193x^2 + 2.7778x - 6.1765$	0.3558	0.5965**
Observation value	Straight line	$y = -0.8063x + 74.708$	0.3569	0.5074
	Quadratic curve	$y = -0.1978x^2 + 1.7645x + 68.709$	0.5573	0.7465**
Predictive value	Straight line	$y = -0.7331x + 74.232$	0.9866	0.9933
	Quadratic curve	$y = -0.0215x^2 - 1.0134x + 74.886$	0.9945	0.9972***
Normal probability plot	Straight line	$y = 1.3364x + 60.78$	0.9804	0.9902
	Quadratic curve	$y = 0.0098x^2 + 1.2091x + 61.077$	0.9809	0.9904***

Note: ***, ** and * respectively showed the high, significant and low correlation levels.

3.2.3 The relationship between fruiting branch diameter and wide transverse diameter of fruit after fruit post-ripening.

(i) Regression statistics: standard error was 2.6452.

(ii) Variance analysis: residual of SS was 69.9709, residual of MS was 6.9971, Significance F value was 0.1950 (Table 6).

Table 6 Variance analysis between fruiting branch diameter and wide transverse diameter of fruit after fruit post-ripening

Item	df	SS	MS	F value	Significance F
Regression analysis	1	13.4957	13.4957	1.9288	0.1950
Residual	10	69.9709	6.9971		
Total	11	83.4667			

(iii) Analysis on residual curve, curve of observed value, curve of predicted value and normal probability chart.

Residual curve, observed value curve, predicted value curve and normal probability chart between fruiting branch diameter and wide transverse diameter of fruit were shown as Fig. 7 – Fig. 9. Quadratic curve regression equation and linear regression

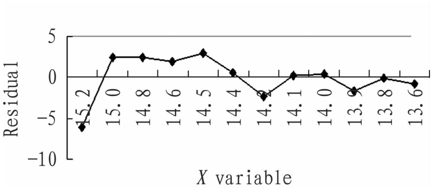

Fig. 7 Residual

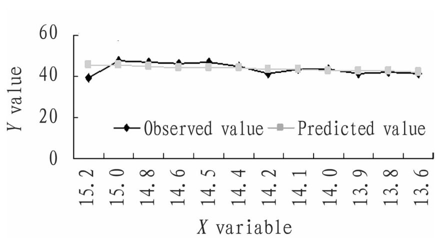

Fig. 8 Observation and predictive values

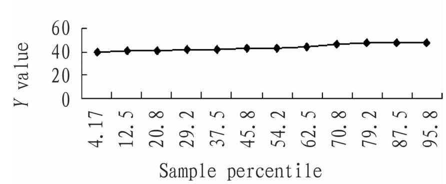

Fig. 9 Normal probability plot

equation were used for comparative analysis. R of quadratic curve regression equation was bigger than that of linear regression equation, and its results all corresponded with quadratic curve rule. Correlation coefficients of residual curve, observed value curve, predicted value curve and normal probability chart respectively showed lowly positive correlation, significantly positive correlation, highly positive correlation and highly positive correlation, and significant difference levels were respectively insignificant difference, significant difference, significant difference and significant difference (Table 7).

Table 7 Straight line and quadratic curve analysis

Item	Fitting way	Regression equation	Determination coefficient	Correlation index (R)
Residual	Straight line	$y=0.0417x+0.2712$	0.0036	0.0600
	Quadratic curve	$y=-0.0964x^2+1.212x-2.6541$	0.1810	0.4254*
Observation value	Straight line	$y=-0.3469x+46.021$	0.2061	0.4540
	Quadratic curve	$y=-0.0875x^2+0.7902x+43.368$	0.3284	0.5731**
Predictive value	Straight line	$y=-0.3051x+45.75$	0.9866	0.9933
	Quadratic curve	$y=0.009x^2-0.4218x+46.022$	0.9945	0.9972***
Normal probability plot	Straight line	$y=0.7531x+38.871$	0.9718	0.9856
	Quadratic curve	$y=-0.012x^2+0.5967x+39.236$	0.9741	0.9870***

Note: ***, ** and * respectively showed the high, significant and low correlation levels.

3.2.4 The relationship between fruiting branch diameter and thick transverse diameter of fruit after fruit post-ripening

(i) Regression statistics: standard error was 2.0260.

(ii) Variance analysis: residual of SS was 41.0451, residual of MS was 4.1045, Significance F value was 0.5733 (Table 8).

Table 8 Variance analysis between fruiting branch diameter and thick transverse diameter of fruit after fruit post-ripening

Item	df	SS	MS	F value	Significance F
Regression analysis	1	1.3916	1.3916	0.3390	0.5733
Residual	10	41.0451	4.1045		
Total	11	42.4367			

(iii) Analysis on residual curve, curve of observed value, curve of predicted value and normal probability chart.

Residual curve, observed value curve, predicted value curve and normal probability chart between fruiting branch diameter and thick transverse diameter of fruit were shown as Fig. 10 – Fig. 12. Quadratic curve regression equation and linear regression equation were used for comparative analysis. R of quadratic curve regression equation was bigger than that of linear regression equation, and its results all corresponded with quadratic curve rule. Correlation coefficients of residual curve, observed value curve, predicted value curve and normal probability chart respectively showed positive correlation, positive correlation, highly positive correlation and highly positive correlation, and significant difference levels were respectively insignificant difference, insignificant difference, significant difference and significant difference (Table 9).

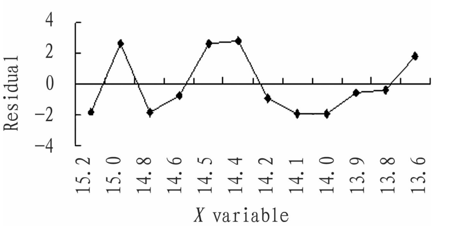

Fig. 10 Residual

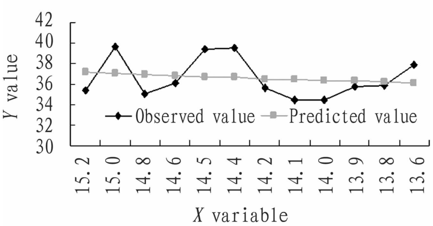

Fig. 11 Observation and predictive values

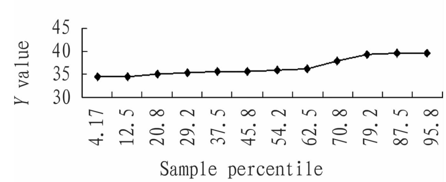

Fig. 12 Normal probability plot

Table 9 Straight line and quadratic curve analysis

Item	Fitting way	Regression equation	Determination coefficient	Correlation index (R)
Residual	Straight line	$y=0.0013x+0.0086$	0.0001	0.0100
	Quadratic curve	$y=0.0023x^2+0.0307x+0.0772$	0.0002	0.0141
Observation value	Straight line	$y=-0.0983x+37.262$	0.0332	0.1822
	Quadratic curve	$y=-0.0051x^2-0.1662x+37.418$	0.0341	0.1847
Predictive value	Straight line	$y=-0.098x+37.254$	0.9866	0.9933
	Quadratic curve	$y=0.0029x^2-0.1354x+37.341$	0.9945	0.9972***
Normal probability plot	Straight line	$y=0.5119x+33.289$	0.8830	0.9397
	Quadratic curve	$y=-0.0426x^2-0.042x+34.582$	0.9401	0.9696***

Note: ***, ** and * respectively showed the high, significant and low correlation levels.

3.2.5 The relationship between fruiting branch diameter and fruit core length after fruit post-ripening.

(i) Regression statistics: standard error was 0.1337.

(ii) Variance analysis: residual of SS was 0.1789, residual of MS was 0.0179, Significance F value was 0.2600 (Table 10).

Table 10 Variance analysis between fruiting branch diameter and fruit core length after fruit post-ripening

Item	df	SS	MS	F value	Significance F
Regression analysis	1	0.0255	0.0255	1.4256	0.2600
Residual	10	0.1789	0.0179		
Total	11	0.2044			

(iii) Analysis on residual curve, curve of observed value, curve of predicted value and normal probability chart.

Residual curve, observed value curve, predicted value curve and normal probability chart between fruiting branch diameter and fruit core length were shown as Fig. 13 – Fig. 15. Quadratic curve regression equation and linear regression equation were used for comparative analysis. R of quadratic curve regression equation was bigger than that of linear regression equation, and its results all corresponded with quadratic curve rule. Correlation coefficients of residual curve, observed value curve, predicted value curve and normal probability chart respectively showed lowly positive correlation, significantly positive correlation, highly positive correlation and highly positive correlation, and significant difference levels were respectively insignificant difference, significant difference, significant difference and significant difference (Table 11).

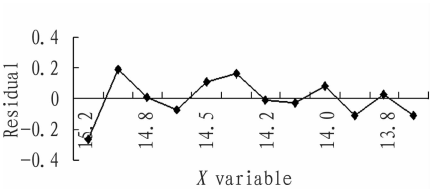

Fig. 13 Residual

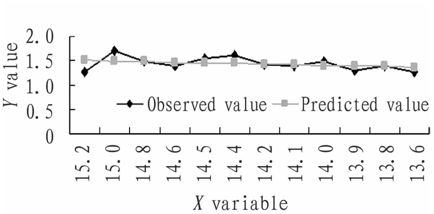

Fig. 14 Observation and predictive values

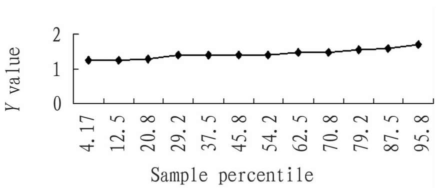

Fig. 15 Normal probability plot

Table 11 Straight line and quadratic curve analysis

Item	Fitting way	Regression equation	Determination coefficient	Correlation index (R)
Residual	Straight line	$y = -0.0011 + 0.0074$	0.0010	0.0316
	Quadratic curve	$y = -0.0085x^2 + 0.0743x - 0.1687$	0.2525	0.5025**
Observation value	Straight line	$y = -0.0144x + 1.522$	0.1452	0.3811
	Quadratic curve	$y = -0.0054x^2 + 0.056x + 1.3577$	0.3367	0.5803**
Predictive value	Straight line	$y = -0.0133x + 1.5145$	0.9866	0.9933
	Quadratic curve	$y = 0.0004x^2 - 0.0183x + 1.5264$	0.9945	0.9972***
Normal probability plot	Straight line	$y = 0.037x + 1.1879$	0.9576	0.9786
	Quadratic curve	$y = 0.0013x^2 + 0.0197x + 1.2282$	0.9691	0.9844***

Note: ***, ** and * respectively showed the high, significant and low correlation levels.

3.2.6 The relationship between fruiting branch diameter and sugar content of fruit juice after fruit post-ripening.

(i) Regression statistics: standard error was 1.0035.

(ii) Variance analysis: residual of SS was 10.0695, residual of MS was 1.0070, Significance F value was 0.1517 (Table 12).

Table 12 Variance analysis between fruiting branch diameter and sugar content of fruit juice after fruit post-ripening

Item	df	SS	MS	F value	Significance F
Regression analysis	1	2.4261	2.4261	2.4094	0.1517
Residual	10	10.0695	1.0070		
Total	11	12.4956			

(iii) Analysis on residual curve, curve of observed value, curve of predicted value and normal probability chart.

Residual curve, observed value curve, predicted value curve and normal probability chart between fruiting branch diameter and sugar content of fruit juice were shown as Fig. 16 – Fig. 18. Quadratic curve regression equation and linear regression equation were used for comparative analysis. R of quadratic curve regression equation was bigger than that of linear regression equation, and its results all corresponded with quadratic curve rule. Correlation coefficients of residual curve, observed value curve, predicted value curve and normal probability chart respectively showed lowly positive correlation, significantly positive correlation, highly positive correlation and highly positive correlation, and significant difference levels were respectively insignificant difference, significant difference, significant difference and significant difference (Table 13).

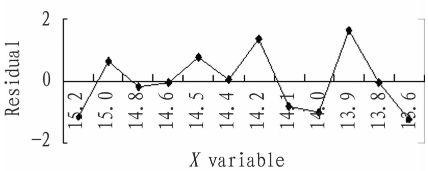

Fig. 16 Residual

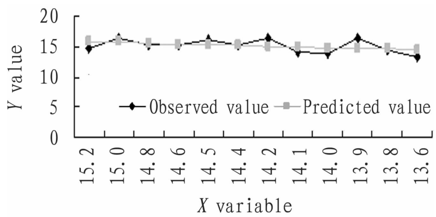

Fig. 17 Observation and predictive values

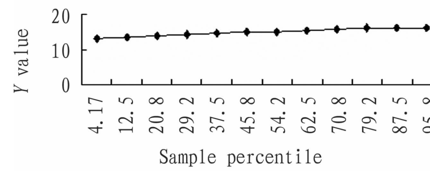

Fig. 18 Normal probability plot

Table 13 Straight line and quadratic curve analysis

Item	Fitting way	Regression equation	Determination coefficient	Correlation index (R)
Residual	Straight line	$y = -0.0075x + 0.0488$	0.0008	0.0283
	Quadratic curve	$y = -0.0357x^2 + 0.4564x - 1.0336$	0.1696	0.4118 *
Observation value	Straight line	$y = -0.1369x + 15.952$	0.2144	0.4630
	Quadratic curve	$y = -0.0319x^2 + 0.2776x + 14.985$	0.3230	0.5683 **
Predictive value	Straight line	$y = -0.1294x + 15.903$	0.9866	0.9933
	Quadratic curve	$y = 0.0038x^2 - 0.1788x + 16.019$	0.9945	0.9972 ***
Normal probability plot	Straight line	$y = 0.29x + 13.177$	0.9627	0.9812
	Quadratic curve	$y = -0.0131x^2 + 0.461x + 12.778$	0.9811	0.9905 ***

Note: ***, ** and * respectively showed the high, significant and low correlation levels.

4 Conclusions and discussions

4.1 Analysis on correlation coefficient (i) Correlation level. Fruiting branch diameter of *A. chinensis* showed highly positive correlation with number of fruit ventricle, significantly positive correlation with single fruit weight when picking and the indexes after fruit post-ripening (single fruit weight, loss rate of single fruit weight, longitudinal diameter of fruit and fruit core width), lowly positive correlation with sugar content of fruit juice after fruit post-ripening, and positive correlation with thick transverse diameter of fruit after fruit post-ripening. (ii) Significant difference level. Fruiting branch diameter of *A. chinensis* had extremely significant difference with number of fruit ventricle, significant difference with fruit core width, and insignificant difference with other indexes. It illustrated that the larger the fruiting branch diameter, the bigger the indexes after fruit post-ripening, such as single fruit weight, longitudinal diameter of fruit and fruit core width and number of fruit ventricle. That is to say, fruiting branch diameter had the maximum influence on fruit core width and number of fruit ventricle, followed by single fruit weight and longitudinal diameter of fruit, and then sugar content of fruit juice.

4.2 Regression analysis Regression analysis between fruiting branch diameter of *A. chinensis* and single fruit weight, longitudinal diameter of fruit, wide transverse diameter of fruit, thick transverse diameter of fruit, fruit core length and sugar content of fruit juice after fruit post-ripening was conduced, and results were as below. (i) Standard errors were respectively 12.4248, 4.2731, 2.6452, 2.0260, 0.1337 and 1.0035. (ii) Difference levels were 0.0743, 0.0658, 0.1950, 0.5733, 0.2600 and 0.1517, that is, fruiting branch diameter of *A. chinensis* had significant difference with thick transverse diameter of fruit, and insignificant difference with other indexes. (iii) Quadratic curve regression equation and linear regression equation of residual curve, curve of observed value, curve of predicted value and normal probability chart were analyzed, and the results all corresponded with the rule of quadratic curve. It illustrated that fruiting branch diameter had the maximum influence on fruit core width and number of fruit ventricle after fruit post-ripening, followed by single fruit weight and longitudinal diameter of fruit, and then fruit core length, wide transverse diameter of fruit and sugar content of fruit juice.

The influence of fruiting branch diameter of *A. chinensis* on its fruit quality change in post-ripening period by other analysis methods also needed further research. When picking *A. chinensis* fruit, fruiting branch diameter directly affected single fruit weight, loss rate of single fruit weight, longitudinal and transverse diameters of fruit, fruit core length, fruit core width, number of fruit ventricle and sugar content of fruit juice after fruit post-ripening. It further illustrated that the larger the fruiting branch diameter, the bigger the indexes, such as single fruit weight, longitudinal and transverse diameters of fruit, fruit core length, fruit core width, number of fruit ventricle and sugar content of fruit juice after post-ripening. That is to say, fruiting branch diameter had the maximum influence on fruit core width and number of fruit ventricle, followed by single fruit weight and longitudinal diameter of fruit, and then sugar content of fruit juice, which may be related to internal factors of fruiting branch of *A. chinensis*. Fruiting branch with different diameters had different nutrient conditions, which inevitably caused difference of the indexes after post-ripening, such as single fruit weight, longitudinal diameter of fruit, wide transverse diameter of fruit, thick transverse diameter of fruit, fruit core length, fruit core width, number of fruit ventricle, and sugar content of fruit juice. The research of Chen Kunsong *et al.* showed that post-ripening and softening of *A. chinensis* after picking was divided into two stages: softening starting stage and latter fast softening stage. The correlation between storage condition and fruit quality change in post-ripening period, physiological change and fruit quality change in post-ripening period, ethylene and fruit quality change in post-ripening period[9-12]. Jia Decui *et al.* studied the influences of pre-cooling treatment, picking period and storage temperature on *A. chinensis* fruit quality change in post-ripening period[13-15]. Jin Fanglun *et al.* thought that different fruit retention amounts of *A. chinensis* at fruiting branch and different fruiting parts directly affected fruit quality change rule in post-ripening period, and was one of key factors for fruit softening and senescence[16-17]. When applying the research result into production, it is suggested that fruiting branch diameter could be as one of important bases of *A. chinensis* fruit quality change in post-ripening period. It also could predict the indexes after fruit post-ripening by investigating fruiting branch diameter and regression equation, such as single fruit weight, longitudinal and transverse diameters of fruit, fruit core and sugar content of fruit juice, and provide the reference for making scientific management measures of *A. chinensis*.

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