
Effect of Tree Age and Fruit Age on Fruit Development and Fruit Quality of Pummelo Var. Tabtimsiam

Na Nakorn, S.* and Chalumpak, C.

Department of Plant Science, Faculty of Agriculture, Rajamangala University of Technology Srivijaya, Nakhon Si Thammarat Campus, Thailand.

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Abstract Effects of tree age and fruit age on fruit development and fruit quality of Pummelo var. Tabtimsiam. The experiment was conducted at the local orchards of Mr. Wirat Soksang, located in the Klongnoi sub-district, Pakpanang district, Nakhon Si Thammarat province, Thailand from June, 2013 to July, 2014. The effect of tree age 6 and 8-year-old trees could develop as indicated fruit weight(g), peel weight (g), pummelo fresh(g), diameter of fruit (cm) and fruit circumference (cm) was advanced significant difference compared to the 4-year-old trees. Also the fruit quality of tree age 6 and 8-year-old trees most higher total soluble solid (TSS), titratable acidity (TA) and TSS/TA ratio than 4-year-old trees. The fruit age at 6th 6.5th 7th and 7.5th month was develop of fruit weight(g), peel weight (g), pummelo fresh(g), diameter of fruit (cm) and fruit circumference (cm), the result shown that fruit age at 7th and 7.5th months could develop the highest of fruit weight(g), peel weight (g), pummelo fresh(g), diameter of fruit (cm) and fruit circumference (cm) and highest of fruit quality as indicated of TSS, TA and TSS/TA ratio.

Keywords: tree age, fruit age, fruit development, fruit quality, pummel

Introduction

Tabtimsiam is the geographical indications (GI) product in Thailand and a popular new pummelo cultivar in the premium fresh-fruit marketplace. The external appearances of Tabtimsiam pummelo fruit and leaves should have the dark green color and cover with soft hair, the internal appearances of Tabtimsiam pummelo thin light pink peel with tight row of small dark pink to red pummelo fresh, juicy with a sour - sweet taste (Kaewtubtim and Issarakraisila, 2011). All of production for domestic consumption and exporting. Recently, the demand for this fruit has gradually increased in both domestic and international markets, especially in China, Taiwan, Malaysia, Singapore and Brunei. . Nowadays, the price of Tabtimsiam pummelo from the hand of the farmer is 150-250 bath/fruit, the farmer's orchard expands to plantation increasing continuously for commercial purpose. The major problem of Tabtimsiam pummelo in the production area,

* **Corresponding author:** Na Nakorn, S.; **Email:** nanakornsp@yahoo.com

the farmer they lack of data on the effects of tree age and fruit age on fruit development and fruit quality for making a decision by harvesting time the Tabtimsiam pummelo. The fruit quality is very important for consumption and marketability of inside and outside the country. In Tabtimsiam pummelo external fruit quality parameters include fruit weight, peel weight, pummelo fresh, diameter of fruit and fruit circumference, whereas internal fruit quality includes TSS,TA and TSS:TA.

The objectives of the study were aimed to determine the effects of tree age and fruit age on fruit development and fruit quality of Pummelo var. Tabtimsiam.

Material and methods

Plant materials

The experiment was conducted at the Mr.Wirat Suksang orchard, Klongnoi sub-district, Pakpanang district, Nakhon Si Thammarat province, Thailand. 4, 6 and 8-year-old field-grown Tabtimsiam pummelo trees were used in this study from June, 2013 to July, 2014. Plants under investigation were grown in the same location and were subject to rigorously similar cultural practices.

Treatments

3x4 factorial in completely randomized design (CRD) with single tree plots replicated five times was used. The treatments included 2 factors; A : the difference age of pummelo tree (4, 6 and 8-year-old trees) and B: the difference age of pummelo fruit (6th 6.5th 7th and 7.5th month)

Data recording and analysis

At the 6th 6.5th 7th and 7.5th month from 4, 6 and 8-year-old trees were collected fruit weight (g), peel weight(g), pummelo fresh(g), diameter of fruit (cm) and fruit circumference (cm), peel thickness, total soluble solid (°Brix) and titratable acidity (%). The data analysis was used program-R and treatment means were statistically compared using Duncan's Multiple Range Test (DMRT)

Results

Fruit growth and development

The fruit growth and development of the pummelo var. Tubtimsiam at difference age of tree was indicated of fruit weight, peel weight and pulp

flesh were significant differences among the tree age, 8- year-old of tree was shown the highest of fruit weight (1709.71 g), peel weight (435.24 g) and pulp flesh (1299.76 g), 6- year-old of tree as followed 1571.88 409.99 1147.29 g , respectively. and 4- year-old of tree was recorded the lowest of fruit weight (149.16 g), peel weight (357.91 g) and pulp flesh (1064.49 g) (Table 1). The peel thickness has showed significant differences among the tree age, 4- year-old of tree was recorded the highest of peel thickness (1.10 cm) The fruit diameter and fruit circumference has showed significant differences among the tree age, 8- year-old of tree was shown the highest of fruit diameter (17.05 cm) and fruit circumference (52.63 cm), 6- year-old of tree as followed 15.64 cm and 49.12 cm , respectively, and 4- year-old of tree was recorded the lowest of fruit diameter and fruit circumference 15.18 and 48.05 cm, respectively (Table 2).

The fruit growth and development of the pummelo var. Tubtimsiam at difference age of fruit (6 6.5 7 and 7.5 months) was indicated of fruit weight, peel weight and pulp flesh weight were significant differences among of difference age of fruit the highest fruit weight was shown at the 7.5th 7th 6.5th and 6th mounts were 1699.30 1681.01 1474.99 and 1452.78 g , respectively, the peel weight were significant differences among of difference age of fruit the highest peel weight was shown at the 6th 6.5th 7th and 7.5th mounts were 423.61 407.68 390.28 and 382.62 g , respectively, the pulp flesh weight were significant differences among of difference age of fruit the highest pulp flesh weight was shown at the 7.5th 7th 6.5th and 6th mounts were 1315.55 1229.18 1084.76 and 1052.59 g , respectively, (Table 1).

The peel thickness were not significant differences among means of difference tree age of fruit at the 6th 6.5th 7th and 7.5th mounts were 1.17 1.10 1.09 and 1.03 cm, respectively, fruit diameter was shown significant differences among means the 7.5th 7th 6.5th and 6th mounts 16.47 16.20 15.88 and 15.27 cm, respectively, also fruit circumference was shown significant differences among means at the 7.5th 7th 6.5th and 6th mounts were 51.25 51.14 49.39 and 47.95 cm, respectively, (Table 2).

Table 1. Fruit development of pummelo var. Tubtimsayam at the difference age of tree and age of fruit on fruit weight (g), peel weight (g) and pummelo fresh (g)

Treatments	fruit weight (g)	peel weight (g)	pummelo fresh (g)
Age of tree (A)			
4-years	1449.16 ^c	357.91 ^c	1064.49 ^c
6-years	1571.88 ^b	409.99 ^b	1147.29 ^b
8-years	1709.71 ^a	435.24 ^a	1299.76 ^a
Age of fruit (B)			
6 months	1452.78 ^b	423.61 ^a	1052.59 ^b
6.5 months	1474.99 ^b	407.68 ^{ab}	1084.76 ^b
7 months	1681.01 ^a	390.28 ^b	1229.18 ^a
7.5 months	1699.30 ^a	382.62 ^b	1315.55 ^a
Probability level of significance (ANOVA)			
Source of variation			
Age of tree (A)	<.0001	<.0001	<.0001
Age of fruit (B)	<.0001	<.0001	<.0001
AxB	<.0001	<.0001	<.0001
CV (%)	7.34	7.44	9.82

Mean values with each column followed by a same letter are not significantly at $p \leq 0.05$ tested by DMRT

Table 2. Fruit development of pummelo var. Tubtimsayam at the difference age of tree and age fruit on peel thickness (cm), fruit diameter (cm) and fruit circumference (cm)

Treatments	peel thickness (cm)	fruit diameter (cm)	fruit circumference (cm)
Age of tree (A)			
4-years	1.10	15.18 ^c	48.05 ^c
6-years	1.10	15.64 ^b	49.12 ^b
8-years	1.09	17.05 ^a	52.63 ^a
Age of fruit (B)			
6 months	1.17	15.27 ^c	47.95 ^c
6.5 months	1.10	15.88 ^b	49.39 ^b
7 months	1.09	16.20 ^{ab}	51.14 ^a
7.5 months	1.03	16.47 ^a	51.25 ^a
Probability level of significance (ANOVA)			
Source of variation			
Age of tree (A)	0.963	<.0001	<.0001
Age of fruit (B)	0.1614	<.0001	<.0001
AxB	0.0003	<.0001	<.0001
CV (%)	13.58	3.43	2.20

Mean values with each column followed by a same letter are not significantly at $p \leq 0.05$ tested by DMRT

Table 3. Fruit quality of pummelo var. Tubtimsayam at the difference age of tree and age of fruit on total soluble solid (^oBrix), titratable acidity (%) and TSS/TA

Treatments	total soluble solid (^o Brix)	titratable acidity (%)	TSS/TA
Age of tree (A)			
4-years	10.23 ^b	0.60 ^a	17.13
6-years	10.28 ^b	0.48 ^b	21.31
8-years	10.93 ^a	0.44 ^b	24.84
Age of fruit (A)			
6 months	9.92 ^c	0.59 ^a	16.81
6.5 months	10.37 ^b	0.49 ^b	21.16
7 months	10.50 ^b	0.49 ^b	21.42
7.5 months	11.12 ^a	0.46 ^b	24.17
Probability level of significance (ANOVA)			
Source of variation			
Age of tree (A)	<.0001	<.0051	-
Age of fruit (B)	<.0001	<.0001	-
AxB	<.0001	<.0001	-
CV (%)	3.87	5.79	-

Mean values with each column followed by a same letter are not significantly at $p \leq 0.05$ tested by DMRT

Fruit quality

The quality of the pummelo var. Tubtimsiam at difference age of tree was indicated of total soluble solid was significant differences among the tree age, 8 6 and 4- year-old was shown the means are 10.93 10.28 and 10.23 °Brix, respectively, the titratable acidity also shown significant differences among means the tree age at 4 6 and 8- year-old were 0.60 0.48 and 0.44 °Brix , respectively (Table3).

The quality of the pummelo var. Tubtimsiam at difference age of fruit was indicated of total soluble solid was significant differences among means at the 7.5th 7th 6.5th and 6th mounts were 11.12 10.50 10.37 and 9.92 °Brix, respectively, the titratable acidity also shown significant differences among means of difference age of fruit at the 6th 6.5th 7th and 7.5th mounts are 0.59 4.49 0.49 and 0.46 percent, respectively (Table3).

Discussion

Effects of tree age of pummelo var. Tumtimsiam on fruit weight, peel weight, pummelo fresh, peel thickness, fruit diameter and fruit circumference, the data were shown significant difference the average means of among tree age on fruit weight, pummelo fresh, fruit diameter and fruit circumference were increasing related to the tree ages increase, accepted the average mean of peel thickness is slightly increased with the tree ages from 4-year-old trees to 8-year-old trees. The difference tree age was effected to fruit development in term of fruit size, tree age and fruit size had significant influence on fruit weight, peel weight, pummelo fresh, peel thickness, fruit diameter and fruit circumference. Large sized fruit from 8-year-old trees and 6-year-old trees had more the biggest fruit size while, less fruit size was obtained from 4-year-old trees, because, the young tree is smaller canopy, lesser number of leaves and all of these factors related to the photosynthesis rate. Kramer and Kozłowski (1979) ; Flore and Lakso (1989) was explained that the leaves are the main source of photosynthesis in plants, but CO₂ assimilation can also take place in stems, flowers and fruit. Photosynthetic rates are generally low in young unexpanded leaves, and increase up to full leaf expansion or soon after the leaves become fully expanded. Effects of tree age of pummelo var. Tumtimsiam on fruit quality, it is very important for consumption and marketability, fruit from 8-year-old trees and 6-year-old trees had more higher TSS and lower TA than fruit from 4-year-old trees. In citrus external fruit quality parameters include colour, size, rind smoothness and blemishes whereas internal fruit quality includes TSS, TSS:TA. In *Prunus salicina*, 5-10 year old trees had higher ascorbic acid concentrations than 20-30 year old trees, however taste, acidity and soluble

solid contents did not significantly vary with the tree age (Dong Hui *et al.*, 2005).

The effect of fruit age of pummelo var. Tumtimsiam was harvested at 6th, 6.5th, 7th and 7.5th month on fruit development as indicated of fruit weight, peel weight, pummelo fresh, peel thickness, fruit diameter and fruit circumference. The optimal time for harvesting of pummelo var. Tumtimsiam depend on the fruit size and fruit quality, the size of fruit and fruit quality were related to fruit age at 6th, 6.5th, 7th and 7.5th month. The optimal time for harvesting from this experiment showed that at 7th and 7.5th months due to the fruit size as indicated by weight, peel weight, pummelo fresh, peel thickness, fruit diameter and fruit circumference were increased and the internal physical was determined TSS, TA and TSS:TA ratio also increase. Flavor and taste are related to the level of total soluble solids (TSS), titratable acidity (TA), and the amount of aromatic or bitter flavors in the fruit. Ahmed *et al.* (2006b); Saleem *et al.* (2008c) explained that citrus fruit quality may be indicated by external features, such as rind colour, size, and rind texture, and internal physical (seediness, juice contents) and biochemical characters like ascorbic acid, TSS, TA and TSS:TA ratio. Na Nakorn *et al.* (2015) was reported that total soluble solid was increased when the fruit developed from the 1st month to 7.5th month and the titratable acidity has the values decreasing opposite with the total soluble solid when the fruit developed from the 1st month to 7.5th month. Tree age affected acidity and TSS content of 'Satsuma' mandarin and juice content, TSS, acidity and ripeness index of oranges (Matsumoto *et al.*, 1972; Frometa and Echazabal, 1988). Bramlage (1993) reported that pome fruit harvested from young trees was highly susceptible to postharvest disorders.

Conclusion

This study shows that effects of tree age at 6-year-old trees and 8-year-old trees of pummelo var. Tumtimsiam had more fruit size and fruit quality than 4-year-old trees. The age of fruit at 7th and 7.5th month also had more fruit size and fruit quality than fruit age at 6th and 6.5th month.

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