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A New Sweet Persimmon: 'Romang'

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Abstract

'Fuyu' and 'Jiro' sweet persimmon were selected and introduced from Japan and account for over 90% of the persimmon production in Korea. The goal of our breeding program is to select domestic sweet persimmon to replace the cultivars from Japan and balance the unequal distribution of late maturing cultivars. 'Romang' was a cross of 'Ro-19' and 'Okugosho' in 1997 and it was selected as '97-23-29' in 2004 for its attractive eating quality and finally selected in 2008 since it had good characteristics with little yearly variation. 'Romang' is the first pollination-constant non-astringent (PCNA) persimmon in Korea. The intermediate growth habit is semi-spreading. Its maturation period as a mid-season cultivar was estimated at about 110 days after full bloom. Average fruit weight was 185 g and the fruit has oblate shape, red-orange skin color, and few physiological disorders such as fruit cracking at the apex.

Depending on characteristics of astringency, presence of seeds, and flesh color (Kajiura, 1946; Kikuchi, 1948), persimmon (*Diospyros kaki*) cultivars are classified into four types as follows: 1) pollination-constant and non-astringent (PCNA), 2) pollination-variant and non-astringent (PVNA), 3) pollination-variant and astringent (PVA), and 4) pollination-constant and astringent (PCA). The PCNA type is qualitatively different from the other three types in the level of tannin accumulation in the fruit because the PCNA-type fruit accumulates less tannin and the tannin cells are much smaller than in the other three types (Yonemori and Matsushima, 1985; Kanzaki et al., 2001). Persimmon is one of the major fruit crops and among the oldest cultivated fruits in Korea. Most cultivars are astringent, and the PVNA cultivar 'Johongsi' is generally known and appeared in Daeduck area of Damyang county, Jeon-nam province. In Korea, all of the sweet persimmons cultivated commercially were introduced from Japan in the 1900s. All nonastringent cultivars are of Japanese origin, except for 'Luo Tian Tian Shi', which is of Chinese origin (Yamada et al., 1993; Yamada et al., 1994; Wang, 1982). In 2014, persimmon production was 385,000 T and ranked second behind China, and is cultivated on 27,000 ha in Korea (Korea Statistical Information Service, 2016). Sweet persimmon's area has dramatically decreased from 20,000 ha in 2000 to 11,800 ha in 2015 (Korea Statistical Information Service, 2016). The main reason for declining production likely is the unequal distribution of cultivars 'Fuyu' and 'Jiro' which have poor fruit quality and ripen late, and are susceptible too cold injury in the fall. Therefore, we need to develop new cultivars that have good fruit quality and ripen earlier than 'Fuyu' and 'Jiro'. The PCNA genotype appears to be homozygous recessive for the natural loss of astringency, since the trait of natural astringency-loss in PCNA-type fruit is qualitatively inherited in the progenies and the PCNA genotype is recessive to the other three types (Ikeda et al., 1985; Kanzaki et al., 2001). Therefore PCNA-type cultivars are usually used to obtain PCNA-type seedings. We aim to develop persimmon cultivars of PCNA-type that are earlier maturing and have less physiological disorders than those introduced from Japan. In this study, we selected a new sweet persimmon cultivar that matures 15 days earlier and has less physiological disorders than 'Fuyu', and fruits had high sugar concentrations and soft juicy flesh.

Materials and Methods

In 1997 'Ro-19' was crossed with 'Okugosho' growing in the persimmon genetic resources orchard at the Pear Research Institute, National Institute of Horticultural and Herbal Science, Rural Development Administration in Korea. The seeds of F_1 progeny were collected as fully ripen fruits. The seeds were washed with water, dried for one day at room temperature, put in a polyethylene bag after treating with Benomyl wettable powder, and stored at 5℃ until used. Sprouted seeds were sowed in 10cm-diameter jiffy pot in May in 1998. Of the 260 seeding, 241 were planted in the breeding field located in Yeongam

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(34.51N, 126.36E) in April of the following year. A seedling labelled as '97-23-29' was initially selected in 2004 for its good eating quality. After initial selection, seven trees each of '97-23-29', 'R-19', 'Okugosho' and 'Shinsyuu' were propagated on the *D. kaki* seedling rootstock, and planted at a spacing of 5 m between rows and 4 m between trees. 'Shinsyuu' was considered the control for comparison because it ripens at a similar time in Korea and the fruit quality is best of cultivars of similar ripening time. All trees were trained to a central leader growth habit. Fruit traits were examined according to the Manual for Agricultural Investigation (RDA, 2003). We also investigated fruit cracking and fruit apex cracking with the naked eye, and divided cracking-severity into three levels of weak, medium and strong.

To prevent undesirable fruit setting, excessive flower buds were thinned to one bud per spur at 10-15 days before bloom to ensure a leaf-to-fruit ratio of > 20. For stable fruiting, the orchard consisted of about 5% pollinizers and bee hives were placed in the orchard just before bloom.

As trees came into bearing, five fruits were selected to investigate the fruit characteristics from each of seven trees per cultivar for 3 years from 2006 to 2008, and two or three times per season to ascertain the time of optimum maturity. The tree size was about 3.5 m height and 3 m width, and the yield per tree was about 40 kg. After the fruits were weighed, flesh firmness was measured on each side of the fruit with penetrometer (Zwick, DE/ZO 5T3 Kor.) equipped with an 8 mm diameter plunger. Thereafter, total soluble solids concentration was measured on each fruit by expressing juice from each side of the fruit onto a digital refractometer (Atago PR-101, Japan).

Data were analyzed as a completely randomized design with SAS's Proc GLM. When Analysis of Variance indicated that cultivars differed significantly ($P<0.05$) means were compared with Duncan's Multiple Range Test (DMRT) at 5% level using SAS statistical software (V 9.1, SAS Institute Inc., North Carolina, USA).

Description

'Ro-19' was released from a cross between 'Daigosho' and 'Hanagosho', which ripens in mid-Oct. (Naju region, Korea) (Fig.1). It has dense fresh texture, high sugar concentration, and fruit weight averaged 230g, but there is a little fruit cracking and fresh softening at the fruit apex. The other parent of 'Romang' is 'Okugosho', a medium size fruit, with rough flesh texture and a little cracking at the fruit apex. Although the parents have faults, we

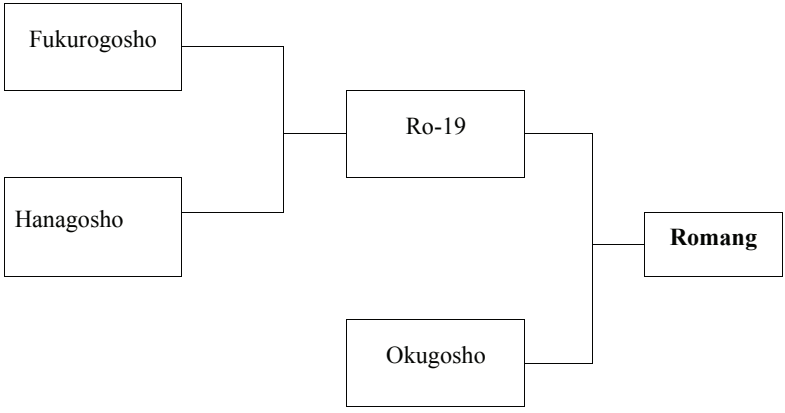

Fig. 1. Pedigree of 'Romang' persimmon

Table 1. Tree characteristics of 'Romang' persimmon compared to its parents, 'Ro-19' and 'Okugosho' and 'Shinsyuu' served as a control at Naju, Korea from 2006 to 2008.

Cultivar	Tree vigor	Tree form	One-Year Shoot					
			Length	Thickness	Color sunny side	Number of lenticels	Size of lenticels	Shape of lenticels
Romang	Medium	Semi-spreading	Medium	Medium	Brown	Many	Medium	Elliptic
Ro-19	Medium	Semi-spreading	Medium	Medium	Grey brown	Medium	Small	Circular
Okugosho	Medium	Semi-spreading	Medium	Medium	Brown	Few	Large	Elliptic
Shinsyuu	Medium	Semi-spreading	Medium	Thick	Brown	Medium	Medium	Elliptic

expected the cross to produce high quality F_1 progeny. The cross produced 241 progenies. We first selected PCNA-type, '97-23-29' strain and named it 'Wongyoba-01' at nine years after crossing in 2006 and in 2008 it was named 'Romang' because it showed little yearly variation and good fruit characteristics (see cover photograph).

'Romang' has moderate tree vigor and semi-spreading tree shape similar to 'Ro-19' and 'Okugosho'. The length of one-year-old shoots is medium, and bark on the sunny side is brown, similar to 'Okugosho'. The number of lenticels tends to be more than its parent and 'Shinsyuu', the size is medium, and the shape is elliptic (Table 1, Fig. 2). The characteristics of mid-shoot leaves were evaluated after shoot extension ceased. Following terminal bud development, mid-shoot leaves ware elliptic, which tended to differ from its parents, ovate for 'Okugosho', and obovate for 'Shinsyuu'. The leaf apex was obtuse, similar to 'Shinsyuu', but different from its parent, that were acute and the leaf base was round (Table 2, Fig. 3). Female flowers typically bloomed on 31 May, which is about three days later than 'Ro-19', and one day later than 'Shinsyuu' (Table 2).

Maturation of 'Romang' fruit was about

Fig. 2. One-year-old shoots of 'Romang' persimmon compared with 'Shinsyuu'.

Table 2. Leaf and flower characteristics of 'Romang', 'Ro-19', 'Okugosho' and 'Shinsyuu' persimmon at Naju, Korea from 2006 to 2008.

Cultivar	Full bloom date	Leaf blade			Flower type
		Shape	Shape of apex	Shape of base	
Romang	31 May.	Elliptic	Obtuse	Rounded	F[z]
Ro-19	28 May.	Ovate	Acute	Rounded	F
Okugosho	29 May.	Ovate	Acute	Obtuse	FM
Shinsyuu	30 May.	Obovate	Obtuse	Obtuse	F

[z] F indicate only female flowers; FM indicates female and male flowers.

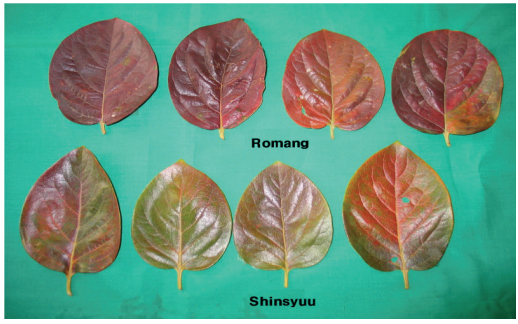

Fig 3. Leaf blade of 'Romang', 'Ro-19', compared with 'Shinsyuu' persimmon.

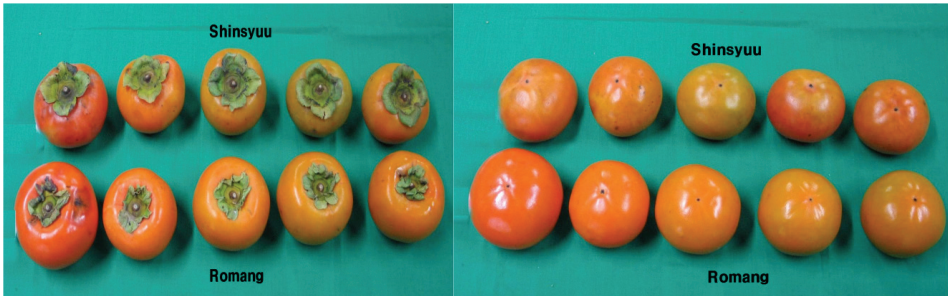

Fig. 4. Fruits of 'Romang' compared with 'Shinsyuu' persimmon.

110 days after full bloom, which was three days and seven days earlier than 'Ro-19' and 'Okugosho', respectively (Table 1, Table 3). The fruits were medium size (185 g), similar to 'Okugosho' (186 g), and smaller than 'Ro-19' (220 g), and 'Shinsyuu' (215 g). 'Romang' fruit shape was oblate, truncate in the apex of longitudinal section, the cross-section was

circular and the red-orange skin color darker than 'Ro-19' and 'Okugosho', and similar to 'Shinsyuu' (Table 2, Table 3). The soluble solids concentration was significantly higher (18.6 %) than 'Ro-19' (16.3 %), 'Okugosho' (16.2 %) and 'Shinsyuu' (16.4 %). 'Romang' had significantly softer fresh firmness (64 N) than 'Ro-19' (76 N), and 'Okugosho' (82 N), but similar to 'Shinsyuu' (59 N) (Table 2). Fruit cracking and fruit apex cracking were regarded as serious physiological disorders threatening stable production in Korea, but 'Romang' had less fruit cracking and fruit apex cracking than its parents and 'Shinsyuu' (Table 3).

Table 3. Ripening time and fruit characteristics of 'Romang' persimmon compared to its parents, 'Ro-19' and 'Okugosho' and 'Shinsyuu' served as a control at Naju, Korea from 2006 to 2008.

Cultivar	Maturity[z]	Fruit wt. (g)	Fruit shape	Skin color	Shape of apex in longitudinal section	General shape in cross section
Romang	110	185 b[y]	Oblate	Orange Red	Truncate	Circular
Ro-19	113	229 a	Oblate	Orange	Rounded	Circular
Okugosho	117	186 b	Oblate	Orange	Truncate	Circular
Shinsyuu	106	215 a	Oblate	Orange Red	Truncate	Circular

[z] Days after full bloom.
[y] Means within columns followed by common letters do not differ at the 5% level of significance, by Duncans multiple range test.

Table 4. Fruit characteristics and physiological disorder of 'Romang' persimmon compared to its parents, 'Ro-19' and 'Okugosho' and 'Shinsyuu' served as a control at Naju, Korea from 2006 to 2008.

Cultivars	SSC[z] (%)	Flesh firmness (N)	Juiciness	Cracking of fruit apex	Cracking of fruit	Persimmon type[y]
Romang	18.6 a[z]	64 c	High	Little	Little	PCNA
Ro-19	16.3 b	76 b	Moderate	Moderate	Little	PCNA
Okugosho	16.2 b	82 a	Low	Moderate	Severe	PCNA
Shinsyuu	16.4 b	59 c	High	Moderate	Moderate	PCNA

[z] Means within columns followed by common letters do not differ at the 5% level of significance, by Duncans multiple range test.
[y] *type = pollination constant non-astringent.

Availability

Protection for 'Romang' was applied for in Sept. 2009 and registered in 2015 (The No. 5520) after DUS (distinctness, uniformity and stability) test for two years by Korea Seed & Variety Service.

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