JARQ 40 (2), 177 – 181 (2006) http://www.jircas.affrc.go.jp

Development of an Earl's-Type Melon, 'Earl's Kagayaki', with Resistance to Cotton-Melon Aphid, Powdery Mildew and Fusarium Wilt

Yoshiteru SAKATA[1]*, Tetsuya OYABU[2,4], Kazunori YABE[2], Mitsuhiro SUGIYAMA[1], Masami MORISHITA[3], Sinji SUGAHARA[2] and Takeo SAITO[1]

[1] Department of Fruit Vegetables, National Institute of Vegetable and Tea Science (NIVTS) (Ano, Mie 514–2392, Japan)
[2] Horticulture Division, Aichi-ken Agricultural Research Center (AARC) (Nagakute, Aichi 480–1193, Japan)
[3] Department of Plant Breeding, National Agricultural Research Center for Hokkaido Region (Sapporo, Hokkaido 062–8555, Japan)

Abstract

'Earl's Kagayaki', an Earl's-type melon (*Cucumis melo* L. var. *reticulatus*) with resistance to cotton-melon aphid (*Aphis gossypii* Glover), powdery mildew (*Podosphaera xanthii* (Castaggne) U. Braun & N. Shishkoff), and fusarium wilt (*Fusarium oxysporum* f. sp. *melonis* (Leach et Currence) Snyder et Hansen) was registered as melon cultivar 'Norin Kou No.7' and released in 2004 in Japan. The fruit weight is around 1,500 g, the shape is spherical, the rind color is greenish gray, and the skin is finely netted. The flesh is yellowish green with a desirable aroma, and the taste is superior to common Earl's-type cultivars with the Brix value of 13 degrees. The shelf life is 5 to 7 days after harvest. 'Earl's Kagayaki' can be grown in all the Earl's-type melon production areas of Japan and also in other temperate and sub-tropical regions. This cultivar is primarily recommended for production in suburban areas, in farmlands with sightseeing tours, and by the farmers having fruits-stores. This cultivar is suitable for spring cultivation and summer-autumn cultivation under greenhouse conditions.

Disciplines: Horticulture
Additional key word: *Cucumis melo*

Introduction

The leaf-roll growth disorder and virus-disease infections caused by the cotton-melon aphid (*Aphis gossypii* Glover), and the occurrence of powdery mildew (*Podosphaera xanthii* (Castaggne) U. Braun & N. Shishkoff), are severe problems in Earl's-type melon production areas of Japan. Although many trials have been conducted, there are some difficulties associated with using natural enemies (high cost, instable effect, etc.), instead of using agrochemicals, to control the cotton-melon aphid. Most of the melon cultivars used recently are supposed to have the resistance to powdery mildew derived from the resistant sources of Kurume 2, 'Fukamidori', C-68, etc. However, because of the differentiation of the races of the pathogen, the breakdown of the resistance to powdery mildew has been occurring severely, especially in autumn season, and it has led us to depend on fungicides to control powdery mildew. On the contrary, the demands for food production with reduced agrochemicals or without agrochemicals have been increasing and breeding cultivars with integrated disease and pest resistance has become an urgent assignment.

Development of 'Earl's Kagayaki'

National Research Institute of Vegetables, Ornamental Plants and Tea (present; National Institute of Vegetable and Tea Science: NIVTS) had bred a green-flesh cantaloupe melon, 'Melon Parental Line 3', and released it in 1993, by using the cotton-melon aphid and powdery

Present address:
[4] Aichi-ken Chita Agriculture Extention Center (Handa, Aichi 475–0903, Japan)
*Corresponding author: fax +81–59–268–1339; e-mail ysakata@affrc.go.jp
Received 14 February 2005; accepted 6 June 2005.

mildew resistant accession of AR 5[1] as a breeding material. Although the 'Melon Parental Line 3' has merits such as the disease and pest resistance, slightly compact sized plant, and early maturing, it has not been adopted as a parent for breeding the Earl's-type melon cultivars. That is because it has some disadvantages, such as susceptibility to fusarium wilt (*Fusarium oxysporum* f. sp. *melonis* (Leach et Currence) Snyder et Hansen), smaller fruit, weakly netted fruits, and short shelf life.

Under these conditions the authors had begun breeding for high quality Earl's-type melon F_1 cultivars with resistance to cotton-melon aphid, powdery mildew and fusarium wilt. More than one hundred combinations of trial F_1 hybrids were made and evaluated, and two trials of Melon Kyu-Ai Kou 1 and Kyu-Ai Kou 2 were found to have not only the resistance to cotton-melon aphid, powdery mildew and fusarium wilt but also excellent fruit quality. The two trials were the hybrids between the NIVTS bred accession of AR91-2 and the Aichi-ken Agricultural Research Center (ARRC) bred accessions of Aichi 3 and Aichi 4. One of the trials of Melon Kyu-Ai Kou 1 was confirmed as an excellent Earl's-type melon in a series of specific characteristics tests and the tests for regional adaptability conducted from 2001 to 2003. The accession was named and registered as 'Earl's Kagayaki' (Norin Kou 7) in 2004. 'Earl's Kagayaki' is the first Earl's-type melon cultivar with cotton-melon aphid resistance in Japan. By the registration of 'Earl's Kagayaki', AR91-2 was also named 'Kurume MP-4' and registered as a melon parent cultivar in 2004.

Pedigree of 'Earl's Kagayaki'

The 'Earl's Kagayaki' is the hybrid between the NIVTS bred accession of 'Kurume MP-4' and the Aichi-ken Agricultural Research Center bred accession of Aichi 3 (Fig. 1). The hybrid was selected in performance tests held in NIVTS and AARC from 2000 to 2003. The performance of its resistance, quality and other traits was confirmed in a series of specific character tests and the tests for regional adaptability from 2001 to 2003.

The pedigree of a male parent, 'Kurume MP-4', which has resistance to cotton-melon aphid and powdery mildew, is shown in Fig. 2. The resistance was introduced from AR 5 cantaloupe[1] and the fruit quality was introduced from 'Earl's K' and 'Earl's Favourite Natsu kei 6'. Another parent of a female parent of Aichi 3, which has resistance to fusarium wilt (race 0 and 2) and excellent fruit quality, is a selection from the hybrid between 'Earl's Crest' and 'Earl's Favourite Natsu kei 7'[2].

Characteristics

As 'Earl's Kagayaki' was bred as a Japanese Earl's-type melon cultivar, it is assumed that the cultivar is to be grown under greenhouse conditions and the single main stem is trained vertically with one fruit set.

1. Plant and fruit

The plant of 'Earl's Kagayaki' is slightly more compact than the Japanese standard cultivar of 'Earl's Miyabi

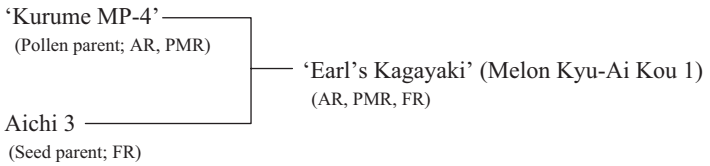

Fig. 1. The pedigree of 'Earl's Kagayaki'
AR: Aphid resistant, PMR: Powdery mildew resistant,
FR: Fusarium wilt resistant.

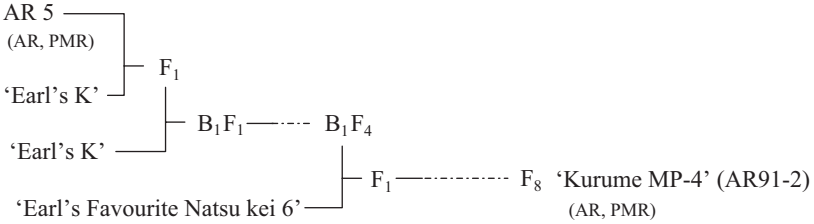

Fig. 2. The pedigree of the male parent, 'Kurume MP-4'
AR: Aphid resistant, PMR: Powdery mildew resistant.

Soshun Banshu Kei' (Table 1). Cultivation is relatively easy because of its high and stable abilities of female-flower-bearing and fruit setting. It takes 25–35 days to flower (10 th node) after transplanting and takes 50–55 days to mature the fruit after anthesis, that is, 'Earl's Kagayaki' is approximately 5–7 days earlier in maturing than the common Earl's-type melon (data not shown).

The fruit weight is around 1,500 g in Japanese standard cultivation (Table 2) and is smaller than the common fruit size (approximately 1,700–1,800 g). However, by adjusting the cultivation method, especially the watering regime, the fruit can weigh 1,800 g and more. The fruit shape is spherical, the rind color is greenish gray, and the skin is finely netted (Fig. 3, Table 3). The flesh is yellowish green with a desirable aroma, and the taste is superior to that of common Earl's-type cultivars with a Brix value of approximately 13 degrees. The shelf life is 5 to 7 days after harvest and is relatively shorter than other cultivars.

2. Disease and pest resistance

'Earl's Kagayaki' is free from leaf curl (roll) (Fig. 4), and the multiplication of cotton-melon aphids on the leaves of 'Earl's Kagayaki' is lower than that of common melon cultivars (Table 4). The resistance to cotton-melon aphid is derived from 'Kurume MP-4'. 'Earl's

Table 1. Characteristics of 'Earl's Kagayaki' plant

Cultivars	Plant height (cm)	Leaf no.	Leaf length (cm)	Leaf width (cm)	Stem diameter (mm)	Ratio of female flower (%)	Ratio of fruit setting (%)
Earl's Kagayaki	152	26.0	33.9	28.4	11.4	96.3	99.3
Earl's Miyabi[a)]	162	26.2	33.8	29.3	11.9	89.0	91.6

a): 'Earl's Miyabi' is the control cultivar. Average of 7 trials from 1999 to 2003.

Table 2. Characteristics of 'Earl's Kagayaki' fruit (1)

Cultivars	Fruit weight (g)	Fruit height (mm)	Fruit diameter (mm)	Rind color	Peduncle diameter (mm)	Peduncle length (mm)	Scar diameter (mm)
Earl's Kagayaki	1,521	137.0	135.0	Greenish gray	10.1	10.1	21.6
Earl's Miyabi[a)]	1,744	149.0	138.0	(Greenish) gray	9.6	16.7	19.4

a) : 'Earl's Miyabi' is the control cultivar. Average of 7 trials from 1999 to 2003.

Table 3. Characteristics of 'Earl's Kagayaki' fruit (2)

Cultivars	Netting	Flesh color	Flesh thickness (mm)	Brix (degree)	Aroma	Shelf life (day)
Earl's Kagayaki	Sharp and dense	Yellowish green	38.8	13.2	Medium	5–7
Earl's Miyabi[a)]	Sharp and denser	Pale yellowish green	42.1	12.4	Slight	7

a): 'Earl's Miyabi' is the control cultivar. Average of 7 trials from 1999 to 2003.

Table 4. Cotton-melon aphid resistance of 'Earl's Kagayaki'

Cultivars	Leaf curl		Aphids	
	(%)	Evaluation	(No.)	Evaluation
Earl's Kagayaki	0	Resistant	10.4 bc*	Resistant
Earl's Miyabi	100	Susceptible	46.3 a	Susceptible
Kurume MP-4	0	Resistant	6.6 c	Resistant
Earl's Favourite	100	Susceptible	31.8 ab	Susceptible

*: Means separation in columns by Kruskal-Wallis ANOVA ($P<0.05$).
Five aphids were released at cotyledonary stage and checked at 5th day.

Fig. 3. Fruit of 'Earl's Kagayaki'

Fig. 4. Leaf roll caused by cotton-melon aphid parasitization
Upper: 'Earl's Kagayaki' 7 days after release of aphids (resistant). Lower left: 'Kurume MP-4' 7 days after release of aphids (resistant). Lower right: 'Earl's Miyabi' 7 days after release of aphids (susceptible).

Fig. 5. Melon plants severely damaged by powdery mildew
Foreground : 'Earl's Miyabi' (susceptible).
Background : 'Earl's Kagayaki' (resistant).

Table 5. Disease resistance of 'Earl's Kagayaki'

Cultivars	Powdery mildew				Fusarium wilt			
	Race 1		Race 2		Race 0		Race 2	
	RIP[b] (%)	Evaluation	RIP (%)	Evaluation	RIP (%)	Evaluation	RIP (%)	Evaluation
Earl's Kagayaki	0	Resistant	25	Resistant	0	Resistant	0	Resistant
Earl's Miyabi[a]	100	Susceptible	100	Susceptible	0	Resistant	0	Resistant

a): 'Earl's Miyabi' is the control cultivar. b): Ratio of infected plants.

Kagayaki' also has resistances to powdery mildew (races 1 and 2) and fusarium wilt (races 0 and 2) (Table 5, Fig. 5). The resistance to powdery mildew is also from 'Kurume MP-4'. Fusarium wilt resistance is from Aichi 3. These characteristics enable farmers to save on agro-chemicals. It will provide additional value for the consumer as the fruit of 'Earl's Kagayaki' can be grown with reduced amounts of agro-chemicals.

3. Suitable production area

'Earl's Kagayaki' can be grown in all the Earl's-type melon production areas of Japan and also in temperate and sub-tropical regions. The cultivar is suitable for early-spring cultivation and autumn cultivation under greenhouse conditions. As the shelf life is not so long, production is primarily recommended in suburban areas, in farmlands with sightseeing tours, and by the farmers having fruits-stores.

References

1. McCreight, J. D., Kishaba, A. N. & Bohn, G. W. (1984) AR Hale's Jumbo, AR 5, and AR Topmark: melon aphid-resistant muskmelon breeding lines. *HortScience*, **19**, 309–310.
2. Oyabu, T. & Yabe, K. (2001) Breeding of a cultivar of Earl's type melon with long shelf life, cotton-melon aphid, powdery mildew and fusarium wilt resistance. *Ann. Rep. Aichi-ken Agric. Res. Cent., Hort. Div.,* **12,** 52–56 [In Japanese].