'Shenmei #3' Strawberry

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'Shenmei #3' is a new strawberry (*Fragaria ×ananassa* Duchesne ex Rozier) cultivar from the Forestry & Fruit Research Institute of the Shanghai Academy of Agricultural Sciences. The fruit ripen in the early to midseason and are large and firm with a sweet and aromatic flavor. The fruit are well adapted for processing and fresh markets. The plants and fruits are resistant to powdery mildew [*Podosphaera macularis* (Wallr.) U. Braun & S. Takam]. 'Shenmei #3' does well near Shanghai and is recommended for trial in other regions with mild winter and spring weather such as Florida and Louisiana in the southern United States and in southern Japan.

Origin

'Shenmei #3' was selected from a seedling field in 1997 by the strawberry research group of Forestry & Fruit Research Institute (FFRI) of Shanghai Academy of Agricultural Sciences (SAAS) from the progeny of a cross between 'Kunouwase' and 'Toyonoka' made in 1995. 'Kunouwase' (USDA-ARS; PI 641178) was released as a cultivar in Japan in 1983 and was used as a parent mainly because of its powdery mildew resistance. 'Toyonoka' (USDA-ARS; PI 616632), also released in 1983, was used as a parent because of its good fruit quality, especially its desirable color, conical shape, and pleasing taste (Minegishi, 1989).

'Shenmei #3' was evaluated for 10 years (1998 to 2007) in trials in Shanghai and other regions of southeastern China (lat. 28°45'–33°25'N, long. 118°20'–123°25' E). The most extensive testing was done in the FFRI of SAAS, where 'Shenmei #3' was planted in replicated trials with 'Toyonoka' and 'Kunouwase' as control cultivars. From 1998 to 2007, three 20-plant plots were established each year in mid-September in a randomized complete block design (partial data shown in Table 1). Freshly dug plugs (transplants started from

runner tips) in each plot were spaced 18 cm apart in the row with 25 cm between the rows in an annual hill plasticulture production system. The 40-cm tall and 55-cm wide raised beds were covered with black plastic (0.08 mm). Drip irrigation was set up and provided water and fertilizer at standard rates for commercial production (Barclay, 2006). Weeds were pulled from the planting holes and the first blossoms were also removed.

Fruiting began ≈7 weeks after establishment. Ripe fruit were harvested two to three times a week from late December to mid-April. At each harvest, the total number of fruit were counted and weighed from each plot. The fruit were graded based on the commercial fresh market standards used in Shanghai (Ye et al., 1998). A random sample of 20 fruit from three harvests each year was collected to determine firmness, soluble solids, titratable acidity, and ascorbic acid content. Each fruit was tested using a fruit firmness meter (GUSS Manufacturing, Strand, South Africa) controlled with software (FTAWin provided by the manufacturer). A probe that was 15 mm in diameter was pressed 8 mm into the fruit at the shoulder to measure the flesh firmness (in kilograms). After the fruit were tested for firmness, they were pureed in a blender. The soluble solids content of the fresh puree was assessed using a refractometer (Atago DBX-55, Tokyo, Japan) and the titratable acidity and ascorbic acid were assessed using the methods described by Wang et al. (2002).

Description

'Shenmei #3' (Fig. 1A) is a short-day cultivar developed in Shanghai, China, that

should be adapted to other similarly mild temperate climates throughout the world. 'Shenmei #3' plants are moderately vigorous, larger, and more compact than the current standard 'Toyonoka'. The plants of 'Shenmei #3' have a mean height of 298 mm and a mean canopy diameter of 333 mm. The plants of 'Toyonoka' are an average of 186 mm in height and 290 mm in canopy diameter. The compact growth habit facilitates high plant density for greater yield per acre. The plants also have a compact habit in which the ripe fruit are readily visible, improving harvest efficiency. Plants of 'Shenmei #3' have more runners than either of its parents based on visual observation.

The leaves of 'Shenmei #3' are coriaceous with a lustrous, smooth surface. The inflorescence emerges horizontally through the canopy in mid-October on plants that were planted in mid-September. The average diameter of the primary flower receptacle and corolla is 6.5 mm and 36.8 mm, respectively. The first inflorescences commonly have more than 14 flowers and the ratio of harvestable fruits to flowers is above 60% (data not shown). The first fruits of 'Shenmei #3' ripen in late December in Shanghai, 3 to 7 d later than 'Toyonoka'. The duration of harvest is ≈4 months.

Shanghai growers of 'Shenmei #3' reported yields of approximate 24,000 kg·ha⁻¹ during 2004–2007 when grown in annual hill culture. This yield is greater than the current standards such as 'Toyonoka' in Shanghai. In replicated trials at our experimental station during 2001–2003, the mean yield per plant for 'Shenmei #3' was higher than that of 'Kunouwase' and similar to 'Toyonoka' (Table 1). The ratio of the number of marketable fruits (well-formed fruit that weighed over 6 g and had no obvious defects) to the total number of fruits was above 92% for 'Shenmei #3', which was comparable to 'Toyonoka' but better than 'Kunouwase' (Table 1). Typically, small fruit size was the most common defect among the cultivars evaluated. 'Shenmei #3' had fewer deformed fruit than either of the other two cultivars evaluated. Diseased fruit were not common among cultivars in either year of the trial.

'Shenmei #3' fruit appearance is excellent (Fig. 1B). The berry shape is conical with an

Table 1. Average yield, percents marketable, and percentage of fruit that are small, deformed, or diseased for plants grown in Shanghai during the 2001–2002 and 2002–2003 trial years.

Year	Cultivar	Yield per plant (g) ^a	Marketable fruit (%) ^b	Small fruit (%) ^c	Deformed fruit (%) ^d	Diseased fruit (%) ^e
2001–2002	Shenmei #3	357.5 a ^a	92.51 a ^a	4.0 c ^a	2.4 c ^a	1.1 a ^a
	Toyonoka	345.7 a	86.52 ab	6.4 b	6.3 a	0.8 b
	Kunouwase	223.2 b	79.66 b	15.0 a	4.5 b	0.9 b
2002–2003	Shenmei #3	412.1 a	95.39 a	2.8 b	0.4 c	1.5 b
	Toyonoka	395.6 a	88.47 ab	2.2 b	6.4 b	2.2 a
	Kunouwase	245.5 b	79.67 b	9.0 a	9.8 a	1.5 b

^aMean for two planting years with 20 plants from two harvests weighed each year.

^bSmall fruit are those less than 6 g that are considered unmarketable in Shanghai markets.

^cFruit characterized by uneven flesh and abnormal shape.

^dMainly caused by gray mold (*Botrytis cinerea*).

^eMean separations within columns and within trial year by Duncan's new multiple range test ($P \leq 0.05$).

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Fig. 1. Fruiting plant (A) and berries (B) of 'Shenmei #3'.

Table 2. Fruit traits for 'Shenmei #3' strawberry and its parents in Shanghai, China (2005–2007).

Cultivar	Mean fruit wt (g) ^z	Firmness (kg) ^y	Soluble solids (°Brix) ^x	Titrateable acidity (g·L ⁻¹) ^w	Ascorbic acid (mg/100 g fresh weight) ^v
Shenmei #3	14.8 a ^v	0.47 a ^v	10.8 a ^v	0.71 c ^v	94.0 a ^v
Toyonoka	12.9 b	0.26 c	9.5 b	0.94 a	61.65 b
Kunouwase	9.3 c	0.33 b	9.2 b	0.83 b	68.05 b

^zMean for three planting years with 50 fruits from two harvests weighed each year.

^yBy Fruit Firmness Meter (GUSS Manufacturing, South Africa) on 20 fruits from three harvests each year; the probe was penetrated to 8 mm deep at the fruit shoulder.

^xBy refractometer (Atago DBX-55, Japan) on 20 fruits from three harvests each year.

^wTitrateable acidity and ascorbic acid were determined on 20 fruits from three harvests each year following Wang et al. (2002).

^vMean separations within columns by Duncan's new multiple range test ($P \leq 0.05$).

Table 3. Evaluation of three strawberry cultivars for symptoms of powdery mildew in 2004 in Shanghai, China.

Cultivar	Percentage of plants showing symptoms (%)	Disease incidence (%)	Resistance class
Shenmei #3	10.8 b ^z	36 b ^z	Mid
Toyonoka	45.0 a	90 a	Low
Kunouwase	8.0 b	16 c	High

^zMean separations within columns by Duncan's new multiple range test ($P \leq 0.05$).

average length to width ratio of 1:37. 'Shenmei #3' fruit weighed more than those of 'Toyonoka' and 'Kunouwase' in our trials (Table 2). The fruit are glossy with an external skin color that is a deeper, more uniform red than that of 'Toyonoka' or 'Kunouwase'. Achenes are yellow to red, evenly distributed, and sunken into the fruit surface. The internal flesh color is red with a light red core. The calyx is small and easily removed, which is important for processing.

The flesh firmness and the total soluble solids content of 'Shenmei #3' fruit were higher than those of 'Toyonoka' and 'Kunouwase' fruit, whereas the titrateable acidity was lower (Table 2). 'Shenmei #3' fruit contained

significantly more ascorbic acid than those of the other cultivars (Table 2). An informal evaluation of fruit quality was conducted using a group of 52 strawberry breeders and growers from different regions of China as evaluators. Briefly, samples from the field were randomly presented and each evaluator was given unlimited fruit and asked to score 'Shenmei #3', 'Toyonoka', 'Kunouwase', and other cultivars on a 1 to 5 scale for appearance, color, flavor, and overall fruit quality. Both fresh and processed fruit were evaluated. Approximately 70% of the participants rated the flavor of 'Shenmei #3' as superior to that of 'Toyonoka' and 'Kunouwase' on the 1 to 5 scale. The juice of

'Shenmei #3' has an intense flavor and aroma.

In the field trials, 'Shenmei #3' was moderately susceptible to common leaf spot caused by *Mycosphaerella fragariae* (Tul.) Lindau and Verticillium wilt caused by *verticillium dahliae* Kleb. compared with 'Kunouwase'. As a result of these potential disease problems, the nursery stock must be of the highest quality. 'Shenmei #3' is tolerant to anthracnose fruit rot caused by *Colletotrichum acutatum* J.H. Simmonds in Shanghai. The resistance of 'Shenmei #3' to gray mold (*Botrytis cinerea* Pers.:Fr.) is just above average, similar to 'Kunouwase'. Most notably, 'Shenmei #3' shows higher resistance to powdery mildew than 'Toyonoka', although the resistance is slightly lower than that of 'Kunouwase' (Table 3). In commercial fields in Shanghai, only very low levels of powdery mildew have been detected in 'Shenmei #3', even when grown adjacent to susceptible cultivars displaying severe symptoms of this disease such as 'Toyonoka'.

'Shenmei #3' is a promising cultivar with good flavor and strong aroma. It is ideally suited for the grower and the customer because of its fruit shape, high productivity, and long shelf life.

Availability

'Shenmei #3' is protected by plant breeders' rights under license from the nurseries in China (Chinese New Variety Right No. CNA004122E). For licensing information, contact the Forest & Fruit Research Institute of Shanghai Academy of Agricultural Sciences, 25# Nanhua Street, Minhang Zone, Shanghai 201106, China.

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