

‘Liaoning 1’ Walnut Cultivar

Baojun Zhao, Feng Liu, Yonghong Gong, and Dongsheng Li

Liaoning Institute of Economic Forestry, 116031, Dalian City, Liaoning Province, China

Yahui Chang

Liaoning Wuhuading National Nature Reserve, 125200, Suizhong, Huludao City, Liaoning Province, China

Yunfei Wang

Forestry Technology Extension Station of Jianchang County, 125300, Huludao City, Liaoning Province, China

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Walnuts are widely distributed in China where they have a long history of cultivation (Gao et al., 2010). Walnut germplasms have been collected and used in various countries, including China, allowing for the discovery of promising genotypes (Chen et al., 2014). Selected or crossbred cultivars have been used to establish orchards since the 1980s in China (Zhao et al., 2010). China has 440,300 hm² of walnut cultivation area with an annual nut production of 1.6 million metric tons and is ranked first among the walnut-producing countries of the world (Yi, 2017). The Liaoning Institute of Economic Forestry (LIEF) was one of the pioneers of walnut research in China and initiated its walnut breeding program in 1959. International walnut cultivars, including Payne, Franquette, Sunland, and Chico, were introduced into China during 1992–95, but they were unable to survive the cold winter in Liaoning province. ‘Liaoning 1’ was released as a new Persian walnut (*Juglans regia* L.) cultivar in China on 15 Oct. 2018. This new cultivar was bred and evaluated at LIEF. It has a high yield and excellent nut traits and has thus been widely planted in North China.

Origin

‘Liaoning 1’ originated from a controlled cross between the Persian walnut (*J. regia*) germplasms ‘10103’ and ‘11001’ in 1971 (Liu et al., 1990). The germplasm ‘10103’, an unreleased selection with a terminal bearing habit, was used as the female parent because of its resistance to coldness and its high yield

and large nut size. The germplasm ‘11001’ is a selection with a lateral bearing habit and was used as the male parent due to its robust growth, smooth nut surface, and thin nutshell. ‘Liaoning 1’ was preliminarily selected as a desirable genotype based on its lateral bearing habit, vigorous growth, dense and robust branches, attractive nut appearance, and thin nutshell. The first selection was during the 1974 season (April–November) and was identified as ‘7103-1’. After 6 years of assessment, ‘7103-1’ was authorized as the most promising walnut selection by the Department of Science & Technology of Liaoning Province in 1979. In 1986, ‘7103-1’ was evaluated in national regional experiments and was renamed ‘Liaoning 1’ in 1989. In 1999, it was certified by the Liaoning Provincial Forest Tree Certification Committee (LPFTCC) as a cultivar with the registration number LC96040 and a 3-year validation planting period. After the validation dates, the evaluation was reperformed during 2015–18. In Oct. 2018, it was approved by LPFTCC. The cultivar number was assigned as Liao S-SV-JR-002-2018.

Description and Performance

The cultivar is characterized by a rounded or oblong canopy with an upright or half-spreading growth habit (Fig. 1). The annual shoot with short internodes is thick

and robust. The first female flower appears in the second year, while the male flower occurs in the third year after planting. The abundant fruiting period occurs in the seventh year after planting. This is a laterally fruitful cultivar made up of more than 90% lateral buds. The short fruiting shoot produces two or three female flowers. The flowering is protandrous, with male and female flowers overlapping for 2 to 3 d. In the region of Dalian in Northeast China, leafing is in the middle of April, and leaf shedding occurs in early November (Fig. 2). The pollen-shedding period is at the beginning of May, and the female flower blooming period is in mid-May (Fig. 2). The harvest date is usually in the middle of September. A comparison of the pollen shedding and female flower blooming dates for ‘Liaoning 1’ with ‘Liaoning 4’, ‘Liaoning 5’, and ‘Liaoning 7’ is shown in Fig. 2. ‘Liaoning 1’ is a dwarf cultivar suitable for high-density plantations (Yu et al., 2016). ‘Liaoning 1’ is a cultivar exhibiting good winter-hardiness and performs well in severe cold climates in China (Zhang et al., 2012). Liu and Gao (2012)



Fig. 1. ‘Liaoning 1’ walnut tree at the end of the 18th vegetation period (4.5 m tall, 18.46 m² canopy area on average).

Cultivar	Leaf Date	May																		Harvest Date		
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18			
Liaoning1 (protandrous)	4/16	—————					☆	—————												☆	9/10
Liaoning4 (protandrous)	4/14	—————					☆	—————												☆	9/10
Liaoning 7 (protandrous)	4/15	—————					☆	—————												☆	9/10
Liaoning 5 (protogynous)	4/16					☆					—————								☆	9/10

Fig. 2. The leafing dates, pollen-shedding period, pistillate bloom times, and harvest dates for the walnut cultivars ‘Liaoning 1’, ‘Liaoning 4’, ‘Liaoning 7’, and ‘Liaoning 5’. The straight lines indicate the male flower, the dashed lines indicate the female flower, and the stars are the peak bloom dates.

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B.Z. is the corresponding author. E-mail: agroforestry@163.com.

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reported that ‘Liaoning 1’ has low susceptibility to walnut blight (*Xanthomonas campestris* pv. *juglandis*) compared with 17 walnut cultivars or clones, including ‘Tulare’.

We evaluated the nut traits of ‘Liaoning 1’ according to “The National Standard of the People’s Republic of China: Guidelines for the Conduct of Tests for Distinctness, Uniformity and Stability—*Juglans* (*Juglans* L.)” (Pei et al., 2011). The nut shape of ‘Liaoning 1’ is round and smooth with a light color (Fig. 3). The apex is flat, and the bottom is



Fig. 3. Nuts of ‘Liaoning 1’.

slightly concave. The longitudinal, transverse, and lateral diameters are 3.5, 3.4, and 3.5 cm, respectively, on average. The suture is flat and tight in combination. The nutshell is 0.9 mm on average and the inner fold degenerates, thus the whole kernel is easy to remove. The average nut weight is 9.4 g, with the kernel contributing 59.6% of the nut weight. The color of the kernel is classified as yellow-white. In 2017, the nutrient content of the ‘Liaoning 1’ kernel was measured and evaluated. The kernel contained 58.4%, 23.3%, and 62.1% oil, protein, and fat, respectively. The contents of nonessential amino acids, essential amino acids, and vitamin E were 14.66, 5.64, and 31.86 g·100 g⁻¹, respectively, and the contents of brass and polyphenols were 15.96 and 18.03 mg·g⁻¹, respectively. The contents of Ca, K, Mg, P, B, Mn, Fe, Cu, and Zn were 1201.88, 3140.45, 1521.59, 3436.01, 15.09, 101.84, 48.10, 13.16, and 30.74 mg·kg⁻¹, respectively.

We conducted field trials for ‘Liaoning 1’ at three locations in Liaoning Province (Table 1). One-year-old grafted trees of ‘Liaoning 1’ were arranged in a randomized

complete block design, with each location containing three blocks and a given number of trees for each block (Table 1). The growth characteristics were investigated in 2018 (Table 2). For example, at the end of the 18th vegetation period in the town of Paotai, the average trunk diameter, height, and canopy area values were 15.12 cm, 4.5 m, and 18.46 m², respectively (Table 2). The yield of ‘Liaoning 1’ in the field trials in the three locations from 2015 to 2018 was superior to the other cultivars tested (Tables 3–5).

‘Liaoning 1’ has performed well in walnut-producing areas in northern China, such as Hebei, Shanxi, Shaaxi, and Liaoning provinces. It requires fertile soil and standard management practices. The advantages of ‘Liaoning 1’ include its smooth nut surface, high kernel percentage, thin nutshell, and high nut yield. The disadvantages of ‘Liaoning 1’ include that it does not adapt to poor soil conditions and has strict cultivation requirements; for example, fertile, well-drained soil and a well-designed drainage and irrigation system. We recommend 4 m × 6 m spacing for ‘Liaoning 1’ planting with

Table 1. Field trials in three locations.

Location ²	Geo-location	Planting yr	Number of trail cultivars/selections	Spacing (m)	Trees per block
Leijiadian town ²	N40°45’ E119°53’	1985	8	3 × 5	12
Gaotai town	N40°30’ E120°25’	2000	9	3 × 4	20
Paotai town	N39°24’ E121°45’	2001	11	3 × 3	5

²Leijiadian town, Jianchang county, Huludao city; Gaotai town, Shuizhong county, Huludao city; Paotai town, Jinpu new district, Dalian city.

Table 2. Growth profiles in the three locations in Fall 2018.

Location ²	Tree age (yr)	Avg trunk diam (cm)	Avg ht (m)	Avg canopy (m ²)
Leijiadian town	33	31.21	7.5	No measurement
Gaotai town	19	14.23	4.3	No measurement
Paotai town	18	15.12	4.5	18.46

²Leijiadian town, Jianchang county, Huludao city; Gaotai town, Shuizhong county, Huludao city; Paotai town, Jinpu new district, Dalian city.

Table 3. In-shell nut yield of ‘Liaoning 1’ walnut compared with ‘Liaoning 4’, ‘Liaoning 5’, and ‘Liaoning 7’ from the 30th to 33th leaf after planting in Leijiadian town.

Cultivar	Yield (kg·ha ⁻¹) ²			
	2015	2016	2017	2018
Liaoning 1	3,669.6 ± 89.3 a ^y	3,537.6 ± 58.7 ab	3,616.8 ± 216.2 a	3,399.0 ± 109.5 a
Liaoning 4	3,550.8 ± 223.5 ab	3,722.4 ± 102.0 a	3,610.2 ± 194.0 a	2,778.6 ± 163.9 b
Liaoning 5	2,343.0 ± 125.0 c	2,362.8 ± 126.3 c	2,772.0 ± 233.2 b	2,428.8 ± 125.5 b
Liaoning 7	3,022.8 ± 227.2 b	3,273.6 ± 182.6 b	3,003.0 ± 121.1 ab	3,227.4 ± 123.5 a

²Based on 660 trees/ha. The data shown are the mean value ± SE.

^yMean separation in columns by Duncan’s multiple range test at $P \leq 0.05$.

Table 4. In-shell nut yield of ‘Liaoning 1’ walnut in comparison with ‘Liaoning 4’, ‘Liaoning 5’, and ‘Liaoning 7’ from the 16th to 19th leaf after planting in Gaotai town.

Cultivar	Yield (kg·ha ⁻¹) ²			
	2015	2016	2017	2018
Liaoning 1	3,646.5 ± 54.0 ab ^y	3,531.0 ± 117.5 a	3,918.8 ± 50.5 a	3,778.5 ± 59.8 ab
Liaoning 4	3,770.3 ± 68.4 a	3,456.8 ± 49.2 a	3,597.0 ± 62.4 b	4,108.5 ± 199.5 a
Liaoning 5	1,311.8 ± 54.3 c	1,320.0 ± 53.2 b	1,278.8 ± 57.3 c	1,287.0 ± 53.1 c
Liaoning 7	3,382.5 ± 175.2 b	3,349.5 ± 104.6 a	3,869.3 ± 28.7 a	3,522.8 ± 207.4 b

²Based on 825 trees/ha. The data shown are the mean value ± SE.

^yMean separation in columns by Duncan’s multiple range test at $P \leq 0.05$.

Table 5. In-shell nut yield of ‘Liaoning 1’ walnut in comparison with ‘Liaoning 4’, ‘Liaoning 5’, and ‘Liaoning 7’ from the 15th to 18th leaf after planting in Paotai town.

Cultivar	Yield (kg·ha ⁻¹) ^z			
	2015	2016	2017	2018
Liaoning 1	3,263.4 ± 141.5 a ^y	4,151.4 ± 135.6 a	4,084.8 ± 136.2 a	3,185.1 ± 201.8 b
Liaoning 4	3,674.1 ± 223.1 a	3,785.1 ± 118.6 b	3,896.1 ± 104.0 a	3,963.3 ± 140.7 a
Liaoning 5	1,764.9 ± 37.1 b	1,776.0 ± 52.2 d	1,720.5 ± 46.6 c	1,731.6 ± 60.1 c
Liaoning 7	2,131.2 ± 48.2 b	2,253.3 ± 98.4 c	2,120.1 ± 78.8 b	2,053.5 ± 135.1 c

^zBased on 1110 trees/ha. The data shown are the mean value ± SE.

^yMean separation in columns by Duncan’s multiple range test at $P \leq 0.05$.

pollination by ‘Liaoning 6’, which was bred by LIEF and released in 2008.

Availability

Small amounts of hardwood scion are available from the author.

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