

# ‘ZhaoXia’: A Northern Highbush Blueberry with Early Maturity and Good Storage Quality

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Blueberry is considered a perishable fruit, even under conditions of proper storage with relative humidity of 90% to 95%, at  $\sim 4^{\circ}\text{C}$  (reference) (Li et al. 2021). Cold storage wastes energy and requires storage space to guarantee fruit quality and avoid spoilage (Li et al. 2021). Therefore, cultivar attributes of early maturity, good firmness, and resistance to detrimental effects of transportation and storage are important for the blueberry industry. ‘ZhaoXia’ is resistant to storage, with hard and brittle fruits that are not easily softened, resulting in a longer storage period. Fresh fruits can be stored for half a month in a refrigerator at  $4^{\circ}\text{C}$ .

ZhaoXia (CNPVP 20210638) was released by Dalian Senmao Modern Agriculture Co., Ltd. as an early-season, northern highbush blueberry (*Vaccinium corymbosum* L.) cultivar. The new cultivar has stable yield, good flavor, and is suitable for planting of various scales. In particular, high sweetness, thin fruit wax, uniform texture, small picking scar, and medium firmness (3.56 N) enhance the opportunities for it to compete successfully in the early-maturing and storage-capable blueberry fresh market. Compared with other northern highbush cultivars, ‘ZhaoXia’ has similar chill-hour requirements, allowing it to adapt to the high-chilling areas of northern China (600–1200 h,  $<7.2^{\circ}\text{C}$ ).

## Origin

‘ZhaoXia’ was selected from an open-pollinated seedlings of ‘Harrison’. ‘Harrison’ was released in 1974 by North Carolina State University and resulted from a cross of ‘Croatan’  $\times$  US-11-93. It is an early- to middle-season cultivar (Xu et al. 2022).

Open seeds of ‘Harrison’ were collected in June 2010, and 256 seedlings were generated in a field plot in Dalian Senmao Modern

Agriculture Co. Ltd. In Spring 2012, these seedlings were transplanted to a field trial at Dalian Pushilan Agricultural Technology Co., Ltd. (Shuangsheng Village, Changling Town, Zhuanghe City, Dalian, Liaoning Province) at a row spacing of 2.0 m  $\times$  1.5 m between plants.

The performance characteristics of ripe berries the mature fruits were recorded when they first fruited in late Jun 2015 and were continually evaluated every year thereafter. Among them, one seedling performed well and showed potential promise, which was finally named as ‘ZhaoXia’. ‘ZhaoXia’ is characterized by large fruit that is flat round, thin and evenly textured, light red with a small and concave fruit scar; fruit firmness is large, the fruit has high sweetness, good yield, and is suitable for fresh food varieties. From Jun 2018 to Jun 2021, the tissue culture method was used for passage and continuous observation. This included plant morphology, flowering and fruiting characteristics, fruit yield, and fruit quality. In Dec 2021, this cultivar was certificated by the Plant Variety Protection certificate of the State Forestry and Grassland Administration and was named ‘ZhaoXia’.

## Description

In the test, three plants of the same age with no disease or insect of each ‘ZhaoXia’ and maternal parent ‘Harrison’ were selected and monitored over 4 years from 2018 to 2021. Morphological characteristics, plant yield, maturity (Table 1), and other blueberry characteristics were observed and measured (Table 2), and plant growth habits, berry cluster density, and berry flavor were subjectively evaluated. Berry attributes of size, firmness, and color that are generally important for commercial blueberry ratings (NeSmith 2018) were higher for ‘ZhaoXia’, whereas picking scar and flavor of ‘ZhaoXia’ were better than ‘Harrison’. Both cultivars have high-density fruit cluster, round fruits, and small picking scars; excellent flavor; and are suitable for the fresh market. We use “Agricultural Industry Standard of the Republic of China Grades and

Specifications of Agricultural Products—Blueberries” as the evaluation criterion.

Berry size was measured by weighing 30 berries of each cultivar and calculating the average berry weight. The berries of ‘ZhaoXia’ were larger than those of ‘Harrison’. The average berry size of ‘ZhaoXia’ was 1.47 cm  $\times$  1.88 cm (height/width), with the maximum berry size reaching 1.5 cm  $\times$  1.94 cm. The average berry weight was 2.37 g, and the maximum weight observed was 4.05 g (Fig. 1). The fruit of ‘Harrison’ was 1.35 cm  $\times$  1.52 cm (height/width) (Fig. 2). The average berry weight was 1.95 g, and the maximum berry weight was 2.3 g. In addition, the average yields of ‘ZhaoXia’ and ‘Harrison’ were 3.0 and 3.06 kg per plant, respectively.

We took 30 berries from each cultivar and used the Royal Horticultural Society (RHS) Colour Chart for fruit color determination. ‘ZhaoXia’ was light blue (RHS 102-A), and ‘Harrison’ was medium blue (RHS 101-A). Berry firmness measurements were performed on 30 berry samples by using the GY-4 Digital Fruit Sclerometer (Edburg Instruments Corp, Zhejiang, China). ‘ZhaoXia’ had greater firmness than ‘Harrison’ (3.56 vs. 2.92 N). The picking scar of ‘ZhaoXia’ was smaller than that of ‘Harrison’ (0.19 vs. 0.2 cm), measured by using a vernier caliper. The size and picking scar are important quality attributes. Blueberry fruit do not form a true abscission zone. When the fruit is removed from the plant, both vascular and epidermal tissues rupture, leaving a wound that is an excellent entry point for decay organisms (Beaudry 1992). However, low sugar/titratable acidity (Ac) or soluble solids/Ac ratios are also associated with good storage quality (Galletta et al. 1971).

Soluble solids content ( $^{\circ}\text{Brix}$ ) and titratable acidity (% citric acid) were determined by using a Pocket Brix/Acidity Meter (Blueberry) (PAL-BXIACID7; Atago Corp., Tokyo, Japan) (Xu et al. 2022). The soluble solids content level of ‘ZhaoXia’ was lower than that of ‘Harrison’ (10.07 vs. 14.00  $^{\circ}\text{Brix}$ ), and its titratable acidity was higher than that of ‘Harrison’ (0.32 vs. 0.22% citric acid). Therefore, the storage tolerance of ‘ZhaoXia’ appears to be better than that of ‘Harrison’ (Galletta et al. 1971).

In general, good berry color, firmness, and small picking scar are desirable traits for shipping and storage for fresh market (Carter et al. 2002). ‘ZhaoXia’ has all these features and is therefore recommended for commercial production.

## Availability

‘ZhaoXia’ was patented by the National Forestry and Prairie Bureau in Dec 2021 under certificate number CNPVP20210638. The cultivar is owned by Dalian Senmao Agricultural Technology Co., Ltd., Dalian, China. Propagation rights have been licensed to Dalian Senmao Agricultural Technology Co., Ltd. Growers may request information about how to obtain propagules by contacting H. Wang and G. Xu at Dalian Senmao

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Table 1. Yields and fruit ripening date of ‘ZhaoXia’ and ‘Harrison’, 2019–22.

Cultivars	Yield (avg kg/plant ± SD) <sup>i</sup>				50% fruit ripening date (range)	
	2019 (4 yr old) <sup>ii</sup>	2020 (5 yr old) <sup>ii</sup>	2021 (6 yr old) <sup>ii</sup>	2022 (7 yr old) <sup>ii</sup>	4-yr avg	4-yr avg
ZhaoXia	3.15 ± 0.70	2.91 ± 0.50	3.08 ± 0.73	2.86 ± 0.59	3.00 ± 0.63	15 Jun (17 Jun–25 Jun)
Harrison	2.89 ± 0.60	3.15 ± 0.70	3.08 ± 0.64	3.11 ± 0.65	3.06 ± 0.65	25 Jun (20 Jun–30 Jun)

<sup>i</sup> Average berry weight of 30 berries sampled.

<sup>ii</sup> The age of the test plants for 2019–22.

Table 2. Fruit quality attributes (±SD) of ‘ZhaoXia’ and ‘Harrison’ (age range of tested plants was 4 to 6 years), 2020–22.

Cultivars	Berry wt (g) <sup>i</sup>	Scar (cm) <sup>ii</sup>	Firmness (N) <sup>iii</sup>	Soluble solids (°Brix) <sup>iv</sup>	Titrateable acidity (% CA) <sup>iv</sup>
ZhaoXia	2.37 ± 0.4	0.19 ± 0.03	3.56 ± 0.8	10.07 ± 2.02	0.32 ± 0.14
Harrison	1.95 ± 0.27	0.20 ± 0.01	2.92 ± 0.68	14.00 ± 1.53	0.22 ± 0.08

<sup>i</sup> Average berry weight of 30 berries sampled.

<sup>ii</sup> The picking scar was measured by vernier caliper, with an average of 30 intact fruits.

<sup>iii</sup> The firmness was measured in Newtons (N) as the force value (kilograms) of 1 cm<sup>2</sup>, with an average of 30 intact fruits.

<sup>iv</sup> Soluble solids and titrateable acidity were determined using one blended cup of the sample fruit. CA = citric acid.

Modern Agriculture Co., Ltd., Xinshi Village, Huajia Street, Jinzhou New District, Dalian. This published genetic material has been deposited at Dalian Senmao Agricultural

Technology Co., Ltd., and it is available for research purposes, including the development and commercialization of new cultivars.



Fig. 1. Fruit of ‘ZhaoXia’ northern highbush blueberry.



Fig. 2. Fruit of ‘Harrison’.

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