

# THE AGRO-BIOLOGICAL CHARACTERISTICS OF SOME ORANGE VARIETIES, INCLUDING BH, BU HA TINH AND RON, GROWN IN QUY HOP, NGHE AN PROVINCE

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## ARTICLE INFORMATION ABSTRACT

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The research was carried out on three common orange varieties grown in the Quy Hop district, Nghe An province, including BH, Bu Ha Tinh and Ron, by using the questionnaire on the characteristics of 7-year-old orange varieties grown according to the production process of Nghe An Department of Agriculture and Rural Development. The results obtained on the agro-biological characteristics of 3 orange varieties named BH, Bu Ha Tinh and Ron, are the basis to help farmers understand the characteristics of orange varieties to identify, as well as provide scientific data for research institutions, management units in conservation, selection, production, supply and management of orange varieties in Nghe An province and the whole country.

**Keywords:** BH orange; Bu Ha Tinh orange; Ron orange.

## 1. Introduction

In Nghe An province (2022), the total citrus cultivation area was 2,644.6 hectares, of which the productive area accounted for 2,251.9 hectares, yielding an average productivity of 12.77 tons/hectare. Nghia Dan district had the largest concentrated citrus cultivation area with 735.1 hectares, followed by Con Cuong (377 hectares), Yen Thanh (333.5 hectares), Quy Hop (241.3 hectares), Thanh Chuong (228.1 hectares), and Nghi Loc (127.5 hectares). Within the total citrus cultivation area, the Xa Doai orange variety accounted for 1,519.9 hectares (57.57%), Valencia (V2) and Song Con covered 462.9 hectares (17.50%), Van Du covered 441.5 hectares (16.69%), and BH orange accounted for 220.4 hectares (8.3%). Additionally, other minor varieties, such as Bu Ha Tinh, Ron, CT36, and Xuong Quyt, occupied an area of approximately 50-60 hectares (1.2%-2.27%) [1].

In the last 3-5 years, the citrus cultivation area in Nghe An has continuously declined (a reduction of 2,090 hectares in 2022 compared to 2020), accompanied by a decrease in productivity and fruit quality due to degradation. The primary causes include substandard

seedling quality (many households purchased unverified seedlings from the market or propagated their plants using non-certified scions and cuttings) and pest and disease infestations [1], [5].

In 2019, the Intellectual Property Office of Vietnam issued Decision No. 5004/QD-SHTT, upgrading the geographical indication for Vinh orange products to encompass 73 communes across 11 citrus-growing districts in Nghe An province. This decision included four orange varieties: Xa Doai, Van Du, Song Con, and Valencia (V2), adding the V2 variety to the initial three varieties stated in Decision No. 386/QD-SHTT dated May 31, 2007 [2], [3]. These varieties' agronomic and biological characteristics were studied and published in recent research [6].

Identifying mother trees for scion selection, seedlings for cultivation, and commercial fruit products is critical in the seedling production process for producers, growers, and consumers. Thus, in addition to the four varieties (Xa Doai, Van Du, Song Con, and Valencia V2) cultivated in Nghe An province, which has been studied and published, researching the agronomic and biological characteristics of BH, Bu Ha Tinh, and Ron oranges is crucial. This will enable producers to accurately identify, propagate, and utilize citrus varieties. Furthermore, it will provide supplementary scientific data for research institutions and management units to improve citrus varieties' conservation, breeding, production, distribution, and management in Nghe An province and across Vietnam.

## **2. Research methodology**

### **2.1. Research materials**

The study focused on three orange varieties: BH, Bu Ha Tinh, and Ron. These varieties were in their 7th year of commercial production, cultivated in private orchards and managed following the orange production protocols established by the Department of Agriculture and Rural Development of Nghe An (Decision No. 1870/QD-SNN, dated December 27, 2013). All activities were supervised and coordinated by Xuan Thanh Agricultural One-Member Limited Company.

### **2.2. Experimental setup**

The experiments were conducted from January 2018 to March 2019 in the citrus orchards of farmers under the management of Xuan Thanh One Member Agricultural Company Limited, located in Minh Hop commune, Quy Hop district, Nghe An province. The experiment included three treatments with three replications. Each treatment corresponded to one variety, with three plots per variety, each containing 10 trees, making 30 trees per variety.

### **2.3. Methods for monitoring agronomic and biological indicators**

**Variety description method:** Based on the description guidelines by the Plant Resources Center, 2013 [4].

#### **Monitoring growth indicators:**

- Tree height: Measured from the base to the apex of the main stem.
- Trunk diameter: Measured on the main trunk at 50 cm above the base.
- Canopy diameter: Measured in two directions (East-West and North-South) and averaged.

- Flowering stages monitoring (on four evenly distributed branches per tree): Bud appearance time: Recorded when buds first appeared on the tree. Initial flowering time: The duration from the first bud opening to when 10% of the buds on the tree had bloomed. Peak flowering period: When 50-70% of the buds on the tree have bloomed.

**Fruit-setting rate:** Nylon or mesh was used to collect flowers and fruits falling from the canopy, starting from the bud appearance phase. Observations were made every 7-10 days until the fruit set was stabilized with no further drop. The fruit-setting rate was calculated using the formula:

$$\text{Fruit - setting rate (\%)} = \frac{\text{Number of fruits remaining on the tree at harvest}}{\text{Total number of flowers monitored}}$$

Where the total flowers monitored equals the sum of the number of fruits remaining at harvest and the number of fallen flowers and fruits.

**Monitoring yield and yield component indicators:**

- Fruit weight (grams): Randomly selected, 30 fruits were weighed, and the average value was recorded.

- Fruit diameter (cm): Randomly selected 30 fruits were measured, and the average value was recorded.

- Fruit height (cm): Randomly selected 30 fruits were measured using callipers, and the average value was recorded.

- Number of effective fruits per tree (fruits/tree): Counted at harvest.

- Individual yield (kg/tree): Total weight of fruits harvested from 30 monitored trees per variety, with the average value recorded.

**Biochemical indicators determination:**

- Dry matter content: Using the H.HD.QT.001 method.

- Total sugar content: Using the H.HD.QT.162 method.

- Total acid content: Using the H.HD.QT.185 method.

- Vitamin C content: Using the H.HD.QT.104 method (HPLC).

- Brix value: Using the NIFC.05.M.203 method.

## **2.4. Data processing method**

The data were statistically analyzed using the ANOVA method with SPSS 22.0 software.

## **3. Results and discussion**

### **3.1. Botanical characteristics of orange varieties**

The botanical characteristics of three orange varieties, all at the commercial fruit-bearing stage (7 years old), were monitored. These varieties exhibited evergreen vegetative growth and a spreading growth habit. All varieties were propagated via grafting, with rootstock derived from sour orange. The results (Table 1) indicate variations in the botanical characteristics among the three varieties. All three varieties had an intermediate branch angle, similar to Van Du and V2 oranges but different from Xa Doai oranges (broad branch angle) and Song Con oranges (narrow branch angle) [6]. The branch density ranged from dense (BH and Bu Ha Tinh oranges) to medium (Ron oranges).

At the same tree age, there was no significant difference in traits such as tree height, trunk diameter, canopy diameter, and the number of first-order branches. ANOVA analysis confirmed no statistically significant differences at  $p < 0.05$ .

**Table 1: Botanical characteristics of orange varieties**

Monitoring indicators	Orange variety		
	<b>BH</b>	<b>Bu Ha Tinh</b>	<b>Ron</b>
Branch density	Dense	Dense	Medium
Branch angle	Medium	Medium	Medium
Tree height (cm)	$348.6 \pm 22.4^a$	$325.5 \pm 21.2^a$	$335.8 \pm 38.3^a$
Trunk diameter (cm)	$7.64 \pm 2.55^a$	$6.82 \pm 1.66^a$	$7.16 \pm 1.59^a$
Canopy diameter (cm)	$430.51 \pm 40.82^a$	$417.55 \pm 43.84^a$	$436.78 \pm 42.33^a$
Number of first-order branches	$2.98 \pm 0.68^a$	$3.01 \pm 0.89^a$	$2.69 \pm 1.03^a$

**Note:** In the same row, different superscript letters are different at  $p < 0.05$ .

### 3.2. Leaf characteristics of orange varieties

The observations revealed common leaf traits across all three varieties: light green young leaves, dark green mature leaves, simple leaf arrangement, and rounded leaf tips. However, differences in leaf traits were noted (Table 2): Bu Ha Tinh oranges had non-waisted leaves, while BH and Ron oranges had waisted leaves. BH and Ron oranges had smooth leaf margins, whereas Bu Ha Tinh oranges had serrated margins. BH and Bu Ha Tinh oranges displayed inverted egg-shaped petioles and elliptical leaf blades, while Ron oranges had heart-shaped petioles and oval leaf blades. The petiole attachment also differed: Bu Ha Tinh oranges lacked petiole wings, whereas BH and Ron oranges had short petioles relative to the blade. Leaf size varied significantly among the varieties. BH oranges had the most extended mature leaves, followed by Ron and Bu Ha Tinh oranges. Leaf width also differed, with BH oranges being the widest, followed by Bu Ha Tinh and Ron.

**Table 2: Leaf characteristics of orange varieties**

Monitoring indicators	Orange variety		
	<b>BH</b>	<b>Bu Ha Tinh</b>	<b>Ron</b>
Leaf shape (with or without waist)	Yes	No	Yes
Leaf margin	Smooth	Sawtooth	Smooth
Leaf shape	Inverted egg shape	Inverted egg shape	Flat inverted heart
Leaves attached	The petiole is shorter than the leaf blade	No small leaf petiole	Leaf petioles are shorter than leaf blades
Leaf blade shape	Elips	Elips	Ovale
Mature leaf length (cm)	$10.00 \pm 0.22^c$	$6.54 \pm 0.31^a$	$9.65 \pm 0.26^b$
Mature leaf width (cm)	$4.11 \pm 0.15^c$	$3.52 \pm 0.24^b$	$3.03 \pm 0.26^a$
Small leaf petiole length (cm)	$1.09 \pm 0.15^a$	-	$2.08 \pm 0.14^b$

**Note:** In the same row, different superscript letters are different at  $p < 0.05$

### 3.3. Fruit characteristics of orange varieties

The fruit characteristics of all three varieties were generally spherical, with truncated fruit bases and apexes and typical segment wall toughness. However, other traits varied (Table 3). BH and Ron oranges had green-yellow peel when ripe and a rough surface, while Bu Ha Tinh oranges had yellow peel with small spines.

**Table 3: Fruit characteristics of orange varieties**

Monitoring indicators	Orange variety		
	<b>BH</b>	<b>Bu Ha Tinh</b>	<b>Ron</b>
Colour of the fruit peel when ripe	Green Yellow	Yellow	Green Yellow
Peel surface	Rough	Small spikes detected	Rough
Peel thickness (cm)	$0.55 \pm 0.16^b$	$0.35 \pm 0.05^a$	$0.72 \pm 0.15^c$
Number of segments/fruit (segments)	$11.54 \pm 1.28^b$	$11.48 \pm 1.62^b$	$9.83 \pm 1.57^a$
Adhesion between segments and peel	Normal	Normal	Weak
Flesh colour	White	White	Light Red
Segment color	Yellow	Deep yellow	Light Red
Fruit core color	Pale yellow	White	White
Segment texture	Fleshy	Spongy	Fibrous

**Note:** In the same row, different superscript letters are different at  $p < 0.05$

The peel thickness showed significant differences, with Ron oranges having the thickest and Bu Ha Tinh oranges having the thinnest peels. The number of fruit segments ranged from 9.83 to 11.54 per fruit, differing significantly between BH, Bu Ha Tinh, and Ron oranges.

Additional distinctions were observed: Ron oranges exhibited weak adherence between segments and peel, a light red albedo, and a white core, whereas BH oranges had a pale yellow core, and Bu Ha Tinh oranges had a white core. Segment colour varied: BH oranges were yellow, Bu Ha Tinh deep yellow, and Ron oranges light red. Segment texture also differed, with BH oranges being fleshy, Bu Ha Tinh oranges spongy, and Ron oranges fibrous.

### 3.4. Seed characteristics of orange varieties

The results (Table 4) showed that Ron oranges were seedless, while BH and Bu Ha Tinh oranges had seeds with spindle shapes and wrinkled surfaces but differed in colour: BH oranges had cream-coloured seeds, and Bu Ha Tinh oranges had brown seeds.

The seed count per fruit did not differ significantly between BH and Bu Ha Tinh oranges. Their seed counts were similar to Van Du oranges but higher than Valencia (V2) and Song Con oranges (3.00-3.80 seeds/fruit) and lower than Xa Doai oranges (18.23 seeds/fruit) [6].

**Table 4:** Seed characteristics of orange varieties

Monitoring indicators	Orange variety		
	<b>BH</b>	<b>Bu Ha Tinh</b>	<b>Ron</b>
Number of seeds/fruit	7.25 ± 2.18 <sup>a</sup>	8.56 ± 3.46 <sup>a</sup>	0.00
Grain shape	spindle shapes	spindle shapes	-
Grain color	Cream Color	Brown	-
Grain surface	wrinkled	wrinkled	-

**Note:** In the same row, different superscript letters are different at  $p < 0.05$

### 3.5. Flowering and fruit setting characteristics of orange varieties

Monitoring results (Table 5) revealed differences in the total number of flowers per tree, the number of fruits retained at harvest, and the fruit-setting rate. Bu Ha Tinh oranges had the highest fruit-setting rate, followed by BH and Ron oranges, with Ron oranges having the lowest rate (1.60%).

**Table 5:** Flowering and fruit setting characteristics of orange varieties

Monitoring indicators	Orange variety		
	<b>BH</b>	<b>Bu Ha Tinh</b>	<b>Ron</b>
Time of bud appearance	7 - 15/11	5 - 10/2	3/11 - 10/11
Initial flowering	20 - 25/11	1 - 5/3	11 - 17/11
Full bloom	26/11 - 2/12	10 - 20/3	23 - 30/11
Flowering end stages	2 - 7/1	27 - 1/4	4 - 9/1
Total number of flowers/plants (flowers)	21,213	10,986	14,413
Number of fruits remaining on the plant at harvest (fruits)	420	252	230
Fruit set rate (%)	1.98	2.29	1.60
Harvest periods	Late September to November	Late December to February of the following year	Early September to November

Differences in the timing of bud appearance, initial flowering, full bloom, and flowering end stages among the varieties resulted in varying fruit maturation and harvest periods. BH and Ron oranges matured early, with harvests from late September to November (before the Lunar New Year). Bu Ha Tinh oranges matured later, coinciding with the Lunar New Year (late December to February).

### 3.6. Yield and yield components of orange varieties

ANOVA analysis at  $p < 0.05$  showed that Ron oranges had the highest fruit height, BH oranges had the most minor fruit diameter, and Bu Ha Tinh oranges had the highest fruit weight. The yield components of the other two varieties did not differ significantly.

Differences in yield components led to variations in individual yields (Table 6). BH oranges had the highest yield, while Ron and Bu Ha Tinh oranges had lower yields, with no significant difference between the latter two.

All three varieties had lower individual yields than Xa Doai and Song Con oranges [6].

**Table 6: Yield and yield components of orange varieties**

Monitoring indicators	Orange variety		
	<b>BH</b>	<b>Bu Ha Tinh</b>	<b>Ron</b>
Fruit height (cm)	$6.44 \pm 0.55^a$	$6.16 \pm 0.22^a$	$7.66 \pm 0.26^b$
Fruit diameter (cm)	$7.15 \pm 0.32^a$	$7.57 \pm 0.18^b$	$7.76 \pm 0.28^b$
Fruit weight (g)	$196.26 \pm 16.27^a$	$222.86 \pm 10.52^b$	$205.66 \pm 12.58^a$
Number of effective fruits (fruits/tree)	$420.34 \pm 32.51^b$	$252.48 \pm 28.69^a$	$230.55 \pm 25.26^a$
Individual productivity (kg/plant)	$82.50 \pm 26.93^b$	$56.27 \pm 20.15^a$	$47.41 \pm 18.31^a$

**Note:** In the same row, different superscript letters are different at  $p < 0.05$

### 3.7. Fruit quality indicators of orange varieties

The biochemical analysis results (Table 7) showed that Bu Ha Tinh oranges had the highest values for dry substance content, total sugar content, total acid content, and Brix, followed by BH and Ron oranges.

Vitamin C content was highest in BH oranges, followed by Ron and Bu Ha Tinh oranges.

**Table 7: Evaluation of biochemical indicators in fruits of orange varieties**

Indicators	Units	Tracking results		
		<b>BH</b>	<b>Bu Ha Tinh</b>	<b>Ron</b>
Dry substance content	g/100g	10.50	12.60	9.40
Total sugar content	g/100g	8.22	9.53	5.20
Total acid content	g/100g	0.64	1.36	0.52
Vitamin C content	mg/100g	27.80	15.30	18.40
Brix value	g/100g	12.50	12.60	5.00

## 4. Conclusion

The three investigated orange varieties, BH, Bu Ha Tinh, and Ron, exhibited evergreen vegetative growth, a spreading growth habit, and intermediate branch angles. Their young leaves were light green, while mature leaves were dark green, with simple leaf arrangement and rounded tips. The fruits were spherical, with truncated bases, apexes, and typical segment wall toughness. Notable differences were observed in various botanical characteristics, including stems, branches, canopies, leaves, fruits, and seeds.

The timing of bud emergence, initial flowering, full bloom, and flowering end stages differed among the varieties, resulting in variations in fruit maturation and harvest periods. BH and Ron oranges matured early, with harvests from September to November. In contrast, Bu Ha Tinh oranges matured from late December to February, coinciding with the Lunar New Year.

Individual yield was highest in BH oranges (82.50 kg/tree), followed by Bu Ha Tinh (56.27 kg/tree) and Ron (47.41 kg/tree) oranges, with no statistically significant differences between the latter two varieties.

Biochemical indicators in the fruits, such as dry substance content, total sugar content, total acid content, and Brix value, were highest in Bu Ha Tinh oranges, followed by BH and Ron oranges. Vitamin C content was highest in BH oranges, followed by Ron and Bu Ha Tinh oranges.

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## TÓM TẮT

### **ĐẶC ĐIỂM NÔNG - SINH HỌC CỦA CÁC GIỐNG CAM BH, CAM BÙ HÀ TĨNH VÀ CAM RỐN ĐƯỢC TRỒNG TRÊN ĐỊA BÀN HUYỆN QUỲ HỢP, TỈNH NGHỆ AN**

**Trần Ngọc Toàn**

*Viện Nông nghiệp và Tài nguyên, Trường Đại học Vinh, Nghệ An, Việt Nam*

Ngày nhận bài 08/10/2024, ngày nhận đăng 18/12/2024

Nghiên cứu được thực hiện trên 3 giống cam được trồng trên địa bàn huyện Quỳ Hợp, tỉnh Nghệ An gồm cam BH, cam Bù Hà Tĩnh và cam Rốn. Sử dụng phiếu điều tra đặc điểm giống để theo dõi các giống cam 7 năm tuổi được trồng theo quy trình sản xuất của Sở nông nghiệp và phát triển nông thôn tỉnh Nghệ An. Kết quả thu được về đặc điểm nông - sinh học của 3 giống cam BH, cam Bù Hà Tĩnh và cam Rốn là cơ sở giúp người dân nắm rõ đặc điểm của các giống cam để nhận diện, cũng như cung cấp dữ liệu khoa học cho các cơ sở nghiên cứu, đơn vị quản lý trong công tác bảo tồn, chọn tạo, sản xuất, cung ứng và quản lý giống cam trên địa bàn tỉnh Nghệ An và cả nước.

**Từ khóa:** Cam BH; cam Bù Hà Tĩnh; cam Rốn.