

**Momčilo RADULOVIC**  
**Merima ĐUKIĆ, Dubravka RADULOVIC<sup>1</sup>**

## **INFLUENCE OF VARIETY AND LOCATION ON UNSHIU CITRUS FRUIT WEIGHT (*Citrus unshiu* March.)**

### **SUMMARY**

A study on three most common varieties of Unshiu mandarin in Montenegro's coast (Chahara, Kawano Wase and Owari) was conducted in three locations in the Municipality of Bar: Šušanj, Bjeliši and Polje in the course of 2010. All three varieties were grafted on the rootstock *Poncirus trifoliata*. During the study, all trees were in the full fruiting period. Standard agricultural operations were conducted in the course of the study (tilling, fertilizing, irrigation and protection against disease agents and pests).

In all mandarin varieties in this study the fruit weight was analysed. Of each variety 90 fruits were taken for analysis (30 fruits from each tree from Šušanj, Bjeliši and Polje, taken in line with a representative sample method). The total of 270 fruits was weighted. In all varieties studied, the fruit weight was measured on an automated analytical balance of the Shimadzu brand, with accuracy of 0.001 mg.

The results of the study on the influence of the variety and the location on Unshiu mandarin (Owari, Kawano Wase and Chahara) show the following: variety Owari has the highest average fruit weight of 107.96 grams, and the lowest variety Kawano Wase with 69.98 grams. The highest average fruit weight of the varieties studied was found in the location Polje 93.91 g, and the lowest in the location Bjeliši 85.14 g. The results of the study show that the fruit weight depends on the variety and that the influence of the location to fruit weight is not significant.

**Keywords:** Unshiu mandarin, variety, location, fruit weight

### **INTRODUCTION**

Unshiu mandarin is a citrus present at the northernmost line of their cultivation area. In the total citrus production worldwide, the share of mandarins is around 20 %.

For the purpose of easier identification of species and varieties, Hodgson's classification (1961) is accepted in practice and division of citrus into 36 species, including five mandarin species. One of these species is the Unshiu mandarin (*Citrus Unshiu* Marc.). According to Japanese botanists Nishiura and

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<sup>1</sup> Momčilo RADULOVIC (corresponding author: rmomo@t-com.me), Biotechnical Faculty Podgorica; Merima ĐUKIĆ, Secondary Agricultural School Bar; Dubravka RADULOVIC, Ministry of Agriculture and Rural Development, Podgorica, MONTENEGRO.

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Tanaka (1977) Unshiu mandarin was developed more than 350 years ago in the southern part of the Kyushu Island (Japan), as an accidental seedling of mandarin fruit imported from southern China. The Unshiu name originates from the Japanese word "oonshiu", meaning "seedless".

From Japan this mandarin spread to many countries of the world with favourable conditions for citrus growing. It was imported into the USA in 1876, in USSR (Georgia) in 1897 (Luss, 1947), in Italy in 1907 (Gutiev, 1958).

Unshiu mandarin was for the first time imported in Montenegro in 1933, when at the governor's estate in Topolica, near Bar, 250 seedlings of this mandarin from the Yokohama (Japan) nursery were planted. These seedlings were a present from the honorary consul of Japan to the Ministry of Agriculture of the Kingdom of Yugoslavia. In 1939, additional 1,000 seedlings were imported from the nurseries in Osaka and Kobe and distributed to farmers in this region (Redžić, 1954).

In Montenegrin coastal region, the number of Unshiu mandarin trees has rapidly risen in the past 30 years. From 125,000 trees in 1983, the number of mandarin trees grew to 420,000 in 2010 (Nikolić and Radulović, 2010). This sudden increase in number of Unshiu mandarin trees in our country is a result of environmental and economic indicators. This is one of the most profitable plant species grown in the open fields in our country. Of all citrus species, Unshiu mandarin is the most popular in Montenegrin coast nowadays (above 80%).

Mandarin is a fruit species that in normal growing conditions gives high and regular yield of 30–35 kg/tree on average, or 32–35 t/ha in our region (Plamenac M. 1978.). In intensive production, yields can reach 70 tons per ha (Spina P. Di Martino E.1991). Mandarin fruits are mainly consumed fresh, and a significantly lesser share is used for production of syrup, fruit or brandy. The purpose of this paper is to assist mandarin farmers in the Municipality of Bar in choosing appropriate varieties for growing in a given location, in order to achieve the highest level of cost-effectiveness of this production.

## MATERIALS AND METHODS

**Chahara** is a Japanese variety that belongs to early varieties as in our conditions it ripens, in average, from mid-September to October 5. It is medium vigour tree and highly productive. Fruit is large, yellow-orange in colour, medium-juicy and only fair flavour. It is easy to separate the peel from the fruit flesh. The fruit quality is somewhat poorer than of the Kawano Wase variety.

**Kawano Wase** is an old Japanese variety. It was named after the breeder Nagoji Kawano, in whose orchard the first trees of this variety were found in 1895. In the following years, trees of similar properties were found in other areas of Japan, so this variety spread further from several similar trees.

The variety was introduced in our country in 1965 from Georgina, so farmers often mistakenly name it "the Russian mandarin". This variety's tree is low in vigour, with a compact, rounded crown. It ripens in October. Its fruit is orange in colour, peel surface is smooth, only occasionally wrinkled, medium to

large in size, somewhat larger in width than in height. It is mistakenly taken as a variety with better resistance to frost than other varieties of Unshiu mandarin. The fleshy part of the fruit is juicy, with a refreshing flavour, peels easily and is usually divided into 12 seedless segments. One of the major advantages of this variety is a very high yield.



Image 1. Unshiu mandarin, Chahara variety

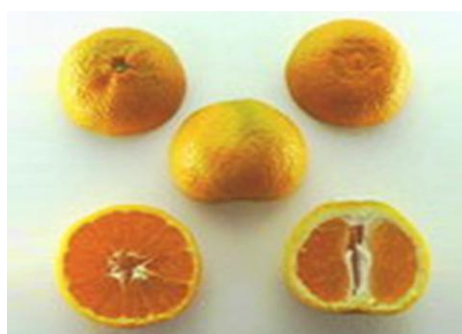


Image 2. Unshiu mandarin, Kawano Wase variety

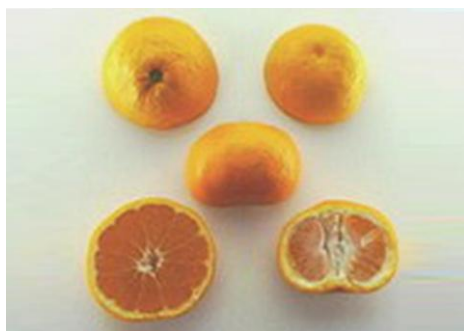


Image 3. Unshiu mandarin, Owari variety

**Owari**, too, is an old Japanese variety. Its tree is well developed and with a loose crown, up to 5 meters in height, without thorns. Leaves are odourless, quite large (up to 11 cm in length), spear-like, with prominent veins. The stem is thick

with barely noticeable stipules. It ripens in November. The fruit is orange-yellow in colour, with a slightly rough or smooth peel. It is easily peeled from the fruit flesh. It has 9-12 segments, easily divided. Fruit flesh is juicy, sweet and fairly aromatic. Its acid content is somewhat lower than in other varieties. It is seedless.

The study on the three said varieties most frequently grown in our country was conducted in three locations in the Municipality of Bar: Šušanj, Bjeliši and Polje in the course of 2010. All three varieties were grafted on the rootstock *Poncirus trifoliata*. During the study, all trees were in the full fruiting period. Standard agricultural operations were conducted in the course of the study (tilling, fertilizing, irrigation and protection against disease agents and pests).

Of each variety 90 fruits were taken for analysis (30 fruits from each tree from Šušanj, Bjeliši and Polje, taken in line with a representative sample method). In all varieties studied, the fruit weight was measured on an automated analytical balance of the Shimadzu brand, with accuracy of 0.001 mg.

The statistical data processing was done by variance analysis, followed by Duncan test for to determine the differences (Hadživuković S. 1991).

## RESULTS AND DISCUSSION

### Influence of variety on fruit weight

The overview of data obtained in the analysis of influence of variety on fruit weight is given in Table 1 below. The highest values for fruit weight among Unshiu mandarin varieties studied were recorded in fruits of Owari variety – 121.06 g., and the lowest in fruits of Kawano Wase variety – 67.25 g. The results of average values of fruit weight per variety were the lowest for Kawano Wase – 69.98g, followed by Chahara variety – 92.94g, and the highest in Owari variety – 107.96 g.

Table 1. Unshiu mandarin fruit weight per variety

Variety	Location	Fruit weight in g.
Chahara	Šušanj	100.83
	Bjeliši	89.95
	Polje	88.06
<b>Average</b>		<b>92.94</b>
Kawano Wase	Šušanj	67.25
	Bjeliši	70.08
	Polje	72.63
<b>Average</b>		<b>69.98</b>
Owari	Šušanj	107.41
	Bjeliši	95.41
	Polje	121.06
<b>Average</b>		<b>107.96</b>

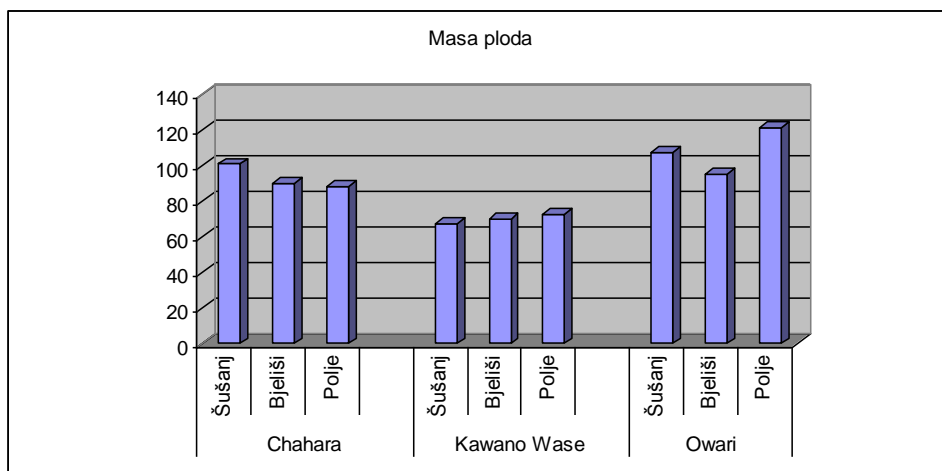


Chart 1. Unshiu mandarin fruit weight by variety

Chart 1 clearly shows that average values for fruit weight are the highest in Owari variety and the lowest in Kawano Wase variety.

Variance analysis of fruit weight of Unshiu mandarin varieties studied show significant differences in fruit weight depending on variety. For those reasons, a comparison among varieties was made using the Duncan multiple range test (Table 3).

Table 2. Variance analysis for fruit weight

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	2162.889	2	1081.444	14.271	0.005
Within Groups	454.667	6	75.778		
Total	2617.556	8			

Sig < 0.05 (where significance level is below 0.05  $H_0$  is rejected and  $H_1$  accepted, meaning that differences are significant)

Table 3. Duncan test for fruit weight

No.	Fruit weight average
9. Owari (Polje)	121 a ...
7. Owari (Šušanj)	107 ab ...
1. Chahara (Šušanj)	101 ab ..
8. Owari (Bjeliši)	95 b ...
2. Chahara (Bjeliši)	90 b ...
3. Chahara (Polje)	88 b ...
6. Kawano Wase (Polje)	73 c ...
5. Kawano Wase (Bjeliši)	70 c ...
4. Kawano Wase (Šušanj)	67 c ...

Owari variety from the location Polje belongs to the first group (a), with the highest mandarin fruit weight (121.06 grams), varieties Owari and Chahara from the location Šušanj belong to the second group (ab), varieties Owari and Chahara from the location Bjeliši and variety Chahara from Polje belong to the third group (b), while variety Kawano Wase from all three locations belongs to the fourth (c).

### Influence of location on fruit weight

The overview of the results of influence of location on fruit weight of Unshiu mandarin varieties studied is given in the Table 4 below. The highest average value of fruit weight was measured in samples taken from the location Polje – 93.91g, followed by location Šušanj 91.83 g, and the least average value of fruit weight was measured in samples taken from the location Bjeliši 85.14 g.

Table 4. Influence of location on fruit weight

Location	Variety	Fruit weight in g.
Šušanj	Chahara	100.83
	Kawano Wase	67.25
	Owari	107.41
	<b>Average</b>	<b>91.83</b>
Bjeliši	Chahara	89.95
	Kawano Wase	70.08
	Owari	95.41
	<b>Average</b>	<b>85.14</b>
Polje	Chahara	88.06
	Kawano Wase	72.63
	Owari	121.06
	<b>Average</b>	<b>93.91</b>

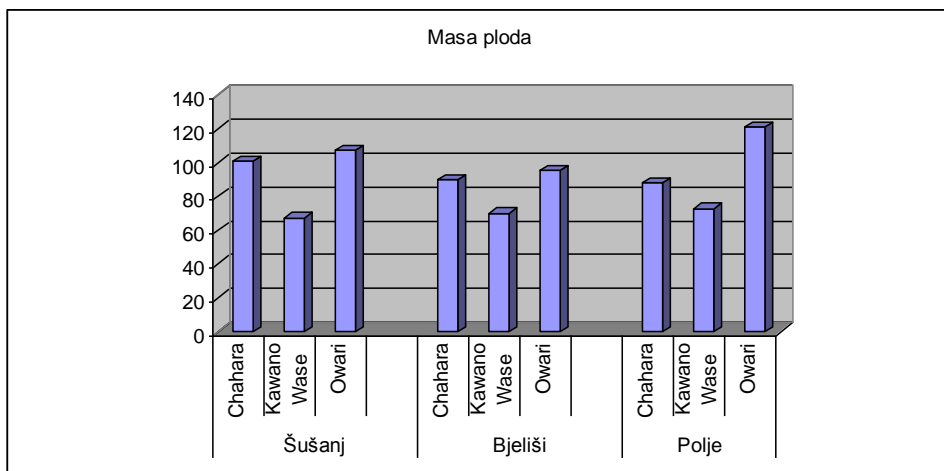


Chart 2. Influence of location on fruit weight

Chart 2 above gives an overview of results of influence of location on fruit weight of Unshiu mandarin (varieties Chahara, Kawano Wase and Owari). The chart shows that fruit weight values in all locations are quite even (in difference to the values by varieties)

The results obtained have values somewhat lower than results obtained for the variety Kawano Wase Bakarić (1983) 80-100 g, Radulović (1998) 80-125 g, Goliadze (1981) 84-89 g, Xu et al., (2000) 114.6 g. However, for Owari variety, the results obtained are somewhat higher than those obtained by Radulović M et.al.(2005) 92.4 g. For Chahara variety, too, results have values somewhat lower – 92.94 g than the values obtained by Radulović M. et.al.(2005) 110.9 g.

## CONCLUSIONS

A study on three most common varieties of Unshiu mandarin in Montenegro's coast (Chahara, Kawano Wase and Owari) was conducted in three locations in the Municipality of Bar: Šušanj, Bjeliši and Polje in the course of 2010. All varieties were grafted on the rootstock *Poncirus trifoliata*. During the study, all trees were in the full fruiting period. Standard agricultural operations were conducted in the course of the study (tilling, fertilizing, irrigation and protection against disease agents and pests).

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