

Momčilo RADULović, Stoja LJUTICA, Slavojka MALIDŽAN¹,

**BIOLOGICAL – POMOLOGICAL FEATURES OF
MANDARIN CLEMENTINE IN THE CONDITIONS OF THE
MONTENEGRIN SUBTROPICAL ZONE**

SUMMARY

Four years of results (2008-2011) are reported for testing of four varieties of mandarin clementine – Clementine No 63, Clementine No 70, Clementine No 92 and clementine Fairchild No 30 – in the agroecological conditions of the Montenegrin subtropical zone. Experimental planting was made in 2004 on the farmland of Mr Mećikukić in Bjeliši, near Bar. Morphology, phenology, fertility, morphometric and physical features of the fruit were studied on the experimental plants (12 of each variety). The average yield was from 5.283 kg to 6.739 kg per ha, and the fruit weight was from 81.6 to 87.0 g. Three varieties of clementine: No 63, No 70 and No 92, are proposed for cultivation in the subtropical zone of Montenegro, while clementine Fairchild No 30 is not suitable for cultivation in this zone.

Keywords: mandarin, clementine, morphology, phenology, fertility, the weight of the fruit.

INTRODUCTION

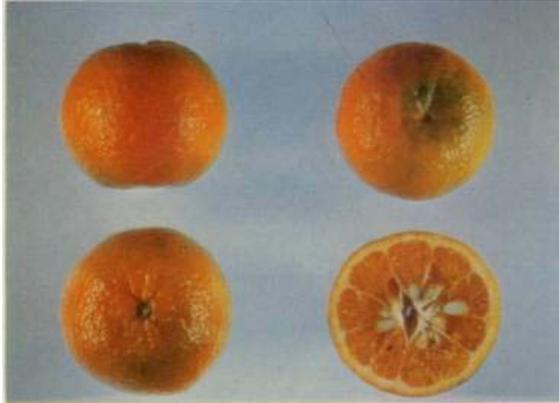
The clementine is a type of agrum that is classified into the mandarins although it probably appeared as a spontaneous hybrid between mandarin Havana and bitter orange in the beginning of the 20th century, in Algeria. It was named after P. Climent from Algeria, who was first to cultivate it. It spread over all the areas where agrums are cultivated.

The tree of the mandarin-clementine is middle lavish or totally lavish, with thick treetops and vertical branches. Its leaves are odourless and a little bit smaller than mandarin *unshiu*. The fruit is medium large, with a mass of 50 to 80 g, a little bit flattened and orange-reddish in colour. The peel is thin and discretely aromatic. The fruit consists of 9 to 11 slices which are juicy, pleasant tasting and very aromatic. It can have 3 to 30 seeds, and some varieties are seedless. In the conditions of Bar, it ripens at the end of October.

On the Montenegrin coast, this variety is underrepresented (less than 1 % from all the types of agrum) and mainly it is planted in gardens as 2-3 trees (the exception is one plantation in Ulcinj – Donji Štoj, with 600 trees). The reason for such a small representation of this type of mandarin in our region is because of

¹ Dr Momčilo RADULović (corresponding author: rmomo@t-com.me);
Stoja LJUTICA, Slavojka MALIDŽAN, Biotechnical Faculty, University of Montenegro.

its higher sensitivity to low temperatures compared to mandarin *unshiu* (Radulović M. 1987, Radulović M. Plamenac M. 1988).



Nevertheless, in the past few years, several small plantations of mandarin clementine have been established by us.

The Mandarin-clementine is much better represented in countries where agrums are planted with no fear of eventual freezing. In Italy, for example, clementine is the dominant type of mandarin, and the areas where agrums are planted accounts for 22%, while in

California it is the most represented type of mandarin, with 56% of all the area under mandarins (Spina P., Martino E. 1991; Vacante V., Calabrese F. 2009).

MATERIALS AND METHODS

Field research is done in a sort of plantation of mandarin clementines in an area of 600 m², which is situated within a bigger plantation of different types of agrums (about 1200 trees). The plantation was established in the spring of 2004 on the flat terrain in Bjeliši, near Bar. The distance between plants is 4 x 3 metres, with the direction of rows from north-west to south-east.

An arrangement of varieties was done in accordance with the method of completely randomised design, with 4 repetition per variety and 3 trees in each replication. In total there were 12 trees of each variety. The research included 3 varieties of mandarin clementine with the marks No 63, 70 and 92 and clementine Fairchild with the mark No 30. All researched varieties were examined for hardiness, phenological features, yield, morphometrics and physics characteristics of the fruit.

The beginning of blooming was determined as the presence of 5 flowers open on the tree, and the end was taken as when 80% of the flowers were in the fading phase. The level of blooming was marked as 1 (no blooming) up to 5 (abundant blooming). The yield was measured per every trunk, and the weight was calculated by dividing yield by the number of fruit. The dimensions of the fruit and thickness of the peel were measured by subler and the separated peel was marked with 1 (difficult separating) up to 5 (easy separating).

RESULTS AND DISCUSSION

Vegetative growth of thickness of the trunk was determined by measuring the diameter of the trunk at 15 cm from the branches during the period from February to March. Dimensions of the diameter of the trunk were recalculated based on the surface of the cross section and are shown in Table 1.

Table 1. Vegetative growth of mandarin clementine trunk thickness in mm² for the period 2008-2011

No	Variety	Vegetative growth in mm ²				Total growth in mm ²
		2008	2009	2010	2011	
1.	Clementine No 63	1.196	2.264	3.399	4.186	2.990
2.	Clementine No 70	1.606	3.548	5.014	7.578	5.972
3.	Clementine No 92	1.349	3.065	3.867	5.653	4.304
4.	Fairchild No 30	1.286	2.468	3.465	4.882	3.596
Average		1.359	2.836	3.936	5.575	4.216

Table 1 shows that the greatest growth of the trunk (secondary thickness growth) was seen in the Clementine No 70 variety, at 5.972 mm². Even in the initial year of this research, this variety also had the highest surface of trunk cross cut (1.606 mm²). Clementine No 70 belongs to rich variety, and the other three are medium rich varieties.

Vegetative growth of trunk height was measured with a ruler (metre) at the same time that the increase in trunk diameter was measured. The greatest growth and height of trunk was again seen for Clementine No 70 (height 270 cm, and growth in three years time of the research 79 cm), again classifying it as a richer variety compared to the other three. These results are shown in table 2.

Table 2. Vegetative growth of mandarin clementine tree height in cm for 2008-2011

No	Variety	Vegetative growth in cm				Total growth in cm
		2008	2009	2010	2011	
1.	Clementine No 63	142	180	203	210	68
2.	Clementine No 70	168	206	238	247	79
3.	Clementine No 92	157	178	203	214	57
4.	Fairchild No 30	145	176	182	194	49
Average		153	185	206	216	63

Radulović M., Plamenac M., Lazović B. (1990) examined the hardiness of these varieties for three years after they were planted and they also determined that the highest growth (tree height) occurred for Clementine No 70, and the shortest for Clementine Fairchild No 30.

Phenological observations indicated that all of the examined varieties had almost the same vegetative and blooming periods, and only Fairchild No 30 showed any difference in blooming. However, as this variety had the smallest yield compared to other three varieties, it can be concluded that our agro-ecological conditions are not suitable for this variety. These results are shown in Table 3.

Table 3. Average dates of phonophases of mandarin clementine for 2008-2011

No	Variety						Ripening	**
		*	start	end	duration	level		
1.	Clementine No 63	15.03	16.05.	4.06.	20	2.4	21.10	158
2.	Clementine No 70	14.03	16.05.	3.06.	19	2.4	19.10	156
3.	Clementine No 92	15.03	16.05.	4.06.	20	2.4	20.10	157
4.	Fairchild No 30	14.03	15.05.	4.06.	19	3.6	22.10	160
Average		14.03	16.05.	4.06.	20	2.7	20.10	158

*Starting of vegetation

**No of days blooming - ripening

Yield – The starting of ripening at the experimental plantation was in 2006 and 1990, so at the beginning of the research, the experimental trees were in their third year since their first yield. Analyses of variance with the LSD test showed no significant difference in yields between clementines No 62, No 70 and No 92, while clementine Fairchild No 30 had a significantly smaller yield. The first three years showed a rising trend in yield, and in the fourth year (2011), the yield was significantly smaller due to the influence of ecological factors (frost, wind). Plamenac M., Radulović



M., Rahović D.(1993) examined related varieties of mandarins in the Montenegrin coast, Clementine No 70 and Clementine No 92. The results of yields of examined varieties are shown in table 4.

Table 4. Average yield of mandarin clementine for the period from 2008-2011

No	Variety	Kg per tree				Yield per tree		kg/ha
		2008	2009	2010	2011	kg/tree		
						kg/tree	Total	
1.	Clementine No 63	4.8	16.4	26.7	15.3	15.8	63.2	6.573
2.	Clementine No 70	4.0	18.6	28.3	12.5	15.8	63.4	6.573
3.	Clementine No 92	4.7	21.8	19.9	18.6	16.2	65.0	6.739
4.	Fairchild No 30	8.4	19.2	13.9	9.1	12.7	50.6	5.283
Average		5.5	19.0	22.2	13.9	15.1	60.5	6.292

Variance analyses

	65.0 (3)	63.4 (2)	63.2 (1)	50.6 (4)
65.0 (3)	-	1.6	1.8	14.4 **
63.4 (2)		-	0.2	12.8**
63.2 (1)			-	12.6 **
50.6 (4)				-

LSD_{0,05}= 8.24LSD_{0,01}= 9.78

Morphometric evaluation of fruits – Morphometric measurements of fruits showed that the mandarin clementines had a slightly flattened shape, with the index of the shape about 0.84. Only the No 70 variety had a bit more flattened shape, with an index of the shape of 0.82. In accordance with the mandarin *unshiu*, which has a shape index of 0.74 to 0.72 and a bit more flattened shape of the fruit (Radulović M., Plamenac M., Stoja L., 1989; Radulović M., Popović R., Perović T., Malidžan S., 2003.). The fruits of the mandarin clementine have a more rounded shape.

Table 5. Average values of morphometrics of mandarin clementine fruit 2008-2011 year

No	Variety	Dimensions of fruit in mm			Index of shape
		height	width	total dimens.	
1.	Clementine No 63	48.3	57.3	105.6	0.84
2.	Clementine No 70	47.7	58.2	105.9	0.82
3.	Clementine No 92	49.1	58.3	107.4	0.84
4.	Fairchild No 30	46.8	55.9	102.7	0.84
	Average	48.0	57.4	105.4	0.84

Physical features of the fruits – The mass of the fruit, as the most important indicator of the physical characteristics of the fruit, was obtained by measuring and counting the fruits on all experimental trees. The other features, namely, the percentage of fleshy parts and peel, the number of slices, mark of separating peel from fleshy parts of the fruit, peel width and the number of seeds, were determined using a representative sample of 20 fruits.



Table 6 shows that the average mass of the fruit was 83.1 g, and that only Clementine No 92 had a slightly bigger fruit mass than the three other varieties.

Table 6. Average value of physical features of fruit of mandarin clementines, 2008 - 2011

No	Variety	Mass of the fruit in gr				*	**	***	****	
		Total	Flesh		Peel					
			gr	%	gr					%
1.	Clement. No 63	81.6	57.2	70.1	24.4	29.9	10.2	4.3	2.7	21,4
2.	Clement. No 70	83.4	61.7	74.0	21.7	26.0	9.9	4.5	2.2	16,1
3.	Clement. No 92	87.0	60.8	70.0	26.3	30.0	10.4	4.3	2.7	18,9
4.	Fairchild No 30	80.3	58.3	72.4	22.0	27.6	10.7	2.8	2.1	22,1
	Average for all varieties	83,1	59.5	71.6	23.6	28.4	10.3	4.0	2.4	19.6

* Number of slices, ** Separating peel, *** Peel width mm, **** Number of seeds

In the researched varieties, the percentage of peel ranged from 26 to 30%, so that an average mass of the fleshy part of the fruit was from 57.2 to 61.7 g, which means that all the varieties are quite equal based on the coarseness of the fleshy part of the fruit. All examined varieties had the same approximate number of slices on average (10.3 slices). However, when the score of separating peel from fleshy part of fruit was examined, the Fairchild No 30 appeared to have a significantly poorer peel separation from the fleshy part of the fruit (score 2.8) compared to the other three varieties (scores 4.3; 4.5; 4.3).

The fruit mass of mandarin *unshiu* is somewhat larger, ranging from 82.5 to 96.3 g (Radulović M., Slavojka M., Čizmović M. 2004; Radulović M., Slavojka M., Perović T.2005).

CONCLUSION

According to the four-year-research on four varieties of mandarin clementine growing in the conditions of the Montenegrin subtropical zone (Bjeliši, Bar), and which involved vegetative growth and increases, phenological observations, yield determinations, morphometric and physiological characteristics of the fruits, the following conclusions can be made:

- The greatest increase over the surface of a transversal cut of tree and height of the tree was seen for the Clementine No 70 variety, and the smallest was seen for Clementine No 63. These results enabled us to have regular planting space between trees in future plantations.
- Phenological research showed that differences at the beginning of vegetation, initiation and duration of blooming, ripening and the number of days from blooming to ripening in the examined varieties are small and so they cannot explain the differences in yield and quality of the fruit. However, the level of blooming for the Fairchild No 30 variety would lead us to conclude that this variety has the highest yield, but the opposite is observed. This shows us that our agro-ecological conditions do not suit this variety and it should be excluded from further research.
- Analyses of variance and LSD tests showed us clearly that the Fairchild No 30 variety has significantly lower yields compared to the other varieties, and between the other varieties there are no significant differences in yields. This indicator again shows that Fairchild No 30 is not appropriate for our agro-ecological conditions. In terms of yield, all three other varieties are equivalent.
- The shape index from 0.82 to 0.84 show that all four examined varieties are slightly flattened and show practically no differences
- The fruit mass is the biggest for Clementine No 92 (an average of 87 g) and the other varieties have an average fruit mass of 80 to 83 g. All varieties have slightly bigger fruit masses, considering that we are talking about young trees, in their beginning years of yield.
- The average number of slices from 0.3 (9.9 to 10.7) in the examined varieties is standard for mandarin clementine.

- All examined varieties have peel widths between 2 and 3 mm, which is suitable for the standard of mandarin clementine. Nevertheless, Clementine No 92 and No 63 have slightly bigger peel widths (2.7 mm).
- Peeling of all three examined varieties, Clementine No 63, No 70 and No 92. was easy, because their scores were from 4.0 to 4.5. However, the Fairchild No 30 variety has a significantly worse separation of peel from fleshy part (score 2.7), which confirms that this variety is not suitable for planting in our region.
- The average number of seeds in all examined varieties is about 20, ranging from 16 to 22.

According to the four-year-research of the four varieties of mandarin clementine in the agro-ecological conditions of the Montenegrin subtropical zone (Bjeliši, Bar), it can be concluded that varieties Clementine No 63, No 70 and No 92 have similar agro-biological features which make them suitable for planting on the Montenegrin coast, whereas Clementine Fairchild No 30 has no features that would encourage its planting in our region.

REFERENCES

1. Radulović M. (1987) - Uticaj zimskog mraza na izmrzavanje nekih sorti pomorandže i mandarine klementine na području Ulcinja. *Jugoslovensko voćarstvo*, vol.21, br.80, str.49-53.
2. Radulović M., Plamenac M. (1988) - Uticaj mraza na prezimljavanje citrusa u ulcinjskom polju. *Zbornik radova Poljoprivrednog instituta*, str.163-170., Titograd
3. Radulović Mirjana, Radulović M. (1988) - Kontrola plodnosti zemljišta u zasadima citrusa okoline Bara. *Poljoprivreda i šumarstvo*, vol.XXXIV br.4., str. 115-122. Titograd
4. Radulović M., Plamenac M., Stoja Ljutica. (1989) - Usporedna proučavanja pomološko-tehnoloških osobina 14 selekcija mandarine unšiu cv. Owari. *Poljoprivreda i šumarstvo*, vol.XXXV br.3-4., str. 61-72. Titograd.
5. Radulović M., Plamenac M Biljana Lazović., (1990) - Ispitivanje bujnosti introdukovanih sorti mandarine unšiu, mandarine klementine i pomorandži. *Poljoprivreda i šumarstvo*, vol. XXXVI br.3-4., str. 309-314. Titograd
6. Plamenac M., Radulović M., Rahović D., (1993) - Novi jugoslovenski sortiment Citrusa (agruma). *Jugoslovensko voćarstvo*, vol.27., br.103-104., str.131-136. Čačak
7. Radulović M. (1998) - Perspektive proizvodnje citrusa u suptropskoj zoni Crne Gore. *Poljoprivreda i šumarstvo*, Vol.44 broj.3-4, str.83-91. Podgorica
8. Radulović M. (2002) – Uticaj podloge na fenološke osobine i prinos agruma, *Jugoslovensko voćarstvo*, Vol. 36, bnr.137-138, str.27- 35. Čačak

9. Radulović M., Popović R., Perović Tatjana, Malidžan Slavojka (2003) – Study of some pomological characteristics of the introduced mandarins cultivars, First symposium on horticulture, 16-20.10.2002. Symposium proceedings, str.568-572. Ohrid –Makedonija
10. Radulović M., Slavojka Malidžan, Čizmović M. (2004) – Proučavanje agrobioloških osobina ranozrelih genotipova mandarine unšiu cvc. Kawano Wase.Poljoprivreda i šumarstvo, Vol. 50, 1-2, 63-71. Podgorica
11. Radulović M., Slavojka Malidžan, Tatjana Perović (2005): Važnije pomološke karakteristike mandarine unšiu (Citrus unshiu Marc.), Voćarstvo, Vol.39.,br152, str.387-394 Čačak
12. Nikolić M., Radulović M. (2010): Suptropske i tropske voćke. Grafika Jureš Čačak, str.1-285.
13. Spina P., Martino E. (1991): Gli Agrumi, Edagricole, 1-382. Bologna, Italija
14. Vacante V., Calabrese F. (2009): CITRUS, Trattato di agrumicoltura, Edagricole, Milano, Italija

Momčilo RADULović, Stoja LJUTICA, Slavojka MALIDŽAN

**BIOLOŠKO – POMOLOŠKE OSOBINE MANDARINE KLEMENTINE
U USLOVIMA CRNOGORSKE SUPOTROPSKE ZONE**

SAŽETAK

U radu su prikazani četvorogodišnji rezultati (2008-2011) ispitivanja četiri sorte mandarine klementine: Clementina No 63, Clementina No 70, Clementina No 92 i klementina Fairchild No 30 u agroekološkim uslovima crnogorske supotropske zone. Ogledni zasad je podignut 2004 godine na gazdinstvu Mećikukića u Bjelišima kod Bara. Na oglednim stablima (po 12 od svake sorte) vršena su izučavanja morfologije, fenologije, rodnosti, morfometrije i fizičkih osobina ploda. Na osnovu rezultata ispitivanja ustanovljeno je da je prosječna rodnost, u fazi uzlazne rodnosti kod mladih stabala, od 5.283 kg do 6.739 kg po ha, a da masa ploda varira od 81,6 do 87,0 grama. Tri sorte klementine: No 63, No70 i No 92 se mogu na osnovu rezultata ispitivanja preporučiti za gajenje u supotropskoj zoni Crne Gore, dok klementina Fairchild No 30 ne odgovara za gajenje u ovoj zoni.

Ključne riječi: mandarina, klementina, morfologija, fenologija, rodnost, masa ploda.