

SELECTION OF RED RASPBERRY GENOTYPES  
(*Rubus idaeus* L.)

**Milica Fotirić,<sup>1</sup> M. Nikolić,<sup>1</sup> Jasminka Milivojević<sup>1</sup>  
and D. Nikolić<sup>1</sup>**

**Abstract:** Pomological properties of seedlings obtained by open pollination of Meeker's yellow clone were investigated. From over a 100 seedlings obtained from this progeny, 16 genotypes with red fruits were selected on the Experimental Station »Radmilovac« that belongs to the Faculty of Agriculture in Belgrade. Dunnett-test was used for single testing of physical and chemical traits of raspberry genotypes. It was found that majority of selected genotypes were in the rank with the standard cultivar Meeker, so the final selection of raspberry genotypes was based on organoleptic characteristics. From 16 examined genotypes nine were selected (I/3/2P, I/6/2, I/8/2, II/2/2P, II/3/4P, II/5/3P, II/8/2, II/8/2P and II/PP/2) for further investigation.

**Key words:** raspberry, selection, genotype, Meeker.

### Introduction

Raspberry production in Serbia has an important place in total fruit production which makes our country one of the greatest raspberry producers in the world (Nikolić *et al.*, 2008). However, this production has specific demands that regard to sort list innovation and breaking up with monotony of Willamette production, which is predominant cultivar in raspberry commercial plantings in Serbia. It is possible to accomplish it with continual work on introduction and creating new raspberry cultivars, that will, in its

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<sup>1</sup> Milica Fotirić, MSc, Mihailo Nikolić, PhD, Jasminka Milivojević, MSc, Dragan Nikolić, PhD, Faculty of Agriculture, 11081 Belgrade – Zemun, Nemanjina 6, Serbia.

genetic base, include all producers, processors, and consumers demands (Stanisavljević *et al.*, 2004).

Raspberry breeding programs are attracting great attention in the world (Finn and Knight, 2002). Universal objectives include good fruit quality, fruit firmness, high yields, extension of the fruiting season, suitability for the fresh and processing market as well as mechanical harvesting (Milutinović *et al.*, 2002; Knight, 2002). Adaptation to different environmental conditions and resistance or tolerance to pests and diseases are also necessary for successful raspberry production (Jennings and Brennan, 2002; Atíla and Ağaoğlu, 2006).

Development of a new raspberry cultivar in the breeding program requires several screening steps, and the entire process can take up to ten years or more before new cultivar is released for nursery propagation and sales (Sjulin *et al.*, 1984).

The main goal of this study was investigation of pomological properties of seedlings obtained by open pollination of Meeker yellow raspberry clone in order to select genotypes that will overcome its parent in morphological, chemical and organoleptic characteristics.

### **Material and Methods**

Fruits of raspberry Meeker yellow clone were taken fully ripen in 2003. Seeds were cleaned, dried, and placed in the paper bags. Stratification was done in natural conditions, in pots with peat, at the end of autumn in 2003. First seedlings appeared in May 2004. Then, seedlings were replanted in containers, with dimensions 7 x 7cm, and grow in the screen house. Till the end of vegetation, majority of them reached the height of 50cm or more. Seedlings planting were done in the spring of 2005 on the Experimental Station »Radmilovac« of the Faculty of Agriculture in Belgrade. Over 100 seedlings were planted at distance of 3 x 0.5m. In preliminary selection 16 genotypes with red fruits were determined and compared with the standard cultivar Meeker.

Morphological properties (fruit weight, fruit length, fruit width and number of drupelets per fruit), chemical fruit properties (content of soluble solids, total sugars, inverted sugars, and total acids) were investigated. Organoleptic assessments of fruit quality, fruit abscission and transportability in selected seedlings were studied according to UPOV (2003) guidelines for raspberry. Investigation was done on sample of 30

fruits in three replications with 10 fruits. Significance of differences between selected genotypes was determined by analysis of variance, and individual testing was done by Dunnett-test for 0.05 and 0.01 probabilities.

### Results and Discussion

According to results of morphological fruit characteristics showed in Table 1, it can be concluded that average fruit weight varied from 2.70g (II/8/2) up to 3.82g (II/3/4P). By testing differences between selected genotypes, considering standard cultivar `Meeker` (3.56g), four examined genotypes had higher values for this property. Obtained results were much higher than those measured by Eydurán and Ağaoğlu (2006), but were lower than obtained results of Cahn *et al.* (1992) who examined a large number of raspberry selections in OR-US breeding program achieving fruit weight from 2.9g to 6.0g.

Tab. 1. - Mean values of physical fruit properties in selected raspberry genotypes

Genotype	Fruit weight (g)			Fruit width (mm)			Fruit length (mm)			Number of drupelets per fruit		
	2007	2008	$\bar{X}$	2007	2008	$\bar{X}$	2007	2008	$\bar{X}$	2007	2008	$\bar{X}$
I/3/2P	4.35	3.09	3.72	19.70	17.43	18.56	20.68	18.16	19.42	93.50	94.67	94.08
I/4/4	3.39	2.48	2.94	18.08	16.58	17.33	19.11	17.22	18.16	81.00	100.67	90.83
I/6/2	3.58	3.35	3.47	19.98	19.06	19.52	19.38	19.02	19.20	105.17	117.17	111.17
I/7/3	3.47	3.08	3.28	18.87	18.31	18.59	18.66	18.02	18.34	69.83	81.50	75.67
I/8/2	3.63	3.03	3.33	17.99	18.48	18.23	20.07	17.80	18.93	88.00	90.67	89.33
I/9/P	2.84	2.98	2.91	17.65	18.05	17.85	17.81	17.28	17.55	96.00	76.50	86.25
II/2/2P	3.78	2.75	3.27	18.89	17.04	17.97	19.98	16.52	18.25	108.17	82.83	95.50
II/3/4P	4.19	3.45	3.82	19.60	18.72	19.16	21.77	20.78	21.27	89.00	123.50	106.25
II/4/3	3.11	2.65	2.88	18.13	16.91	17.52	18.27	16.86	17.57	92.33	84.17	88.25
II/4/5	3.29	2.82	3.06	17.68	16.88	17.28	18.75	17.16	17.96	85.33	92.83	89.08
II/5/4	3.58	2.47	3.03	18.16	16.40	17.28	20.38	15.45	17.92	83.33	69.83	76.58
II/5/3P	4.42	3.05	3.73	19.65	18.02	18.84	20.36	17.24	18.80	122.50	98.67	110.58
II/6/4	3.50	2.53	3.02	18.22	17.14	17.68	19.17	17.67	18.42	88.67	85.50	87.08
II/8/2	2.60	2.80	2.70	17.32	18.14	17.73	16.29	17.44	16.87	80.33	86.67	83.50
II/8/2P	3.95	3.22	3.58	19.90	18.86	19.38	19.88	18.88	19.38	120.50	128.00	124.25
II/PP/2	3.16	3.11	3.14	17.42	17.75	17.59	19.82	18.22	19.02	84.17	81.67	82.92
Meeker	3.55	3.57	3.56	17.99	19.01	18.50	20.84	19.49	20.16	92.50	122.00	107.25

Dunnett's test    **0.05**    0.484                    1.433                    1.493                    18.307  
                          **0.01**    0.608                    1.803                    1.878                    23.031

Since berry size affects acceptance and marketability of fresh raspberry fruits, fruit dimensions (length and width) were measured in this study. The highest value of fruit width, averagely for both years of investigation, had genotype I/6/2 (19.52mm) and the lowest genotypes II/4/5 and II/5/4

(17.28mm). Fruit length varied from 16.87mm (II/8/2) up to 21.27mm (II/3/4P). Concerning the standard cultivar Meeker, six genotypes expressed higher values of fruit width and only one higher value of fruit length.

Number of drupelets per fruit, as an important parameter of the fruit quality was analyzed in this study. Higher values for this characteristic than standard cultivar (107.25), had three examined genotypes, which mostly had higher fruit weight. The highest number of drupelets per fruit had genotype II/8/2P (124.25).

With regard to morphological fruit characteristics, analysis of variance showed very significant differences between examined genotypes, years of investigation and interaction genotype x year. Considering number of drupelets per fruit no significant differences were determined between years of investigation.

Important chemical parameters of examined genotypes are shown in Table 2. The highest soluble solids content was recorded in genotype II/8/2 (12.80%), and the lowest in genotypes I/4/4 and II/5/4 (9.95%). Comparing with standard cultivar 'Meeker' (10.05%), 14 examined genotypes expressed higher values for this property. Cahn *et al.* (1992) obtained similar values of total soluble solids in OR-US breeding program. Genotype (II/4/5) that had the highest total sugar content had also the highest inverted sugar content (9.61%, 8.69%, respectively).

Tab. 2. - Mean values of chemical fruit properties in selected raspberry genotypes

Genotype	Soluble solids (%)			Total acids (%)			Total sugars (%)			Inverted sugars (%)		
	2007	2008	$\bar{X}$	2007	2008	$\bar{X}$	2007	2008	$\bar{X}$	2007	2008	$\bar{X}$
I/3/2P	11.9	12.7	12.30	0.58	0.51	0.55	8.02	8.15	8.09	7.25	7.06	7.16
I/4/4	9.2	10.7	9.95	0.72	0.54	0.63	6.96	7.22	7.09	6.00	6.35	6.18
I/6/2	10.7	12.3	11.50	0.75	0.54	0.65	8.76	8.54	8.65	7.66	7.30	7.48
I/7/3	10.6	11.6	11.10	1.63	0.64	1.14	9.88	8.23	9.06	8.98	7.25	8.12
I/8/2	9.7	11.2	10.45	0.88	0.67	0.78	6.08	7.78	6.93	5.18	6.60	5.89
I/9/P	8.3	12.2	10.25	1.02	0.54	0.78	5.38	9.27	7.33	4.52	8.10	6.31
II/2/2P	12.3	11.9	12.10	0.59	0.54	0.57	7.85	7.48	7.67	6.47	6.22	6.35
II/3/4P	10.5	9.7	10.10	1.47	0.43	0.95	6.36	6.88	6.62	5.52	5.56	5.54
II/4/3	10.7	14.1	12.40	1.02	0.80	0.91	7.18	8.97	8.08	6.56	8.13	7.35
II/4/5	12.9	12.4	12.65	0.68	0.64	0.66	9.76	9.45	9.61	8.78	8.60	8.69
II/5/4	10.0	9.9	9.95	0.80	0.56	0.68	6.34	8.13	7.24	5.30	7.22	6.26
II/5/3P	10.4	11.6	11.00	1.13	0.86	1.00	7.62	8.05	7.84	6.70	6.96	6.83
II/6/4	9.76	10.9	10.33	0.58	0.51	0.55	7.95	8.13	8.04	7.01	7.09	7.05
II/8/2	14.4	11.2	12.80	1.21	0.67	0.94	9.16	8.35	8.76	8.18	7.65	7.92
II/8/2P	10.2	11.3	10.75	0.99	0.62	0.81	8.16	7.28	7.72	7.36	6.37	6.87
II/PP/2	11.1	10.6	10.85	1.31	0.62	0.97	7.58	7.11	7.35	6.57	6.49	6.53
Meeker	10.8	9.3	10.05	1.66	0.70	1.18	7.60	7.59	7.60	6.78	6.54	6.66

Values of total acids varied from 0.55% (I/3/2P and II/6/4) to 1.14% (I/7/3), which means that examined genotypes had lower acids than standard cultivar.

Considering chemical fruit properties, among the studied genotypes and years of investigation, analysis of variance did not establish significant differences. Only total acids showed very significant differences between studied years.

With single testing of genotypes for physical and chemical traits with Dunnett-test, it was shown that majority of selected genotypes were in rank with the standard cultivar Meeker, so the final selection of raspberry genotypes was based on organoleptic characteristics.

Organoleptic evaluation of the fruit quality, obtained by sensory test (methods of positive points) is presented in Table 3. This method was used to evaluate attractiveness and fruit taste (maximal 6 points each), and flavour and fruit firmness (maximal 4 points each). Total organoleptic mark was presented as the sum for all four investigated parameters, which can achieve maximal 20 points.

Tab. 3. - Mean values of organoleptic evaluation of fruit quality in selected raspberry genotypes

Genotype	Taste (1-6)	Attractiveness (1-6)	Aroma (1-4)	Firmness (1-4)	Total mark	Berry abscission* (3-5-7)	Transportability* (3-5-7)
I/3/2P	5.50	6.00	4.00	3.00	18.50	5	5
I/4/4	5.50	4.50	3.50	3.25	16.75	5	5
I/6/2	4.25	4.00	3.50	4.00	15.75	5	5
I/7/3	5.50	5.00	4.00	3.50	18.00	5	7
I/8/2	4.25	4.25	3.50	3.00	15.00	5	5
I/9/P	5.50	5.00	3.50	3.50	17.50	5	7
II/2/2P	4.75	4.50	3.25	4.00	16.50	5	7
II/3/4P	4.75	5.50	3.50	4.00	17.75	5	7
II/4/3	4.75	5.00	3.50	3.00	16.25	5	5
II/4/5	4.00	4.75	3.25	2.50	14.50	5	5
II/5/4	4.00	4.75	3.75	3.25	15.75	5	3
II/5/3P	4.50	6.00	3.50	3.00	17.00	5	5
II/6/4	5.25	4.00	3.50	3.50	16.25	5	5
II/8/2	5.75	6.00	4.00	3.75	19.50	5	5
II/8/2P	4.50	5.50	3.75	3.50	17.25	5	5
II/PP/2	5.00	4.50	3.50	4.00	17.00	5	7
Meeker	4.50	5.50	3.00	3.50	16.50	5	5

\* (3 – low; 5 – moderate; 7- high)

The highest total mark had genotype II/8/2 (19.5 points) and the lowest one genotype II/4/5 (14.5 points), and in comparison with standard cultivar Meeker, nine genotypes had higher values.

Considering the fact that the measuring berry abscission by hand picking is very subjective approach, the results may not be an accurate indication of a seedling's possible behavior when harvested by machine (Mason, 1976). In accordance to it, our genotypes showed quite good marks. With regard to transportability, five genotypes had very good mark for this trait (7), while only one had the lowest mark (3).

### Conclusion

Based on obtained results it can be concluded that majority of selected genotypes were in the rank with the standard cultivar Meeker, so the final selection of raspberry genotypes was done according to organoleptic characteristics.

Generally, among studied red raspberry genotypes nine of them (I/3/2P, I/6/2, I/8/2, II/2/2P, II/3/4P, II/5/3P, II/8/2, II/8/2P and II/PP/2) were selected as promising ones for further investigation.

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SELEKCIJA GENOTIPOVA MALINE CRVENE BOJE  
PLODA (*Rubus idaeus* L.)

**Fotirić Milica,<sup>1</sup> Nikolić M.,<sup>1</sup> Milivojević Jasminka<sup>1</sup> i Nikolić D.<sup>1</sup>**

Rezime

U radu su ispitivane pomološke osobine sejanaca dobijenih slobodnom oplodnjom žutog klona sorte Miker. Od preko 100 odgajenih sejanaca iz ovog potomstva, na oglednom dobru "Radmilovac", Poljoprivrednog fakulteta u Beogradu, odabrano je 16 genotipova crvene boje ploda. Pojedinačnim testiranjem genotipova na morfološke osobine, pomoću Dunnett-ovog testa, pokazano je da se veliki broj izdvojenih genotipova nalazio u rangu sa standardnom sortom Miker, pa je konačna selekcija genotipova maline izvršena na osnovu organoleptičkih osobina. Od 16 ispitivanih genotipova maline izdvojeno je devet (I/3/2P, I/6/2, I/8/2, II/2/2P, II/3/4P, II/5/3P, II/8/2, II/8/2P i II/PP/2) za dalje ispitivanje.

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<sup>1</sup> mr Milica Fotirić, dr Mihailo Nikolić, mr Jasminka Milivojević, dr Dragan Nikolić, Poljoprivredni fakultet, Nemanjina 6, 1081 Beograd - Zemun, Srbija.