UDC 575:634.23
DOI: 10.2298/GENSR1202367L
Original scientific paper

SWEET AND SOUR CHERRY DECORATIVE FORMS

Mirjana LJUBOJEVIĆ, Vladislav OGNJANOV, Dušica BOŠNJAKOVIĆ, Goran BARAĆ, Marina OGNJANOV, Emina MLADENOVIĆ, and Jelena ČUKANOVIĆ

Department of Fruit Science, Viticulture, Horticulture and Landscape Architecture
Faculty of Agriculture, University of Novi Sad

Ljubojević M., V. Ognjanov, D. Bošnjaković, G. Barać, M. Ognjanov, E. Mladenović, and J. Čukanović (2012): *Sweet and sour cherry decorative forms.* - Genetika, Vol 44, No. 2, 367 - 375.

Biodiversity of natural populations, biodiversity located on farm and the introduced cultivars and selections are a rich source of genetic variability in sour and sweet cherries, but they have never been bread with the aim of creating decorative varieties. Low vigour – dwarfing and upright – sour cherry genotypes, NS 1/16 KK and NS 1/24 KK, were selected from natural population of Fruška Gora and private arboretum, respectively. Sweet cherry selections NS 6/15 K and RŠ 8/27 were part of *on farm* conservation of genetic resources. Furthermore, reduction in vigour was achieved by defining specific combining abilities as a result of rootstock/scion interaction. The outcome of this study is unique columnar

Corresponding author: Mirjana Ljubojević, Department of Fruit Science, Viticulture, Horticulture and Landscape Architecture, Novi Sad. Dositej Obradović sq. 8., 21000 Novi Sad. Email: ikrasevm@polj.uns.ac.rs

and dwarf forms that integrate specific genetic potential of varieties and selections, their interaction with rootstocks and traditional horticultural skills. Collected biodiversity is another confirmation that the Balkan peninsula is one of the most valuable secondary centres of genetic diversity and inexhaustible gene pool for breeding both, varieties and vegetative rootstocks.

Key words: decorative forms, *Prunus sp.*, selection, sweet and sour cherry

INTRODUCTION

Aside from the role of sweet and sour cherry as the most profitable fruit species in commercial production, their decorative use (POOLER, 2007), as well as their health benefits are becoming increasingly important (PRVULOVIĆ *et al*., 2011). Sweet and sour fresh fruits are considered as natural source of antioxidants, including polyphenols and anthocyanins (SERRANO *et al*., 2005; MARCASON, 2007). In amateur orchards and gardens where fruit species provide fresh produce that meets family needs throughout the year, cherries occupy a prominent place (STOECKLEIN, 2001a; 2001b). In the gardens, cherries are planted with fruit, dendrological and flower species, but vigour and form are rarely suited for the limited space of a horticultural environment (FREEMAN, 2010, OGNJANOV, 2011). The forms that can potentially have decorative purpose are dwarf, columnar, "*pendula*" and horisontal and upright cordons. Cultivation of fruit trees in containers on balconies, halls and alleys have their horticultural significance in landscape architecture. BOŠNJAKOVIĆ *et al*. (2012) listed numerous species, including several from genus *Prunus*, which are typical for Balkan Peninsula, a secondary center of wild fruit species genetic diversity. The native flora of Serbia, as a part of Balkan Peninsula is rich in the genetic diversity of dwarf sour cherry that can be used for both, decorative purposes and cherry rootstocks breeding (OGNJANOV *et al*., 2012).

The aim of this paper is a morphological and reproductive characterization of cherry cultivars and selections, resulting in dwarf, columnar and ornamental forms suitable for forming decorative fruit-bearing trees. The possibility of reducing vigour, as a result of rootstock/scion interaction, also was studied. The ultimate goal of the study is design of varieties suitable for planting in gardens, which would require a small growth space, and would enhance and enrich landscape by their decorative form and fruit quality.

MATERIALS AND METHODS

Work on developing cherry genotypes for decorative purposes required the complementary field experiments and laboratory research. Selection work has included the inventory and collection of genotypes from natural populations, private collections and productive orchards using positive individual selection, as a part of search for unique and rare traits significant for the realization of the set of breeding objectives. Selection of "oblačinska" sour cherry is a result of the positive clonal

selection applied to positive mutants in the centre of origin and the areas of intensive cultivation.

Morphological characterization was made on the basis of international IBPGR (SCHMIDT *et al.*, 1985) and UPOV descriptors (UPOV, 2006a; 2006b). Measurements of plant, one-year old twigs and leafs vegetative characteristics were conducted in July, after completion of intensive spring growth period.

Morphological characterization of annual plants in two consecutive years was done on specimens produced by bud grafting in August 2008. No green operations were carried out during the growing season, in order to preserve the natural characteristics of growth and plant development. The data were processed by STATISTICA 09 software application (StatSoft, Inc., Tulsa, OK, USA).

RESULTS AND DISCUSSION

Broad intraspecific genetic variability was determined through morphometric characterization of collected material within *Prunus avium* and *Prunus cerasus* germplasm.

SCHUSTER (2009) stated that cherry trees with dwarf, compact, columnar and weeping ("*pendula*", dropping) habit occur occasionally in populations of sour cherry seedlings, and that columnar growth habit in sour cherry have not been reported in literature previously. In our study selections from natural populations distinguished forms with dwarfing habitat, with the crown vigour reduction of less than 50%, compared to standard varieties: sour cherries - NS 1/16 K, NS 1/24 KK, and sweet cherries - RŠ 8/27 and NS 6/15 K. Compared to Sara and Victoria, varieties with similar vigour, introduced from Germany, our selections of sweet cherry NS 6/15 K and sour cherry NS 1/24 KK are characterized by crown with much more acute branching angle, similar to sour cherry clone Pi-Sa 12,165 that SCHUSTER (2009) selected and classified as columnar. Studying diverse gene pool of "oblačinska" sour cherry (*Prunus cerasus*) and european ground cheery (*Prunus fruticosa*), OGNJANOV *et al.* (2012) reported that it was possible to select dwarf and medium-sized genotypes, as well as flowering and fruit-bearing genotypes with various habits (upright, spreading, dropping). MA *et al.* (2009) emphasized that ornamental flowering cherries (*Prunus* species) primarly *Prunus serrulata* are popular for commercial and residental landscapes, but absence of edible fruits in these species leads to search for flowering and fruit-bearing genotypes with fruits for fresh consumption. As reported by OGNJANOV *et al.* (2011) varieties with dense generative elements along the two-year old branches are high productive and deserve a significant place in amateur and productive cherry orchards. Through studies of vegetative and generative characteristics of standard cultivars and selections, we identified genotypes with high yielding capacity, dense and evenly distributed generative and vegetative elements along the two-year and older branches, with a pyramid-like crown and medium vigour. These are the characteristics of NS 1/24 KK selection and sweet cherry cultivars Vera and Celeste (Table 1).

Table 1. Morfometric and reproductive characteristics of studied cherry germplasm

Genotype	Vigour	Branching	Thickness (mm)	Length of internodes (cm)	Relationship between leaf length and width	Leaf shape	Fruit weight (g)
SWEET CHERRY							
Sara	5	3	8.32	3.8	1.89	2	4.76
Viktoria	5	3	10.05	2.64	1.70	2	4.34
Summit	7	5	6.04	3.22	1.95	2	8.50
Vera	5	3	3.89	2.89	1.85	2	8.06
Śandor	9	5	4.26	3.24	2.51	1	7.23
Celeste	7	3	7.5	2.38	2.10	1	9.07
NS 6/15 K	5	5	7.38	2.88	2.39	2	5,99
RŠ 8/27	3	5	3.79	4.17	2.20	1	6,50
SOUR CHERRY							
Maynard	5	3	4.68	1.16	2.06	2	4.10
Lara	3	5	6.53	2.00	2.37	1	5.42
Erdi Botermo	7	7	6.64	3.76	1.93	2	5.19
NS 1/16 KK	3	3	4.55	3.50	3.04	1	5.31
NS 1/24 KK	5	3	6.40	2.36	1.74	2	6.84
St 1	5	5	2.74	1.23	1.86	2	2.05
D1	3	5	5.02	1.66	1.83	2	3.04
D4	5	7	4.85	2.70	1.97	2	2.85
D7	5	7	4.07	4.50	1.87	2	3.25

Vigour: 3 – week, 5 – medium, 7 – stong; Branching: 3 – upright, 5 – spreading, 7 – droping;
Leaf shape: 1 – narow eliptic, 2 - eliptic.

Vegetative and reproductive characteristics of decorative forms were analyzed by Multivariate – Cluster Analysis. Phenotypic distance of investigated cultivars and selections, based on 22 investigated characteristics, divided the seventeen genotypes into two groups at the highest hierarchical level (Fig. 1). The first group consists of dwarf, columnar and decorative varieties and selections with three subgroups. The first consists of upright forms Sarah, Vera, Victoria, Maynard, and two selections of narrow pyramidal, low vigour form – sweet cherry NS 6/15 K

and sour cherry NS 1/24 KK. Closely related are the two genotypes – dwarf sweet cherry RŠ 8/27 and sour cherry NS 1/16 KK. The low vigour sour cherry genotypes (St1 and D1) and decorative *pendula* types (D4, D7 and Erdi Botermo) form the third subgroup. The second group of genotypes, separated by cluster analysis, presents the standard sweet cherry varieties – Summit, Celeste, Sandor – and sour cherry Lara, characterized by medium vigour and a very acute branching angle. Based on the results of cluster analysis it can be seen that main influence on grouping of investigated varieties and selections had vigour and growth habit. Examining 10 important pomological and technological properties of "oblačinska" sour cherry, using hierarchical cluster analysis NIKOLIĆ *et al*. (2005) reported that the method is reliable in determination of the differences between clustered groups.

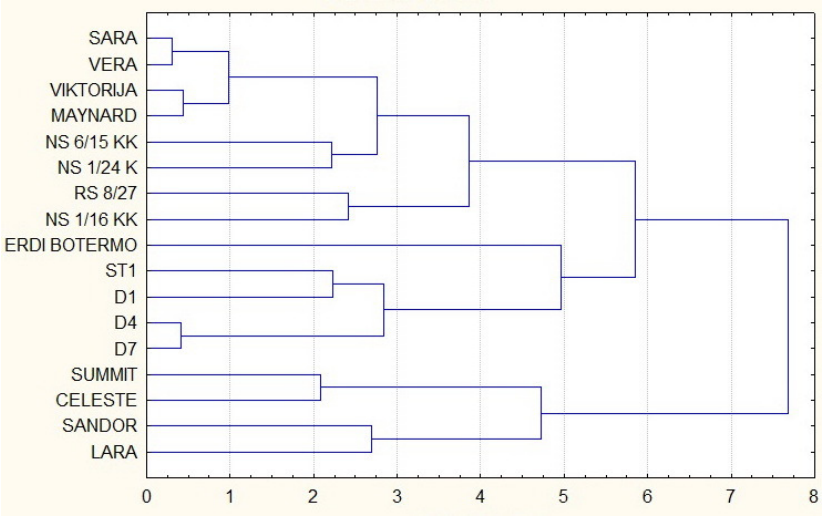

Figure 1. Dendrogram of vegetative and reproductive cherry germplasm characteristics

Study of the rootstock/scion interaction defined unique specific combining abilities of hipobiot and epibiot (Table 2). The results indicate that the interactions are multiple and are manifested in the phenology of fruit trees, growth, vigour and its proportions, as well as regularity of yield and fruit quality. Low vigour was observed at Gisela 5 and "oblačinska"sour cherry, irrespective of the grafted variety or selection. Previous results (ZORIĆ *et al*., 2012) showed that xylem anatomical characteristics of Gisela 5 are responsible for vigour and growth of grafted varieties, while it is still unknown which size-controlling patterns (anatomical, biochemical, physiological) are involved in vigour reduction by "oblačinska" sour cherry rootstock, thus trials were established in 2010 and are still ongoing. Selection NS 6/15 KK is fully incompatible with "oblačinska"sour cherry and partially incompatible with Gisela 5. Beside dwarf form obtained in combination rootstock

Gisela 5 / selection of dwarf sweet cherry NS 6/15 KK, as the achievement of the highest breeding goal for decorative purpose, variety Summit grafted on "oblačinska" sour cherry provides low vigorous trees, which give excellent fruit quality, even without intensive summer pruning.

Table 2. Specific combining abilities of hipobiot and epibiot.

Rootstock	Variety, selection	Tree height (cm)	Trunk diameter (cm)	Number of branches	Branch length (cm)
Gisela 5	Sara	148.2	20.13	2.4	70.36
	Viktoria	112.25	12.72	5	41
	Maynard	75.4	11.94	7.2	42.32
	Erdi Botermo	102.2	15.38	7.4	41.98
	NS 6/15 K	49	10.57	1	45
	NS 1/16 KK	99.4	15.36	7.2	52.16
	NS 1/24 KK	119	15.82	4.2	62.42
Oblačinska sour cherry	Sara	162.8	17.46	3	66
	Viktoria	163.3	16.01	/	/
	Maynard	91.2	13.96	7	39.75
	Erdi Botermo	161.25	16.31	5	44.3
	NS 6/15 K	/	/	/	/
	NS 1/16 KK	93.2	13.88	8	43.66
	NS 1/24 KK	/	/	/	/
Colt	Sara	163	22.39	2	90.5
	Viktoria	187.5	20.96	/	/
	Maynard	74	16.02	7	41.12
	Erdi Botermo	131	15.09	5	42.9
	NS 6/15 K	139	15.36	/	/
	NS 1/16 KK	/	/	/	/
	NS 1/24 KK	148.6	18.63	3	66.88
Prunus mahaleb	Sara	220.4	24.63	3	80.7
	Viktoria	230	21.42	8	90.2
	Maynard	108	14.48	12	53.55
	Erdi Botermo	169.4	19.62	/	/
	NS 6/15 K	135.5	16.19	/	/
	NS 1/16 KK	105	17.63	8	68.08
	NS 1/24 KK	178	22.2	/	/
Prunus avium	Sara	172	16.82	/	/
	Viktoria	168,8	20.07	/	/
	Maynard	75	10.58	/	/
	Erdi Botermo	143.3	14.49	7	38.38
	NS 6/15 K	145	15	/	/
	NS 1/16 KK	90.6	13.05	/	/
	NS 1/24 KK	144	17.89	5	76.14

CONCLUSION

This paper covers all aspects of the conservation of genetic resources: a review of ancient literature, identification of superior genotypes by selection from natural populations *in situ*, on farm, in private collections and productive orchards, characterization and clonal reproduction of the best selections and their collection *ex situ*. Genetic diversity of highest breeding value was confirmed by statistical data analysis and clustering phenotypic characteristics.

On farm conservation of genetic resources and inventory in private arboretums identified several different low vigorous genotypes with different yield and fruit quality. Low vigour cherry genotypes were selected from the natural populations and within standard varieties with similar characteristics. The results of this study proved the feasibility of creating dwarf forms, which are due to unique specific combining ability of the rootstock and the scion, as exemplified by "oblačinska" sour cherry / Summit and Gisela 5 / selection of sweet cherry NS 6/15 KK. Taking all elements into account varieties suitable for columnar forms are those with upright growth, small branching ratio, dense and evenly distributed vegetative and fruiting elements, such as sweet cherry varieties Vera and Celeste and sour cherry selection NS 1/24 KK.

ACKNOWLEDGEMENTS

This research was supported and funded by the Ministry of Education and Science of Serbia as one of the research topics in the project "Selection of sweet and sour cherry dwarfing rootstocks and development of intensive cultivation technology based on sustainable agriculture principles," evidence number TR 31038, for the period 2011-2014.

Received October 1st, 2011
Accepted May 05th, 2012

REFERENCES

BOŠNJAKOVIĆ, D., V. OGNJANOV, M. LJUBOJEVIĆ, G. BARAĆ, M. PREDOJEVIĆ, E. MLADENOVIĆ and J. ČUKANOVIĆ (2012): Biodiversity of wild fruit species of Serbia. Genetika, *44*, (1): 81 - 90.

FORREST, M. (2006): Plant Families. In: Landscape trees and shrubs: selection, use and management. CABI International, Nosworthy Way, Wallington. pp. 100-107.

FREEMAN, J. (2010): The Upper Storey. In: Create Your Own Woodland Garden. Dreamstairway,United Kingdom. pp 76-82.

MA, H., R. OLSEN, M. POOLER and M. KRAMER (2009): Evaluation of flowering cherry species, hybrids, and cultivars using simple sequence repeat markers. Journal of American Society for Horticultural Science, *134* (4): 435 – 444.

MARCASON, W. (2007): What is the latest research regarding cherries and the treatment of rheumatoid arthritis? Journal of the American Dietetic Association, *107*: 1686.

NIKOLIĆ, D., V. RAKONJAC, M. MILUTINOVIĆ, and M. FOTIRIĆ (2005): Genetic divergence of oblačinska sour cherry (*Prunus cerasus* L.) clones. Genetika, *37* (3): 191 - 198.

OGNJANOV, V. (2011): Smaragd apple. HortScience, *46* (6): 952 - 954.

OGNJANOV, V., M. LJUBOJEVIĆ, A. PEČURICA, M. ČALIĆ, E. MLADENOVIĆ and J. ČUKANOVIĆ (2011): Vegetative and reproductive characteristics of new sweet cherry cultivars. In: Proceedings of the 3rd Conference „Innovations in Fruit Production." (Milatović, D., Ed.), ISHS, Belgrade, Serbia, 153 - 163.

OGNJANOV, V., M. LJUBOJEVIĆ, J. NINIĆ-TODOROVIĆ, D. BOŠNJAKOVIĆ, G. BARAĆ, J. ČUKANOVIĆ and E. MLADENOVIĆ (2012): Morphometric diversity in dwarf sour cherry germplasm in Serbia. Journal of Horticultural Science and Biotechnology, *87* (2): 117-122.

POOLER, M.R. (2007): 'Dream Catcher' and 'First Lady' Flowering Cherry. HortScience, *42* (1): 174 - 175.

PRVULOVIĆ, D., Đ. MALENČIĆ, M. POPOVIĆ, M. LJUBOJEVIĆ and V. OGNJANOV (2011): Antioxidant properties of sweet cherries (*Prunus avium*) – role of phenolic compounds. ICABBBE - International Conference on Agricultural, Biosystems, Biotechnology, Biological Engenering, Venice, Italy. World Academy of Science, Engenering and Technology. 1149-1152.

SCHMIDT, H., J.V. CHRISTENSEN, R. WATKINS and R. SMITH (1985): Cherry descriptor list. (Schmidt, H., Christensen, J.V., Watkins, R., Smith, R, Eds.) International Board of Plant Genetic Resources (IBPGR), Rome, Italy. 18-27.

SCHUSTER, M. (2009): Sour cherries *Prunus cerasus* L. with columnar tree habit. Acta Horticulturae (ISHS), *814*: 325 - 328.

SERRANO, M., F. GUILLÉN, D. MARTÍNEZ-ROMERO, S. CASTILLO and D. VALERO (2005): Chemical constituents and antioxidant activity of sweet cherry at different ripening stages. Journal of Agricultural and Food Chemistry, *53*: 2741- 2745.

STOECKLEIN, M.C. (2001a): Deciduous Trees. In: The complete plant selection guide for landscape design. Purdue University Press, West Lafayette, Indiana. pp 66-68.

STOECKLEIN, M.C. (2001b): Deciduous Trees. In: The complete plant selection guide for landscape design. Purdue University Press, West Lafayette, Indiana, pp 293-294.

UPOV (2006a): Guidelines for the conduct of tests for distinctness, homogeneity and stability of the sweet cherry. 31 p. International Union for the Protection of New Varieties of Plants (UPOV), Geneva, Italy.

UPOV (2006b): Guidelines for the conduct of tests for distinctness, homogeneity and stability of the sour and duke cherry. 35 p. International Union for the Protection of New Varieties of Plants (UPOV), Geneva, Italy.

ZORIĆ, L., M. LJUBOJEVIĆ, LJ. MERKULOV, J. LUKOVIĆ and V. OGNJANOV (2012): Anatomical characteristics of cherry rootstocks as possible preselection tools for prediction of the tree vigor. Journal of Plant Growth Regulation. DOI: 10.1007/s00344-011-9243-7

DEKORATIVNE FORME VIŠNJE I TREŠNJE

Mirjana LJUBOJEVIĆ, Vladislav OGNJANOV, Dušica BOŠNJAKOVIĆ, Goran BARAĆ, Marina OGNJANOV, Emina MLADENOVIĆ, i Jelena ČUKANOVIĆ

Departman za voćarstvo, vinogradarstvo, hortikulturu i pejzažnu arhitekturu
Poljoprivredni fakultet, Novi Sad

Prirodne populacije i biodiverzitet, koji se nalazi na gazdinstvima i introdukovane sorte i selekcije predstavljaju bogat izvor genetičke varijabilnosti višnje i trešnje, ali one nikada nisu bile predmet selekcionog rada sa ciljem stvaranja novih sorti sa dekorativnom namenom. Selekcijom iz prirodnih populacija bilo je moguće izdvojiti slabobujne forme iako se trešnja i višnja prirodno odlikuju velikom bujnošću. Slabobujni genotip višnje NS 1/16 KK izdvojen je iz prirodne populacije u Fruškoj Gori, selekcija NS 1/24 KK iz privatnog arboretuma, a selekcija trešnje NS 6/15 K i RŠ 8/27 on farm očuvanjem genetičkih resursa. Smanjenje bujnosti višnje i trešnje postignuto je i definisanjem posebnih kombinacionih svojstava kao rezultat interakcije podloge i plemke. Rezultat ovog rada su jedinstvene patuljaste i stubaste forme, koje objedinjavaju specifičan genetički potencijal sorte i selekcije, njihove interakcije sa podlogom i tradicionalno vrtlarsko umeće. Skupljeni biodiverzitet je još jedna potvrda da je Balkansko poluostrvo jedan od najvrednijih sekundarnih centara divergentnosti sa prirodnim resursima kao neiscrpnim genofondom za oplemenjivanje kako sorti tako i vegetativnih podloga.

Primljeno 01. X. 2011.
Odobreno 05. V. 2012.