Journal of Agricultural Sciences
Vol. 60, No. 2, 2015
Pages 169-176

DOI: 10.2298/JAS1502169N
UDC: 634.8-152.7
Original scientific paper

INHERITANCE OF MATURE LEAF PROPERTIES IN GRAPEVINE PROGENY OBTAINED BY CROSSING MUSCAT HAMBURG AND VILLARD BLANC CULTIVARS

Dragan T. Nikolić*

University of Belgrade, Faculty of Agriculture,
Nemanjina 6, 11080 Belgrade-Zemun, Serbia

Abstract: Variability and inheritance mode of six properties of the mature leaf (size of blade, number of lobes, shape of teeth, general shape of petiole sinus, density of prostrate and erect hairs between veins on the lower side of blade) were analyzed in 90 seedlings of the F_1 generation from the crossing combination of Muscat Hamburg x Villard Blanc. The properties analyzed were classified according to the OIV system of classification and χ^2 test was used to determine the inheritance mode. A substantial variability of the analyzed characteristics was recorded in the hybrid progeny. Size of blade, number of lobes, shape of teeth and general shape of petiole sinus were most probably affected by a great number of genetic factors. Monogenic inheritance was determined with regard to the density of prostrate and erect hairs between veins on the lower side of blade.

Key words: grapevine, F_1 generation, mature leaf, inheritance, property.

Introduction

The available fund of *Vitis vinifera* L. cultivars, despite the extraordinary number, still does not satisfy existing economy of grapevine growing nor the contemporary needs of consumption of grape, wine and products of grape and wine (Nikolić, 2012). Thanks to the fast development of science, nowadays there are many methods that usually alone or in combination with other methods contribute to the rapid creation of new grapevine cultivars. One of the methods to increase the grapevine gene fund is hybridization. Within it, an important place is occupied by interspecies hybridization which creates cultivars that will have reduced sensitivity to biotic and abiotic stresses, beside a satisfying yield and fruit quality (Vojtovič and Najdenova 1980; Singh and Murthy, 1993; Reisch and Pratt, 1996; Lu et al., 2000; Nikolić, 2001, 2006; Nikolić et al., 2007, 2009; Gray et al., 2014).

*Corresponding author: e-mail: nikolicd@agrif.bg.ac.rs

The grapevine (*Vitis vinifera* L.) is attractive for genomic research because it is diploid and has a small genome size of 475–500 Mb relative to other plants (it is approximately four times the size of *Arabidopsis* and one sixth of the size of the corn genome) (Lodhi and Reisch, 1995; This et al., 2006), consisting of 19 chromosomes. The genotypes of grapevine cultivars are highly heterozygous and nearly all modern cultivated cultivars are hermaphroditic, self-fertile and out-cross easily. According to Milutinović (1986), when setting up the plan of crossing and selection of parental partners, the genetic structure of genotypes that are combined in some traits and the character of trait transmission to offspring must be taken into account. Cindrić (1981) states that, due to the high degree of heterozygosity of grapevine cultivars, most traits are inherited complexly so that it can be said that the genetic basis for individual properties is insufficiently known.

The properties of certain grapevine organs such as young shoot, mature leaf, flower, bunch, berry and seed are very important for the description and identification of grapevine cultivars, analysis of inheritance and selection of starting material for breeding. The number of properties to be tested depends of the needs and applied descriptors. Among the many features of mature leaf that are used for description and determination of grapevine cultivars, the following properties are often applied: size of blade, number of lobes, shape of teeth, general shape of petiole sinus, density of prostrate and erect hairs between veins on the lower side of blade.

The aim of this paper was to determine the mode of inheritance of six mentioned mature leaf properties based on comparative morphological analysis of hybrid seedlings of F_1 generation and their parents.

Material and Methods

As a material for investigation, 90 seedlings of F_1 generation from the crossing combination of Muscat Hamburg x Villard Blanc were used. At the same time, with the hybrid seedlings, to establish the mode of inheritance of the examined characteristics, their parental partners were investigated as well. All the investigations were carried out at the experimental field “Radmilovac” of the Faculty of Agriculture, University of Belgrade.

In hybrid seedlings and their parents, six mature leaf properties were examined, and their categorization was performed using a system of OIV codes, described by the IPGRI, UPOV, OIV descriptors (1997). All properties were investigated in the period from the berry set to the beginning of berry ripening. For a description, 10 leaves from the middle third of the shoot were used. Categorizing hybrid seedlings and their parents for each trait was done visually in comparison with standards. The following properties were determined: size of blade (OIV 065); number of lobes (OIV 068); shape of teeth (OIV 076); general shape of petiole sinus

(OIV 079); density of prostrate hairs between veins on the lower side of blade (OIV 084); density of erect hairs between veins on the lower side of blade (OIV 085).

Determining the mode of inheritance of investigated properties was performed using the χ^2 test. The two-way monogenic segregation ratio (3:1 and 1:1) was evaluated.

Results and Discussion

Parental partners, Muscat Hamburg and Villard Blanc had a medium size of blade. Figure 1A shows that more than half of seedlings (54.4%) obtained by crossing of these two cultivars had also a medium size of blade. Only 17.8% of seedlings had very small and 27.8% of seedlings had a small size of blade. In order to follow inheritance of this property, evaluations 1 and 3 were classified into the category of a small size of blade. The χ^2 test results show that the achieved ratio of seedlings with a medium size to seedlings with a small size of blade (49:41) does not match the theoretically expected 3:1 ratio that is valid for monogenic inheritance (Table 1). On this basis, it can be concluded that the size of blade is probably polygenically determined. Polygenic inheritance of leaf size was established and Todorov (1981) examined inbreeding progenies of the Bolgar cultivar.

By crossing Muscat Hamburg which had five lobes and Villard Blanc which had three lobes of mature leaf from 90 produced seedlings of F_1 generation, 68.9% of seedlings had five lobes and 31.1% of seedlings had three lobes of mature leaf (Figure 1B). The mode of inheritance of lobe number is shown in Table 1. The achieved ratio of seedlings with five lobes to seedlings with three lobes of mature leaf (62:28) is not considered as the ratio of 1:1, which is characteristic of monogenic inheritance. From this it follows that the expression of these trait is likely to affect a larger number of genes. The mode of inheritance of leaf lobe number was investigated by Pena (1974), who in addition to others, found that, according to the principles of Mendelian inheritance, genes that control the number of leaf lobes show epistatic reaction (Pt for five lobes, and T for three lobes).

Muscat Hamburg and Villard Blanc had a rectilinear shape of mature leaf teeth. The largest number of their offspring (85.6% of seedlings) also had a rectilinear shape of mature leaf teeth. Other seedlings (14.4%) showed a convex shape of teeth, which was not present in the parental partners (Figure 1C). If the achieved results are compared with the theoretical expected values, it can be seen from Table 1 that the shape of mature leaf teeth is probably polygenically determined. The achieved ratio of seedlings with a rectilinear shape to seedlings with a convex shape of teeth (77:13) does not match the theoretically expected 3:1 ratio that is valid for monogenic inheritance.

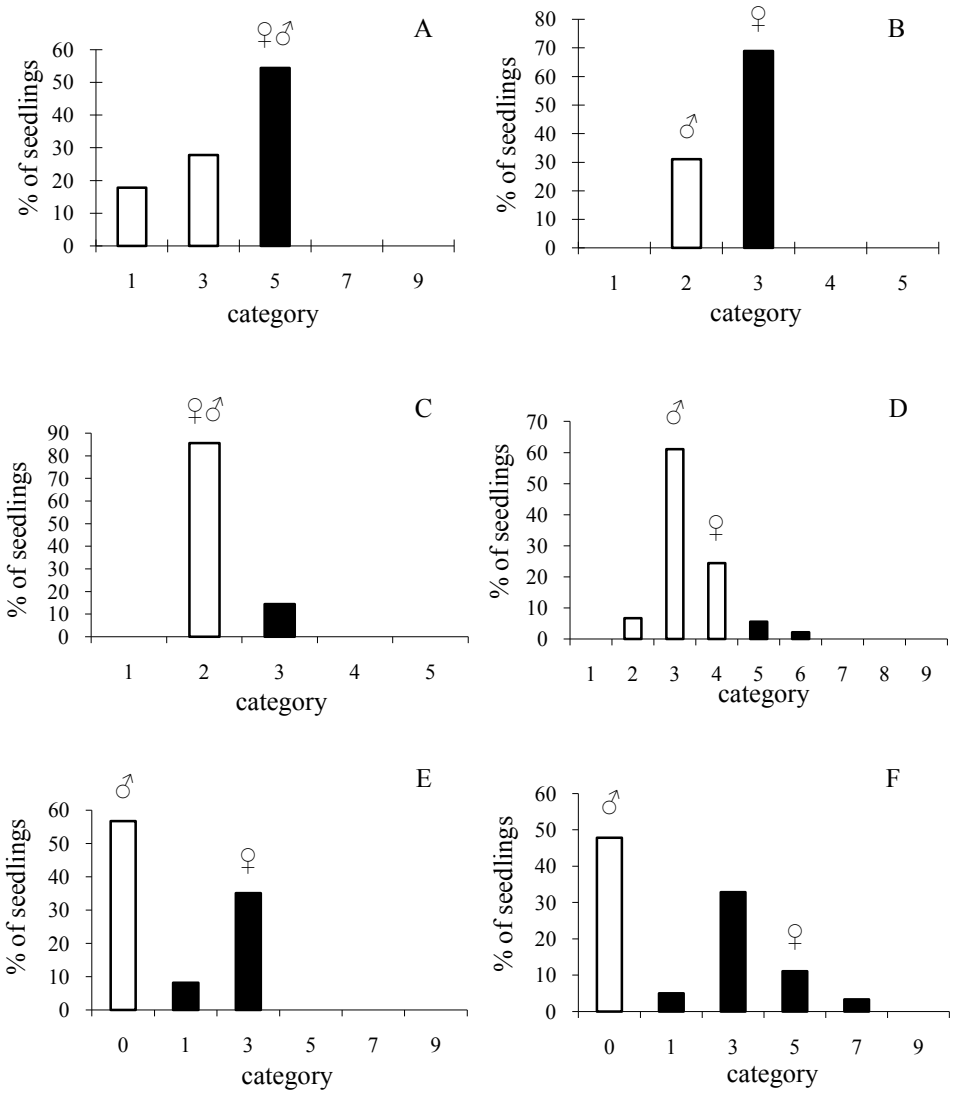

Figure 1. Distribution of frequency of mature leaf properties: A) size of blade (white-small; black-medium); B) number of lobes (white-three; black-five); C) shape of teeth (white-rectilinear; black-convex); D) general shape of petiole sinus (white-open; black-closed); E) density of prostrate hairs between veins (white-absent, black-present); F) density of erect hairs between veins (white-absent, black-present); ♀ – Muscat Hamburg; ♂ – Villard Blanc.

The general shape of petiole sinus in Muscat Hamburg was slightly open and half open in Villard Blanc. The distribution of their progeny was as follows: 6.7% of seedlings had wide open, 61.1% of seedlings had half open, 24.4% of seedlings had slightly open, 5.6% of seedlings had closed and 2.2% of seedlings had lobes slightly overlapping (Figure 1D). In order to follow inheritance of this property, evaluations 2, 3 and 4 were classified into the category of open and evaluations 5 and 6 were marked with the category of a closed general shape of petiole sinus. After connecting evaluations and creation of new categories, it can be concluded that 92.2% of seedlings had open and only 7.8% of seedlings had a closed general shape of petiole sinus. These results agree with the results obtained by Matevska (1970). In the crossing combination of Servan x Muscat Hamburg, it was determined that out of total of 36 individuals, an open general shape of petiole sinus occurred in 80.56% of seedlings. According to Matevska (1970), by crossing of cultivars that have a closed shape of petiole sinus with cultivars that have an open shape of petiole sinus, an open shape of petiole sinus is inherited as a dominant trait. The results of our study (Table 1) show that the achieved ratio of seedlings with an open shape to seedlings with a closed shape of petiole sinus (83:7) does not match the theoretically expected 3:1 ratio. On this basis, it can be concluded that the expression of this trait probably participates in a larger number of genes.

Table 1. Mode of inheritance of mature leaf properties.

Property	Phenotype ratio			χ^2	
	Category	Achieved	Expected	Value	P
Size of blade	medium: small	49:41	3:1	20.28**	<0.01
Number of lobes	five: three	62:28	1:1	12.84**	<0.01
Shape of teeth	rectilinear: convex	77:13	3:1	5.35*	<0.05
General shape of petiole sinus	open: closed	83:7	3:1	14.24**	<0.01
Density of prostrate hairs between veins	present: absent	39:51	1:1	1.60	>0.05
Density of erect hairs between veins	present: absent	47:43	1:1	0.18	>0.05

The data in Figure 1E show that in the Villard Blanc cultivar density of prostrate hairs between veins on the lower side of blade was absent, while in the Muscat Hamburg cultivar it was sparse. From 90 produced seedlings of F_1 generation, obtained by crossing of these two cultivars, density of prostrate hairs between veins on the lower side of blade in 56.7% of seedlings was absent, in 8.2%

of seedlings it was very sparse and in 35.1% of seedlings it was sparse. In order to follow inheritance of this property, evaluations 1 and 3 were classified into the category of present prostrate hairs between veins on the lower side of blade. The results in Table 1 show that the achieved ratio of seedlings with present prostrate hairs to seedlings with absent prostrate hairs between veins on the lower side of blade (39:51) can be considered as the 1:1 ratio that is valid for monogenic inheritance. Muscat Hamburg is probably heterozygous and Villard Blanc is homozygous cultivar for this property. Monogenic inheritance for the density of prostrate hairs between veins was determined by Bešlić et al. (2005).

The density of erect hairs between veins on the lower side of blade was different in the parental partners. Villard Blanc had absent and Muscat Hamburg had medium erect hairs between veins. The distribution of their progeny was as follows: 47.8% of seedlings had absent, 5.0% of seedlings had very sparse, 32.8% of seedlings had sparse, 11.1% of seedlings had medium and 3.3% of seedlings had strong density of erect hairs between veins on the lower side of blade (Figure 1F). In determining the mode of inheritance, this feature is marked as present regarding erect hairs between veins and evaluations 1, 3, 5 and 7 were classified into one common category. Based on the results shown in Table 1, it can be seen that between the achieved and theoretically expected ratio of seedlings with present to seedlings with absent hairs between veins on the lower side of blade, a slight deviation occurs, indicating that it is a monogenic mode of inheritance of this property. Accordingly, Villard Blanc is probably homozygous and Muscat Hamburg is heterozygous cultivar. Monogenic inheritance for the density of erect hairs between veins was determined by Bešlić et al. (2005). Matevska (1970) showed that in the case of the crossing of grapevine cultivars where the leaves are bare on the lower side of blade with cultivars which have erect hairs, most hybrids that have erect hairs between veins on the lower side of blade are obtained in the F_1 generation, but generally speaking, these hybrids have fewer erect hairs than their parental cultivar with erect hairs. The dominance of the leaf with erect hairs over the leaf without hairs was also determined by Ivanov and Vlčev (1975), who examined the heritability of traits in reciprocal, intervarietal crossing of grapevine.

Conclusion

In the investigated hybrid progeny obtained by crossing Muscat Hamburg and Villard Blanc cultivars, considerable variability of all studied mature leaf properties has been manifested.

Size of blade, number of lobes, shape of teeth and general shape of petiole sinus were most probably affected by a great number of genetic factors.

Monogenic inheritance was determined with regard to the density of prostrate and erect hairs between veins on the lower side of blade.

Acknowledgements

This study was supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia, Project TR 31063 and EU Commission, Project AREA, No. 316004.

References

Bešlić, Z., Todić, S., Rakonjac, V. (2005): Inheritance of some morphological traits in hybridization of grapevine cultivars Drenak crveni and Afuz-Ali. Genetika 37(2):137-144.

Cindrić, P. (1981): Oplemenjivanje vinove loze. Poljoprivredni fakultet, Novi Sad.

Gray, D.J., Li, Z.T., Dhekney, S.A. (2014): Precision breeding of grapevine (*Vitis vinifera* L.) for improved traits. Plant Science 228:3-10.

IPGRI, UPOV, OIV. (1997): Descriptors for grapevine (*Vitis* spp.). International Union for the Protection of New Varieties of Plants, Geneva, Switzerland/Office International de la Vigne et du Vin, Paris, France/International Plant Genetic Resources Institute, Rome, Italy.

Ivanov, J., Vlčev, V. (1975): Nasledstveno predavane na njakoi priznaci i svojstva pri recipročno meždusortovo krstosvane na lozata. Gradinarska i Lozarska Nauka 12(5):103-110.

Lodhi, M.A., Reisch, B.I. (1995): Nuclear DNA content of *Vitis* species, cultivars, and other genera of the *Vitaceae*. Theoretical and Applied Genetics 90:11-16.

Lu, J., Schell, L., Ramming, D.W. (2000): Interspecific hybridization between *Vitis rotundifolia* and *Vitis vinifera* and evaluation of the hybrids. Acta Horticulturae 528(2):479-486.

Matevska, N. (1970): Proučvane unasledjavaneto na njakoi priznaci pri krstosvane na desertni sortove lozi. Gradinarska i Lozarska Nauka 7(7):87-96.

Milutinović, M. (1986): Oplemenjivanje hortikulturnog bilja. Poljoprivredni fakultet, Beograd.

Nikolić, D. (2001): Nasleđivanje nekih osobina vinove loze u hibridnom potomstvu sorti Villard noir i Muskat hamburg. Journal of Scientific Agricultural Research 62(3-4):5-13.

Nikolić, D. (2006): Components of variance and heritability of resistance to important fungal diseases agents in grapevine. Journal of Agricultural Sciences 51(1):47-54.

Nikolić, D. (2012): Oplemenjivanje vinove loze. Fleš, Zemun.

Nikolić, D., Milutinović, M., Rakonjac, V. (2007): Morphological and disease resistance characteristics of table grape hybrids. Acta Horticulturae 760:415-418.

Nikolić, D., Milutinović, M., Rakonjac, V., Fotirić, M. (2009): Evaluation of resistance to low temperatures in promising interspecies grapevine hybrids. Acta Horticulturae 827:461-464.

Pena, A. (1974): Contributii la studiul ereditatii unor caractere calitative la vita de vie (*Vitis vinifera* L.-*Vitaceae*). Lucrari Stiintifice, Institutul Agronomic "Nicolae Balcescu", Horticultura 17:101-104.

Reisch, B.I., Pratt, C. (1996): Grapes. In: Janick, J., Moore, J.N. (Eds.), Fruit breeding. Volume II: Vine and small fruits crops. John Wiley and Sons, Inc., pp. 297-369.

Singh, R., Murthy, B.N.S. (1993): Improvement of grape. In: Chadha, K.L., Pareek, O.P. (Eds.), Advances in horticulture: fruit crops-Volume I. Malhotra Publishing House, New Delhi, India, pp. 349-381.

This, P., Lacombe, T., Thomas, M.R. (2006): Historical origins and genetic diversity of wine grapes. Trends in Genetics 22(9):511-519.

Todorov, I. (1981): Razpadaneto na njakoi belezi v inbredni potomstva na loza sort Bolgar. Genetika i Selekcija 14(2):119-131.

Vojtovič, K.A., Najdenova, I.N. (1980): Selekcija vinograda na kompleksnuju ustojčivost k boleznjam i filloksere. Sadovodstvo, Vinogradarstvo i Vinodelie Moldavii 8:27-30.

Received: February 10, 2015
Accepted: February 25, 2015

NASLEĐIVANJE OSOBINA RAZVIJENOG LISTA U POTOMSTVU VINOVE LOZE DOBIJENOM UKRŠTANJEM SORTI MUSKAT HAMBURG I VILLARD BLANC

Dragan T. Nikolić*

Univerzitet u Beogradu, Poljoprivredni fakultet,
Nemanjina 6, 11080 Beograd-Zemun, Srbija

R e z i m e

Varijabilnost i način nasleđivanja šest osobina razvijenog lista (veličina, broj režnjeva, oblik zubaca, oblik peteljkinog sinusa, gustina poleglih malja i gustina uspravnih malja između nerava na naličju lista) ispitivani su kod 90 sejanaca F_1 generacije iz kombinacije ukrštanja Muskat hamburg x Villard blanc. Kategorizacija proučavanih osobina izvršena je pomoću sistema šifri OIV, a određivanje načina njihovog nasleđivanja pomoću χ^2 testa. Dobijeni rezultati pokazuju da je u hibridnom potomstvu ispoljena znatna varijabilnost svih proučavanih osobina. Veličina razvijenog lista, broj režnjeva razvijenog lista, oblik zubaca razvijenog lista i oblik peteljkinog sinusa razvijenog lista najverovatnije su uslovljeni većim brojem genetičkih faktora. Za gustinu poleglih malja i gustinu uspravnih malja između nerava na naličju razvijenog lista utvrđeno je monogensko nasleđivanje.

Ključne reči: vinova loza, F_1 generacija, razvijen list, nasleđivanje, osobina.

Primljeno: 10. februara 2015.
Odobreno: 25. februara 2015.

*Autor za kontakt: e-mail: nikolicd@agrif.bg.ac.rs