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EVALUATION OF THE SUITABILITY OF SEVERAL CULTIVARS FOR ORGANIC GROWING IN THE VITICULTURAL CENTER OF MURFATLAR

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Abstract

The adaptability of the grape cultivars to the biotic and abiotic environment is one of the decisive factors for their suitability to be grown in organic culture conditions. The correct identification of highly suitable cultivars reduces the risks of important yield losses in difficult climatic years. The studies performed took into account the climatic factors evolution in the period of 2011-2013 as compared to the average values recorded for the 10-year period 1991-2010. The purpose was to identify some grape cultivars with suitable yields and genetic resistance to these changes to be grown in this region with organic viticulture technologies. Our studies show that the eco-pedo-climatic factors recorded during the last years were more favourable for the organic vine growing than in the past. Among the cultivars that proved to be suitable for the organic viticulture in Murfatlar, displaying high or moderate resistance to pests, drought and frost, are 'Cristina', 'Columna', 'Mamaia', 'Cabernet Sauvignon', 'Feteasca neagra' and 'Riesling italian'.

Key words*: organic vine growing, stress tolerance to biotic and abiotic factors, red and white cultivars*

INTRODUCTION

The industrialized agriculture with its accompanying shortcomings tends to be replaced by "organic agriculture" which, since the last decade, is starting to gain a more clear outline in our country too (Puia and Soran, 1981).

Organic viticulture has developed as a part of organic agriculture, whether you call it organic viticulture, biological or organic. The principles of organic agriculture are based on detailed know-how of production systems that maximize the local and economical resources, by integrating traditional knowledge with scientific progress. By organic agriculture as the accepted definition by the European it is understood that the culture system which aims at making and keeping productive biological systems without having to rely on products derived from chemical synthesis (Antoce et al., 2008).

Growing the most suitable cultivars with high productivity and quality traits with increased adaptability to the specific conditions of the main growing areas of the country, tolerant to biotic and abiotic stress remains the decisive factor in obtaining economic performance in the wine sector.

In general, all plant physiological processes are influenced by a number of abiotic factors: temperature, light, insolation and precipitation. The climatic potential suitability for optimal development of different plant parts can be appreciated monthly and annual by some dynamic values and strating from the growing season by various climate indicators.

Research undertaken in the recent years have allowed for a global evaluation of the oenoclimatic potential, evaluating also its suitability for organic viticulture in a specific region (Antoce et al., 2007; Carbonneau, 1994; Irimia and Patrichi, 2009; Irimia and Rotaru, 2009).

MATERIALS AND METHODS

The research took place at the Research Station for Viticulture and Oenology Murfatlar on the most popular varieties of white and red wines, recommended for the Murfatlar vineyard according to the Ministry Order 255 of 31.03.2006, evaluating their adaptability to the current climatic conditions and to the attack of various pathogens.

All works performed in the vineyard respected the technological steps specified for the organic culture system in the Regulation (EC) No 834/2007 of the Council concerning the labeling and organic production.

The growing of white wine varieties represents the main direction of production in Murfatlar wine center, but black varieties are cultivated here as well. Among the white varieties were studied: 'Chardonnay' (CH), 'Pinot gris' (PG), 'Italian Riesling' (RI), 'Sauvignon blanc' (SB) and 'Columna' (C). Among the studied varieties for the red wine 'Feteteasca neagra' (FN), 'Cabernet Sauvignon' (CS), 'Pinot noir' (PN), 'Mamaia' (M) and 'Cristina' (CR) were included. With the climate change, the black varieties started recently to enjoy better heliothermal conditions, which allowed the obtainment of quality red wines with denomination of controlled origin.

In biocenotic complexes within Murfatlar vineyard ecosystem, the damaging flora and fauna is relatively diverse and numerous, but only a few species of phytopathogens and pests can cause major economic damage, among them being found: downy mildew (*Plasmopara viticola*), powdery mildew (*Uncinula necator*) and the gray rot of grapes (*Botrytis cinerea*).

The evaluation of biotic stress resistance was performed using a standard evaluation methodology (Genres project, 1999), which consists of visual estimation of the percentage of the infected leaf surface. For each variety a logarithmic scale was used with the following graduation: 1- without symptoms, 2-high resistance, 3-medium-high resistance, 4-moderate resistance, 5-low resistance, 6-moderate sensitiveness, 7-susceptibility, 8-high susceptibility, 9-high sensitiveness.

The evaluation of the cultivar resistance to abiotic factors (drought and frost) was performed in the field, where visual changes in the general appearance of the vine stock were observed and quantified. Each change was estimated using a logarithmic scale, graduated according to the degree of damage observed: 1 - very resistant, 2 - resistant, 3 - moderately resistant, 4 - slightly resistant, 5 - sensitive, 6 - very sensitive.

Climatic data were provided by the weather station Weather Master 2000 produced by Environdata, Australia. The colected data included daily observations regarding maximum and minimum temperature, sunshine and rainfall, based on which have been calculated a range of climate indicators commonly used in viticulture: the real heliothermal index (Branas et al., 1946), the bioclimatic vine index (Constantinescu et al., 1936), the oenoclimatic suitability index (Teodorescu, 1977), the aridity index (Martonne, 1926) and rain factor, Lang (1925).

RESULTS AND DISCUSSION

The climatic factors from the studied period corresponded to years with different conditions. A general analysis of the 2011-2013 period compared with the baseline period (average of 1991-2010), reveals the presence of mild weather that did not cause damage by frost. The absolute minimum air temperature values within the range of endurance for winter buds were -12ºC in 2011 and -14ºC in 2013, while the lowest temperature of -22ºC was recorded in 2012.

Monthly average temperature during the growing season ranged from 19.8°C (2011) to 21.7°C (2013), the average of the three studied years was 20.8°C, showing an increase over the reference period by 1.8ºC. The amount of rainfall during the active growing season varied from one year to another, being more abundant in 2013 (554.4 mm) and deficient in 2011 (238.9 mm).

The number of hours of insolation has been at an average of 2349.3 hours, the lowest values being recorded both in 2011 and 2013, while the highest ones were recorded in 2012 reaching a total of 2791.2 hours (Table 1).

In accordance to the measured climatic indicators it was found that the *heliothermal index* increased to 4.03 as compared to the average of 3.50 which indicates a raise of light

and temperature resources, important for the quality of the late maturing varieties. It is considered that conditions are optimal for grapevines when the value of IH is greater than 2.6 (Sandoiu, 2001).

The bioclimatic vine index (Ibcv) expresses the interaction of temperature, light and humidity; by analyzing these resources dring the period of our study, we observed a decrease in the average of 2011-2013 as compared to the reference period, that is a decrease from 13.6 to 12.2. The specific values of Ibcv for our country vineyards ranges from 5 to 15, the lower values of the range indicating rich water resources, while the higher end values and above indicating vineyards with rich heliothermic resource or years with deficit in rainfall. The values of the oenoclimatic suitability index (IAOe) assess the climatic suitability for a region to obtain red wines, that is the favorability to synthesize anthocyanins in grapes. Its values are between 3700 and 5200. Areas with lower values than 4300 are considered suitable only for white wines, those for which the oenoclimatic suitability index is between 4300 and 4600, have a medium favorability for red wines and the area where values are over 4600, as it is also in our case, are recommended for red wines. This index places Murfatlar vineyard in an area favorable for the production of red wines.

The hydrothermal coefficient (CH) had an average value of 0.85 in the period 1991 to 2010, identical to the average of the studied years. In our country this ratio ranges between 0.7 and 1.8, aside of this range the vine cultivation being not recommended.

Martonne aridity index value recorded over time in Murfatlar wine center falls on the borderline between semi-humid and semiarid climate. This index allows to determine the degree of aridity of a region for characteristic periods (a year or a month), as an expression of a restrictive character which climatic conditions impose to certain crops.

The rain factor proposed by *Lang* is used to illustrate the sequence of rainy or arid months, taking into account the precipitation /temperature ratio, as an expression of the water inputs and outputs from the system influenced by the temperature, which is one of the main factors in evapo-transpiration processes. Its values ranges between 20 and 160, from a desert climate to a wet one. Last years trend places Murfatlar vineyard into a semi-arid climate.

Table 1. Climatic indicators calculated for Murfatlar wine center

	Multiannual average 1991-2010	2011	2012	2013	Average 2011-2013
The average monthly temperature, ºC	12.6	13.5	13.5	14.6	13.8
The average monthly temperature during the growing season, ºC	19.0	19.8	21.0	21.7	20.8
Minimum temperature, ºC	-14.6	-12.2	-22.0	-14.0	-16.1
Maximum temperature, ºC	34.6	37.0	39.8	39.5	38.8
∑ Annual real insolation, (hours)	2203	2092.3	2791.2	2164.3	2349.3
∑ Annual real insolation during the growing season (hours)	1698	1708.2	1973.1	1710.9	1797.4
∑ Annual precipitations,(mm)	513,6	326,8	450,8	727,1	501,6
∑ precipitation during the growing season, (mm)	330	238.9	296.3	554.4	363.2
The hydrothermal coefficient, CH	0.85	0.6	0.6	1.2	0.8
The heliothermal index, Ihr	3.5	3.7	4.9	4.4	4.3
The bioclimatic vine index, Ibcv	13.6	15.0	14.3	7.2	12.2
The oenoclimatic suitability index IAOe	5093	5350.8	5840	5549.2	5580
Martonne aridity index $I_{ar\text{-}DM}$	22.9	13.9	19.2	29.6	20.9
The rain factor Lang	41	24	33	50	36

The ecopedoclimatic characterization and changes observed in recent years have highlighted the favorable conditions for organic cultivation of grapevine in Murfatlar ecosystem. The cultivar assortment in Murfatlar vineyard was selected in time to better sustain the interaction of eco-climatic, ecopedological and secondary biotope factors, but even so vine varieties behave differently to the attack of the main pathogens: downy mildew, powdery mildew and gray mold (Table 2).

Table 2. The relative resistance of the studied varieties to climatic factors and disease attack

Vineyard	Variety	DR	FR	MA	FA	PC
Murfatlar	Chardonnay	4	2	7	7	7
	Pinot gris	5	5	7	7	7
	Riesling italian	4	5	6	3	6
	Sauvignon blanc	4	5	7	7	7
	Columna	3	2	6	7	6
	Cabernet Sauvignon	2	2	6	4	6
	Feteasca neagra	3	3	7	4	6
	Mamaia	3	2	6	7	6
	Cristina	3	3	4	7	4
	Pinot noir	3	2	7	4	7

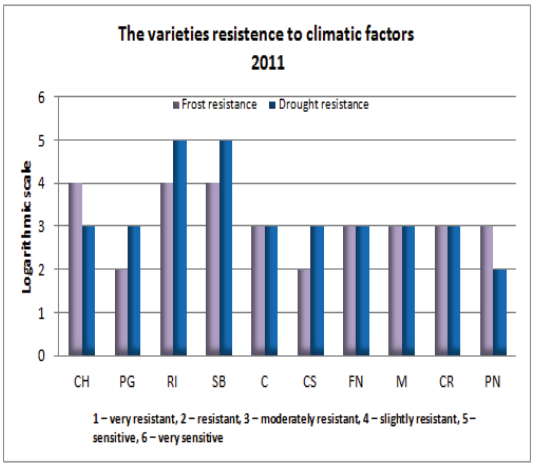
DR = drought resistance şi FR = frost resistence: 1 - very resistant, 2 - resistant, 3 - moderately resistant, 4 - slightly resistant, 5 - sensitive, 6 - very sensitive; MA – vine mildew resistance (*Plasmopara viticola*); FA – powdery mildew resistance (*Uncinula necator*); PC – gray mold resistance (*Botrytis cinerea*): 1- without symptoms, 2-high resistance, 3-medium-high resistance, 4-moderate resistace, 5 low resistance, 6-moderate sensitiveness, 7-susceptibility, 8-high susceptibility, 9-high sensitiveness.

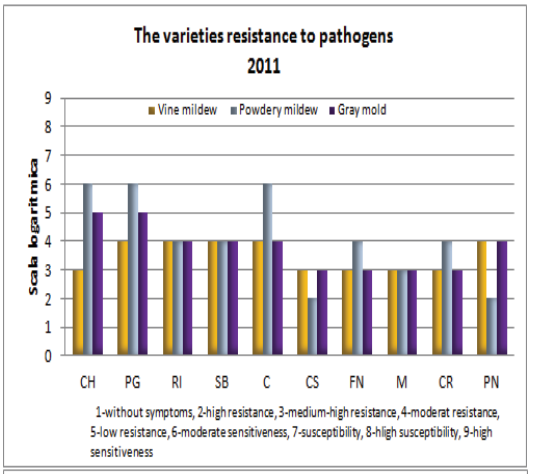
Analyzing the evolution of studied varieties to the two abiotic stress factors, a normal reaction was observed, according to their genetic traits. The varieties resistent to frost were the red varieties, of which 'Cabernet Sauvignon' distinguished itself. Regarding the resistance to drought, the most sensitive were the white varieties 'Riesling Italian' and 'Sauvignon blanc' (Figure 1).

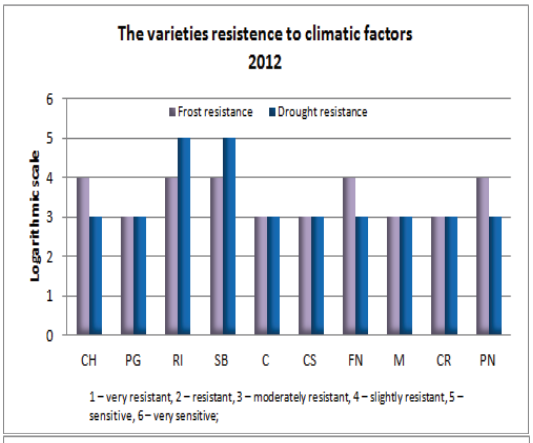
The vine mildew (*Plasmopara viticola*), has a dynamic life cycle, variable and strongly influenced by climatic factors. The vine mildew manifested on leaves and berries by showing spots on the leaves with various aspects, evoluating from oily-yellow spots with a confused outline in spring, to brown-center spots with dry aspect later on. *Plasmopara viticola* showed a stronger attack in 2013 for all studied varieties, the average infestation ranging from 3 to 6, from resistant to moderately susceptible, depending on the variety. Treated with anti-fungal products allowed in organic viticulture, the following varieties have shown a better resistance to vine mildew: 'Pinot gris', 'Sauvignon blanc', 'Columna', 'Cabernet Sauvignon', 'Mamaia' and 'Cristina'.

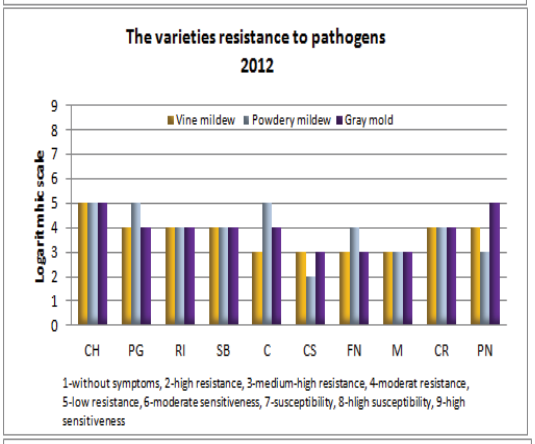
Powdery mildew (*Uncinula necator*), conidial shape Oidium tuckeri, is the most common disease after the vine mildew. In the case of powdery mildew the attack was both on leaves and berries. On the leaves was observed a whitish mycelium, ectoparasite, fine, powdery appearance that stretched forming spots on both surfaces of the limb. Under the mycelium the tissues became brown, but the leaves have only fallen late in fall. The powdery mildew presented higher values of the attack rate in 2011 and 2013, the white wine varieties being more affected, the average infestation being on the evaluation scale from 3 to 6, that is from resistant to moderately susceptible. Among the varieties studied, resistant to attack were 'Sauvignon blanc', 'Italian Riesling', 'Cabernet Sauvignon' and 'Pinot noir', while an opposite behavior displayed 'Chardonnay', 'Columna' and 'Cristina'.

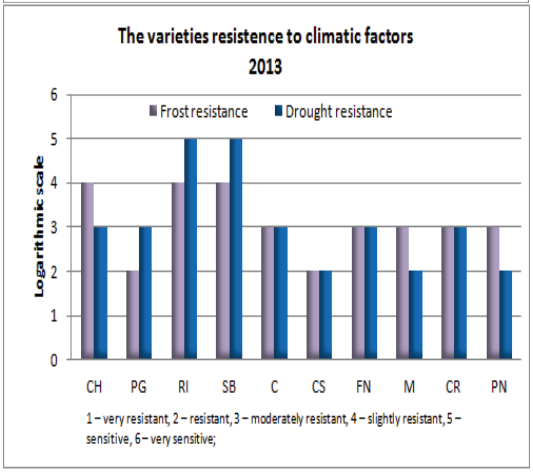
The grape gray mold (*Botrytis cinerea*) is a disease difficult to control, due to the unusual nature of the fungus and the complexity of its life cycle. During the growing season, the pathogen is present in plantations (dormant), so that measures to combat the fungus should be preventively made. The intensity of the attack of gray mold manifested mainly during the months of abundant precipitation. *Botrytis cinerea* showed a strong attack in 2013, due to the year's favorable climatic conditions for the pathogen development. Most susceptible to the attack by gray mold are the varieties 'Chardonnay', 'Pinot gris', 'Italian Riesling' and 'Pinot noir'.











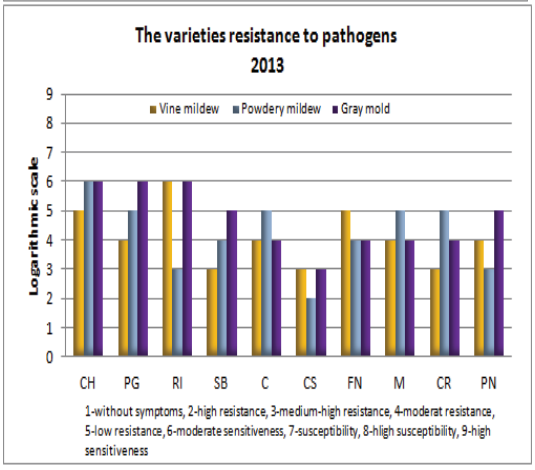


Figure 1. The evaluation of the resistance of the studied white and red varieties to biotic and abiotic factors in Murfatlar vineyard

In Murfatlar ecosystem vineyard the species of pathogens that cause the most significant economic damage and should be kept under control in organic viticulture are downy mildew and gray mold, and of the abiotic factor drought.

Table 3. The hierarchy of the studied varieties according to three factors:downy mildew, gray mold and drought

The suitability to the organic culture	Variety	Downy mildew	Gray mold	Drought resistance	Powdery mildew	Frost resistance
Recommended varieties	Cristina	4	4	3	7	3
	Columna	6	6	2	7	3
	Mamaia	6	6	2	7	3
	Cabernet Sauvignon	6	6	2	4	2
Recommended partially	Riesling italian	6	6	5	3	4
	Feteasca neagra	7	6	3	4	3
Not recommended	Chardonnay	7	7	2	7	4
	Pinot noir	7	7	2	4	3
	Pinot gris	7	7	5	7	5
	Sauvignon blanc	7	7	5	7	4

By taking into account the importance of these three main factors a classification of varieties was attempeted and included in Table 3, based on the resistance showed by the varieties to these factors. We classified the vaieties in there groups: the recommended varieties for organic viticulture the partially recommended and the variaties not recommended.

CONCLUSIONS

The adaptability of grape varieties to biotic and abiotic environmental conditions is one of the decisive factors for their suitability to the growing technologies, including the organic vine culture.

A general analysis of the 2011-2013 studied period compared with the reference period (average of 1991-2010), reveals an increase of the thermal regime and of insolation. The values of the synthetic ecological indicators from the Murfatlar center indicates a favorable area for growing vine with a very good suitability for both white and red wine varieties.

In the biocenotic complex of the Murfatlar vineyard only a few species of phytopathogens cause important economic damages, among them being: the downy mildew (*Plasmopara viticola*) and gray mold of grapes (*Botrytis cinerea*). Permanent supervision of vineyards in order to identify the first signs of pathogen attack during the vegetation period is a major objective to be followed in order to obtain quality grapes, especially in organic viticulture.

Our evaluation showed that the most recommended varieties to be grown organically in Murfatlar vineyard are: 'Cristina', 'Columna', 'Mamaia', 'Cabernet Sauvignon' and partially recommended are 'Feteasca neagra' and 'Italian Riesling'.

This fact is also supported by the ecopedoclimatic conditions, the calculated indexes showing that Murfatlar is a favorable ecosystem for the organic cultivation of vines.

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