THE MOST VALUABLE GRAPEVINE VARIETIES FOR WINE ESTABLISHED BY ANALYTICAL HIERARCHICAL PROCESS FOR A SUSTAINABLE VITICULTURE IN DANUBE TERRACES VITICULTURAL REGION

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Abstract

In order to promote a durable viticulture, an analytical hierarchical process (AHP) have been done to identify the most valuable grapevine varieties for wine in the Danube Terraces Viticultural Region. The grapevine varieties taken into the study are dedicated to white wine (Crâmpoșie, Riesling of Rhin, Fetească albă), red and rosé wine (Negru of Drăgășani, Pinot noir, Cabernet franc, Merlot, Sangioveze). The AHP exercise was based on pairwise comparisons of 11 subjective criteria (including knowledge for recognition, market potential, "celebrity" of the product on the market, biotic and abiotic threats), and expert's opinion. According to the results, the grapevine varieties with the highest potential for this region were selected as being Fetească albă, Merlot and Pinot Noir, also zoned for this wine region. Although the wine production of the area consists mostly of table wines, among which the dominant ones are those for white wines, two varieties for red wines and one for white wine were selected. The analyses were obtained by using the Expert Choice Desktop software (v. 11.5.1683). Taken into consideration the pedoclimatic characteristics of the region and the climatic changes situation, the behaviour of the three ranked grapevine varieties to different stress factors have been discussed. In the Danube Terraces conditions, the drought sensitivity of some grapevine varieties requires the reduction of water stress by irrigation. In areas with heavily eroded land on the slopes or fronts of terraces, it is recommended to use some rootstocks (Kobber 5BB, 41-B, SO4-4) to avoid the appearance of ferro-calcium chlorosis produced by the excessive presence of carbonates.

Key words: AHP, pairwise comparisons, durable viticulture, cultivars, Region VII

The Danube Terraces Viticultural Region is located mostly on the Danube terraces in the south-east of the Romanian Plain and stretches along the lower sides of the Danube, along the border with Bulgaria, from Zimnicea (Teleorman county), to Însurăței (Brăila county) (*figure 1*). According to Order no. 1205/2018 for the approval of the Nomination of the viticultural areas and the classification of the localities by viticultural regions, vineyards and viticultural centers, this region (Region VII) includes in its area the Ostrov and Greaca vineyards (with the viticultural centers Ostov, Băneasa, Oltina, Aliman, all in Constanța county and the viticultural center Greaca (Giurgiu county) respectively, to which are added 4 independent viticultural centers: Feteşti (Ialomița county), Giurgiu (Giurgiu county), Zimnicea and Însurăței. The viticultural centers are spaced between them, but the presence of scattered vineyards, occured in similar ecological conditions, certifies the shaping of a distinct wine – viticultural region called the Danube Terraces.

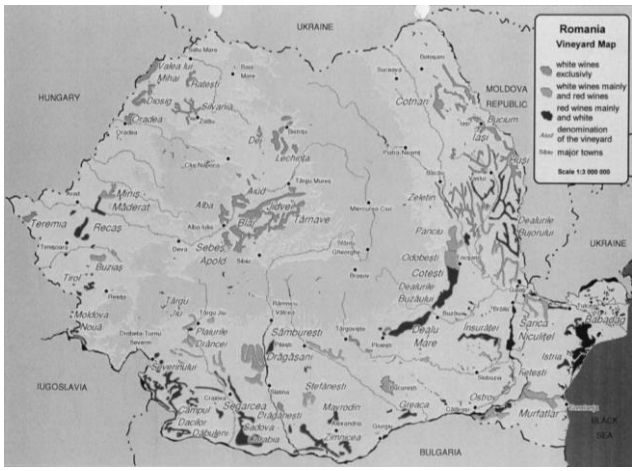

Figure 1 **Romania vineyards map**
Source: https://www.winebehindthelabel.org/team-blogs/kathleens-blog/romania-and-its-wines

Due to its geographical position, this viticultural region has the largest heliothermal resources. On the Romanian territory, the

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values of the Huglin heliothermal index vary between 2341.48 in the viticultural Region of the Danube Terraces and less than 1500 in the Viticultural Region of the Transylvanian Plateau (Irimia L.M. *et al*, 2013).

The conditions during flowering, in the growing and ripening grapes phenophases are very favorable for grapevine growing, both in terms of temperature and humidity. The combined effect of vegetation, water, climate-soil complex created favorable conditions for the grapevine cultivation in many areas of the country, thus explaining the expansion of vineyards on the Black Sea coast and along the Danube.

The climate is temperate continental, stepic and silvostepic, with insufficient precipitation and extreme temperatures, which endanger the normal development of the phenological spectrum if no protective measures are taken (protected crop, irrigation) especially against winter frosts and water deficit during the summer-autumn period. The annual precipitations register an average of 500 mm annually, and during the vegetation period they rich to 300 mm on average, a higher average in the Greaca and lower in the Feteşti viticultural center. As compared to the potential evapotranspiration that varies between 700-750 mm, there is an accentuated water deficit that must be completed by irrigations (Stroe M., 2012).

The low average altitude of the vineyards, of 72 m in the conditions in which the viticulture uses the lands with microslope and microrelief is an important inconvenience, because, although it is located in the most southern part of the country, the Danube Terraces viticultural region reaches an average of minimum extreme temperatures of - 27.0°C, the lowest value being - 30.2°C recorded in Zimnicea and Greaca (Oșlobeanu *et al*, 1991).

The main types of soil from Danube Hills Viticultural Area, defined according to SRTS - 2012 (Florea N., Muntean L., 2012) are the following: calcium chernozem, typical chernozem, eroded cambic chernozem, batigleic aluvisol, aluvisol, eutric regosol, typical kastanoiziom (Toti M. *et al*, 2017).

The Danube Terraces viticultural region is recognized primarily for the production of table grapes from the entire varietal conveyor from early to late maturing varieties, because the vegetation period is the longest here, meaning 202 days.

The wine production consists mostly of table wines, among which the dominant ones are those for white wines. In some wine centers, in certain particularly favorable years, some red wines can also reach the quality required of a quality wine. Among the varieties for white wines, are appreciated: Fetească albă, Feteasca regală, Riesling italian, Sauvignon blanc, Crâmpoşie selecţionată, Pinot gris, Cardonnay, Columna Donaris, and among red varieties are preferred Cabernet sauvignon, Merlot, Pinot noir, Burgund mare (Stroe M., 2012; Antoce A.O. *et al*, 2013).

In Romania the distribution of vineyards by regions is: Moldova – 38%, Muntenia and Oltenia – 29%; Danube Terraces – 13%; Dobrogea – 9%; Crișana-Maramureș – 5%; Transylvania – 4%; Banat – 2% (Ștefan P. *et al*, 2017).

At the 2016-year level, the area cultivated with grapevines in the Danube Terraces was smaller than in 2007 (11250.6 ha as compared with 11822.0 ha) (according with the Romanian viticultural regions, from ONVPV Communication 2007 and Vine Plantations Registry, ONVPV, 2015–2016) (Antoce A.O., Călugăru L.L., 2017).

The aim of this work is the application of a hierarchical methodology (AHP) to give a scientific contribution to a durable viticulture, by assessing and ranking some grapevine varieties of white, red and rosé wine that exploit well the potential of the Danube Terraces Viticultural Region.

MATERIAL AND METHOD

One of the most used multicriteria decision making tool, the AHP method relies on the judgments of experts to derive priority scales (Saaty L., 2008).

The grapevine varieties (*Vitis vinifera* L.) studied by AHP in this paper are dedicated to white wine (Crâmpoșie, Riesling of Rhin, Fetească albă) and, red and rosé wine (Negru of Drăgășani, Pinot noir, Cabernet franc, Merlot, Sangioveze).

In order to determine the most important grapevine varieties for Danube Terraces Viticultural Region, 11 criteria with a scale of 8 levels each were used in the AHP exercise, as follows: criterion 1 - harvesting period (from 1: the shortest harvesting period to 8: the longest

harvesting period); criterion 2 - portfolio of derived products (from 1: the smallest number of derived products to 8: the highest number of derived products); criterion 3 - harvested quantity by one worker in 8 hours (from 1: the lowest quantity to 8: the highest quantity); criterion 4 - harvesting cost (from 1: the lowest cost to 8: the highest cost); criterion 5 - knowledge for recognition (from 1: most recognizable product to 8: hardest recognizable product); criterion 6 - knowledge for harvesting (from 1: the less knowledge necessary to 8: most knowledge necessary); criterion 7 - market potential (from 1: low to 8: high); criterion 8 - perishability (from 1: lowest to 8: highest); criterion 9 - "celebrity" of the product on the market (from 1: the least known to 8: the most popular); criterion 10 - biotic threats (from 1: the fewest threats to 8: the most threats); criterion 11 - abiotic threats (from 1: the fewest threats to 8: the most threats).

The analyses were obtained by using the Expert Choice Desktop software (v. 11.5.1683).

Having a high degree of generality, these criteria have been also used in other fields of research: in the case of forest fruits (Vechiu E., Dincă L., 2019; Enescu R., Dincă L, 2020), for all the non-wood forest products (Blaga T. *et al*, 2019; Tudor C., Dincă L., 2019; Plesca I.M. *et al*, 2019) and even for wild animals (Ciontu C.I *et al*, 2018). An important influence for this analyse are the climatic changes influences reported in the viticulture area (Dincă L. *et al*, 2018b; Vizitiu D.E. *et al*, 2018; Buciumeanu E.C. *et al*, 2019) and the need to formulate solutions (Vizitiu D.E. *et al*, 2019) and recommendations (Dincă L. *et a*l, 2018a).

RESULTS AND DISCUSSIONS

The studied grapevine varieties make good use of the area potential and can be used to obtain wines with a geographical indication "Danube Terraces". Of these, in Order no. 225/2006 regarding the approval of the Zoning of the noble fruitful grapevine varieties admitted in culture in the viticultural areas of Romania are mentioned Fetească albă, Pinot noir and Merlot as being zoned for the Danube Terraces viticultural region.

The AHP alternative ranking, based on expert's opinion, is presented in *table 1*.

Table 1

AHP alternative ranking

Criterion	Grapevine varieties							
	Crâmpoșie	Negru of Drăgășani	Riesling of Rhin	Pinot Noir	Fetească albă	Cabernet franc	Merlot	Sangiovese
1	3	4	6	1	8	5	7	2
2	5	3	4	7	8	1	6	2
3	3	7	6	1	2	4	5	8
4	6	3	4	8	7	5	2	1
5	5	3	4	8	6	2	7	1
6	7	4	3	5	8	2	6	1
7	1	2	5	6	7	3	8	4
8	4	5	3	7	6	1	8	2
9	5	4	3	7	8	2	6	1
10	1	2	8	3	7	5	4	6
11	3	4	8	1	2	5	6	7

According to the AHP results, the grapevine varieties of red and rosé wine with the highest potential for the Danube Terraces, in descending order, were: Fetească albă, Merlot and Pinot Noir (*figure 2*).

It is not at all surprising that the varieties ranked on the first three places are the same as those zoned for this wine region. The other varieties studied also placed in descending order were: Riesling of Rhin, Sangioveze, Crâmpoșie, Negru of Drăgășani, Cabernet franc.

In sustainable viticultural systems, the soil must be protected and improved to ensure its long-term productivity and stability by weeding or mulching, the use of compost or manure, the reduction of soil work and the avoidance traffic of the wet ones. Regular application of organic matter can help to improve soil characteristics such as water infiltration in the arable layer and fertility.

Choosing the grapevine rootstocks is an important criterion for the affinity between scion and rootstock, necessary for a sustainable and harmonious coexistence of the two partners, the scion and the rootstock, within the viticultural ecosystem (Bucur G.M., 2011).

Pinot noir behaves well in combination with Chasselas x Berlandieri 41 B, Riparia gloire, SO4, 3309 C, Teleki 8 B rootstocks. It adapts very well to the temperate continental climate and the best wines are obtained on calcareous soils. Grafting on the Riparia gloire rootstock is recommended on fertile and moist soils with a low limestone content and on Chasselas x Berlandieri 41 B rootstock on dry soils with a high limestone content (Stroe M., 2012). For grafting the Fetească albă variety, SO4-4, Riparia gloire, SC-25 rootstocks are recommended, which manage to temper its growth vigor (Stroe M., 2012). Merlot

has a good compatibility with Riparia gloire, Chasselas x Berlandieri 41B, Riparia x Rupestris 101-14, 26 C, Ruvis, Berlandieri x Riparia Kober 5 BB rootstocks (Constantinescu G. *et al*, 1960; Bucur G.M., 2011; Stroe M., 2012).

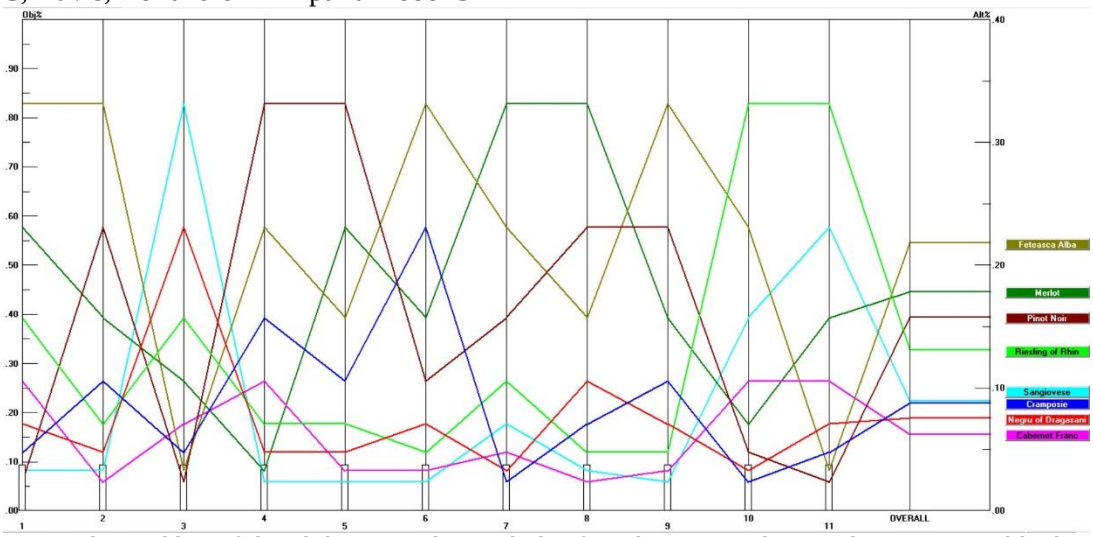

Figure 2 **The ranking of the eight grapevine varieties for wine, grown in Danube Terraces viticultural region**

In the few areas with heavily eroded terrain on the slopes or terrace fronts, it is recommended to use Kobber 5BB, 41-B and SO4-4 rootstocks to avoid the appearance of ferro-calcium chlorosis (due to the excessive presence of carbonates).

Fetească albă, Merlot and Pinot noir varieties show different resistance levels to biotic and abiotic stress factors. However, it was noted that all are sensitive to downy mildew and moths attack (*table 2*).

In the Danube Terraces conditions, the drought sensitivity of some grapevine varieties requires the water defficit reduction through irrigation.

The three grapevine varieties are characterized by a short vegetation period (150-160 days, for Fetească albă and Pinot Noir) that allows the maturation of the wood, or medium-long (180-200 days, for Merlot), which induces a low frost resistance.

Downy mildew, powdery mildew and grey mould are considered the most damaging cryptogamic diseases of grapevines. It was noted that the three varieties are sensitive to downy mildew and moths attack. The climate of the area, with low rainfall, does not favor the development of downy mildew (produced by the *Plasmopara viticola* fungus). Of the three varieties, only Merlot shows good tolerance to grey mould (*Botrytis cinerea*), sensitive varieties can be severely damaged in rainy autumns. The attack of powdery mildew (produced by the *Uncinula necator* fungus) takes place especially in dry summers; Pinot noir variety is very sensitive to powdery mildew.

A high density of mites *Eotetranychus carpini* favored by drought and heat can cause considerable damage. The red mite of the grapevine (*Panonychus ulmi*) it can develop up to seven generations per year, depending on weather conditions. The determining factor of the appearance of the common spider (*Tetranychus urticae*) is drought.

Regrading the grapevine moth (*Lobesia botrana*), which attacks flowers and berries at various stages of development, the pest's eggs are largely destroyed by the sun's rays that penetrate the grapes as a result of working in the green (lateral shoot removal, binding).

Table 2

Behavior of the Fetească alba, Merlot, Pinot Noir varieties to different stress factors (adapted after Constantinescu G. et al., 1960; Stroe M., 2012; https://www.agrodenmar.ro/vita-de-vie-merlot, https://www.horticultorul.ro/vita-de-vie/soliul-de-vita-de-vie-pinot-noir/)

Grapevine varieties	Drought	Frost	Downy mildew	Powdery mildw	Gray mould	Mites	Moths
Fetească albă	Sensitive	Medium tolerance	Sensitive	Medium resistance	Sensitive	High sensitivity	Sensitive
Merlot	Low tolerance	Low resistance	Sensitive	Good tolerance	Good tolertance	Good tolerance	Sensitive
Pinot Noir	High resistance	High resistance	Very sensitive	Sensitive	Very sensitive	Good tolerance	Sensitive

In order to increase the quality of the environment, the inputs from outside the farm, such as chemical fertilizers, must be minimized. Thus, the vegetal cover (between the grapevine rows) can be used to increase the soil content in dry matter (in the first 20 cm), which also opposes

to the calcium, magnesium and nitrates leaching. Fertilization with composted organic fertilizers is also an excellent source of nutrients (vegetable remains, canes, shoots, marc).

In Romania it is registered an active thermal balance between 2700 and 3600°C (Dejeu L.C., 2010) and in the viticultural area of the Danube Terraces the multiannual average in the 1990-2013 period was 3466°C which shows a heating with 197°C as compared to the 1961-1990 period (Irimia L.M. *et al*, 2017), which favors the sugars accumulation and the obtaining of qualitative grape productions.

CONCLUSIONS

According to AHP results, based on pairwise comparisons of subjective criteria with high degree of generality, Fetească albă, Merlot and Pinot noir grapevine varieties for wine were selected as the most important for Danube Terraces viticultural region. Of the group of eight grapevine varieties for wine taken into the study (Crâmpoșie, Riesling of Rhin, Fetească albă, Negru of Drăgășani, Pinot noir, Cabernet franc, Merlot, Sangioveze), only these varieties that ranked on the first three places are zoned for this viticultural region.

In the durable viticultural systems, the soil must be protected and improved to ensure its long-term productivity and stability. It is also necessary to manage all biotic (diseases, pests) and abiotic (drought, frost) stress factors, so that the grapevine plants benefit of an adequate protection, which takes into account the new climatic conditions.

Danube Terraces viticultural region benefits of favorable eco-climatic conditions for grapevine cultivation of and the application of the results can contribute to the development of a sustainable viticulture.

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