ANNALS OF THE UNIVERSITY OF CRAIOVA

Series: ✔*Biology*
✔*Horticulture*
✔*Foodproductsprocessingtechnology*
✔*Environmental engineering*

Vol. XXXI (LXVII) - 2026

PRESERVING THE SOIL STRUCTURE IN VITICULTURE A CHALANGE DUE TO CURRENT CLIMATE CONTEXT

Tudor Mihai[1]*, Tabaranu Gabriel[1], Ferțu Ionela-Daniela[2]
[1]Bujoru Viticulture and Winemaking Research and Development Station, Tg.Bujor, Galați
[2]"Dunarea de Jos" University of Galaţi, Galaţi
* *Correspondence author. E-mail*: farm.tudor@gmail.com

Keywords*: sustainability, soil structure, viticulture, climate change*

ABSTRACT

We are currently facing extreme weather phenomena, and their extension and intensity negatively influence the entire viticultural ecosystem with an impact on production yields and grape quality. For a sustainable conservation of natural resources in viticulture, it is necessary to ensure a scientific basis for all the actions and measures that can prevent and mitigate the consequences of current environmental changes resulted from human intervention. Our study investigates some conservative viticulture strategies that aim at soil improvement and erosion reduction; higher organic matter ratios in superficial soil layers; improving physical properties for arable layer; achieving optimal soil aero-hydric and nutritional regime; creating optimal conditions for water infiltration and conservation throughout soil structure; reducing air pollution as a result of lower green house gas emissios.

INTRODUCTION

Grapes (Vitis vinifera L.), belonging to the Vitaceae family, comprise approximately 60 species distributed in Asia, North America and Europe in subtropical, Mediterranean and temperate climates. Vitis vinifera L. has acquired significant economic interest throughout history, while other species, such as V. berlandieri, V. riparia and V. rupestris, have been used to grow rootstocks. Thousands of cultivars classified as Vitis vinifera L. subsp. Sativa are widely cultivated for fresh fruit, raisins (dried grape berries), juice and mainly for wine [1,2]. The domestication of grapevines appears to have occurred between the 7th and 4th millennia BC, in an area located between the Black Sea and Iran [3,4]. Domesticated genotypes were spread by humans throughout the Near East, Middle East and Central Europe.

Grapevines are believed to possess remarkable climatic adaptability. However, specific climatic conditions are required for balanced ripening of berries and production of high-quality grapes. Accumulated temperatures above 10 °C (base temperature) are required for the initiation of vine growth [7]. Grape growers have adapted varieties and viticultural management practices over the centuries to maintain harvests at desired dates. However, climate around the world is constantly changing. The agricultural productivity of an area is directly correlated with climate,

and several modeling tools and approaches already exist that could be used to predict the effects of climate change using bioclimatic parameters.

Temperature increases induced by climate change are projected to negatively affect ecosystems, but other species could respond positively [8]. Therefore, changes in climatic conditions and, in particular, in the precipitation regime are likely to modify agricultural practices including irrigation and the transport of nutrients and pesticides in the environment. Adopting cultural practices is the first option to reduce adverse climate impacts [9].

Climate change is commonly considered as increasing temperatures and subsequent drought. Other factors, such as increasing atmospheric carbon dioxide (CO2), increasing radiation, wildfires, extreme weather events and floods, and rising sea levels, should be considered. Increasing environmental temperatures trigger advanced grapevine phenology, the date at which buds begin to appear, flowering, and ripening begins. This shifts the ripening phase of the berries to warmer periods of the summer, which will negatively affect the composition of the grapes, especially in terms of aromatic compounds. Early harvest dates under drought conditions are incompatible with the production of grapes or wines of special terroir. Certain secondary metabolites, such as anthocyanins, are negatively affected by high temperatures. Grape acidity, especially malic acid content, decreases at high temperatures [10]. Increased water stress due to high temperatures affects photosynthesis, reduces yields and modulates the composition of grape must, as researchers have already reported [11,12]. Studies suggest that the frequency of extreme weather events is likely to increase. This may have positive or negative implications for grape and wine quality depending on the region and the magnitude of the change. According to the 2007 IPCC report, the average temperature increased by about 0.5°C in the 20th century, and McCarl [13] indicated that a further increase in global climate could reach 1.4°C to 5.8°C by the end of the 21st century. Higher temperatures alter precipitation patterns, increase evapotranspiration and radiation. High radiation causes sunburn in grapes, especially in the pre-ripening phase. To cope with climate change, adaptation strategies are needed to continue producing high-quality grapes/wines and to preserve their characteristics according to their origin in a changing climate..

MATERIAL AND METHODS

Methods and means of analysis and interpretation at SCDVV Bujoru

- Electrochemical method — potentiometric, in aqueous suspension 1:2.5 - pH determination;
- Volumetric method, STAS 7184/21 -82 - determination of humus content (%);
- Egner Riehm-Domingo method and UV-P7S molecular absorption spectrometric method, in aqueous extract - determination of mobile phosphorus (P-Al, ppm);
- Egner Riehm-Donlingo method and photometry method in each case in aqueous extract - determination of mobile potassium (K-A1, ppm);
- Determination of nitrogen content (IN %) - calculation according to the formula: IN, % = (humus x Vah)/100;
- Determination of the degree of saturation in bases (VAh, %) - calculation depending on pH;

• Volumetric method -, SR EN ISO 10693/2014— determination of carbonate content ($CaCO_3$, %).

Experimental variants

1 - control-Black soil

2 - soil with grape pomace

RESULTS AND DISCUSSIONS

The notion of soil is inextricably linked to its content in organic matter. Organic matter constitutes one of the main components of the terrestrial ecosystem, both as a source of nutrients for crop plants, and through the way in which it influences the physicochemical properties and microbiological activity of the soil. Organic matter comes from the accumulation over time of plant and animal remains, in various degrees of decomposition. Organic matter in soil of plant and animal origin undergoes a humification process that has 3 phases:

1) Initial biochemical decomposition, in which oxidation and hydrolysis processes predominate, a stage in which phenolic and quinone radicals are formed, which are structural units of humic substances;

2) Condensation of structural units with various organic compounds containing N;

3) Decomposition and synthesis by the action of heterotrophic and saprophytic microorganisms, resulting in CO_2, NH_3, H_2O and various compounds and ions, the process being known as the mineralization of organic matter in the soil.

As a result of these transformations, numerous substances result, such as:

1. HUMIC substances, stable with high molecular weight, (fulvic, humic acids, humins), with specific colloidal properties that form stable humus. The component acids of humus can combine with: • Bivalent cations forming SATURATED STABLE HUMUS – insoluble in water • Monovalent ions forming UNSATURATED HUMUS – soluble in water.
2. The resulting non-humic substances make up the nutritious humus.

Organic matter is classified from the following points of view: a. chemical: • humic substances (humic acids soluble in alkaline solutions, precipitates in mineral acids and fulvic acids soluble in alkaline solutions, humins insoluble in sodium hydroxide) • non-humic substances b. functional: • stable humus, • nutritious humus c. morphogenetic: • raw humus (mor) is the most imperfect type of humus for an aerated environment, the composition is formed from unbroken organic residues, has a strongly acidic reaction with a low nitrogen content. • moderately formed in an aerated environment, is an intermediate between non-calcic forest humus and raw humus with undecomposed plant residues, with compounds with a low degree of polymerization. • mull, formed in an aerated environment, there is calcic mull, saturated with calcium, with a content of strongly polymerized humic acids, it is formed in the steppe and forest-steppe areas, but also in forest areas with a calcareous substrate, there is also non-calcic mull with an acidic reaction formed on soils that do not contain limestone and marl, with a low content of humic acids and moderately polymerized. • peat is formed in an unaerated environment, the decomposition is incomplete, only intermediate products of humification are formed. Organic matter is formed from fresh organic residues of plant and animal origin and humus.

Humus is the main component of organic matter in the soil. It represents a mixture of macromolecular substances resulting from the decomposition of plant residues, followed by synthesis in humic and humic acids. Humic substances. They are a group of compounds with common characteristics (soluble in NH_4OH or NaOH,

precipitated with HCl), the structure of the compounds is complex and heterogeneous. Humic substances contain, along with larger or smaller fragments of lignin, proteins and sugars, a series of hydroxyl compounds, aromatic polycarboxylic acids, quinones, heterocycles with N 59 and O, amino acids. The structural units are linked together by various types of bonds: -O, - NH-, -N=, -CH2-, -C-O-, -S-S-, and chains of carbon atoms of different lengths. The molecules contain several representative reactive groups: • The carboxylic group –COOH, characteristic of organic acids, by ionization (-COO-) the particle becomes electronegative, attracting another ion. R-COOH → R-COO- + H+ • The phenolic group C6H5-OH, by dissociation becomes negatively charged (C6H5-O-). • The amine group –NH2, can accept a proton becoming a positively charged particle (-NH3 +); can react with the carboxyl group forming peptide bonds, characteristic of the amino acid chains that form proteins. Humus particles can combine with clay particles forming complex organo-mineral particles (the clay-humic complex). The humus content of soils influences the retention capacity and cation exchange. The organic matter content of soils varies between 2-6 %, the amount of organic matter in the soil determines fertility, varies in relation to: climatic factors (temperature, humidity), vegetation factors, crop technology (irrigated, non-irrigated), the use of organic fertilizers, the solifaction process. Characterization of soil fertility according to the humus content, %, of the arable layer (Davidescu, 1999) Characterization of fertility Field crops Greenhouse crops, solariums Soil with loamy-clay texture Sandy soil Soil with loamy-clay texture Sandy soil Very low < 1% < 0.5 % < 2% < 1 % Low 1.1-2 % 0.6-1 % 2.1

Soil dynamics are conditioned by:

- Soil acidity; the formation of acidic compounds as a result of biological processes resulting from nitrification;
- In biological processes, some bacteria eliminate a series of enzymes from different organic compounds;
- The elimination of CO2 from the decomposition of organic matter helps to solubilize phosphorus compounds;
- The accessibility of phosphorus in the soil depends on its pH, the reactions that lead to the retrogradation of phosphorus and its transition to calcium compounds at a pH > 7.3 and to iron and aluminum compounds at a pH < 5.5. Maintaining soil pH between 6 and 7 leads to the highest availability of phosphorus from the soil Accessibility of phosphorus depending on soil pH ([6] Borlan Z. et al.; [8] Davidescu D.)

When conssidering our experimental variants various results were obtained.

- Soil reaction (pH):— It is slightly alkaline, with an average pH value of 8.37 (sample 1-control-black field), being higher by about 0.5, compared to the average of sample 2- variant with composted pomace administration whose value is 7.83, a fact explained by the slightly acidic pH of the composted pomace, which influences to some extent the general pH of the soil.

pH of viticultural soil + composting platform evaluation at SCDVV Bujoru with a digital Bayer thermometer

The pH of viticultural soils varies mainly between 7-8 and very rarely 7, it was found that the soil pH is generally slightly basic, being slightly lower, but it was located in the optimal area in the variant fertilized with composted pomace, which is slightly more acidic.

- Influence of pH on the assimilation of soil elements

⇨ pH = 5 favors the assimilation of K+, Fe2+, Mn2+, Zn2+, SO 2-

⇨ pH = 6 favors the assimilation of NO3-

⇨ pH = 6.5 favors the assimilation of H2PO4-

⇨ pH = 7 favors the assimilation of Ca2+, Mg2+

pH > 7 favors the assimilation of NH4+, MoO4

- Supplying the soil with humus [2;3;10;13].

In sample 1-control-black field, a low humus content is observed, with an average value of 1.89% on a medium-textured soil, the explanation of which is given by the lack of organic matter in the soil and the need to administer organic matter, in order to create a nutritional balance favorable to the growth of plant vigor.

In sample 2 - variant with composted pomace administration, a high humus content is observed, with an average value of 7.54 %. By administering organic matter in the form of composted pomace, the soil humus content increases dramatically, which denotes the great value of achieving a circular viticulture, which ensures environmental protection and an increased supply of organic matter naturally, by recirculating the matter in nature, with minimal specific costs.

- The humus content must be greater than 4-5%, with a nitrogen index (NI) of 3-6, knowing that an NI unit provides 20-30 kg/ha nitrogen in the soil in dry years and 80-100 kg/ha nitrogen in rainy years
- Soil nitrogen supply (by NI% - nitrogen index) [1].

The contribution of organic matter from sample 2-composted grapevine is also evident in the soil nitrogen content, respectively in the nitrogen index, which is very high, selling an average of 7.54 %, compared to the black field control with an average of only 1.85 %. This element, together with phosphorus and water, gives the high potential for plant growth, highlighting once again the effects of implementing a circular agriculture of performance in the agricultural ecosystem.

- Supplying the soil with mobile phosphorus [1].

The supply of mobile phosphorus to the soil is medium, with an average value of 22.14 ppm (sample 1-control-black field) to very well supplied, excessive for some crops, with an average value of 221.89 ppm, in the sample with composted pomace, highlighting the energetic and constitutional contribution of this mineral element, obtained from organic matter.

- The level of mobile phosphorus in the soil must have the values: 8.1-16 mg P2O5/100 g soil, knowing that 1 g P2O5/100 g is equivalent to 7 kg P2O5/ha.

Supply of mobile potassium to the soil [J].

— The supply of mobile potassium to the soil is very well supplied, with an average value of 3260 ppm -sample 2- composted pomace, compared to the control sample 1 - black field, with only 320 ppm (sample 1-control).

- The level The potassium content of the soil should be 16.1-24 mg K2O/100 g soil, knowing that 1 g K2O/100 g soil is equivalent to 13 kg K2O/ha. If these values are not obtained as a result of agrochemical analyses, fertilizers will be applied in appropriate doses.
- The soil has a degree of base saturation (VAh%) of 98.13 % - sample 1-control, black soil and 99.98 % - sample 2, composted grape pomace, values that indicate that the soil is saturated in bases [2].

• The concentration of calcium carbonate (CaCO3) is medium — 3.09 % (sample 1-control) and 2.60 % (sample 2) [2].

No	Sample	pH	Humus%	N I %	P ppm	K ppm	CaCO, %	Vah %
	1 – control – black field mean values	**8.37**	**1.89**	**1.85**	**22.14**	**320**	**3.09**	**98.13**
1	Sample 1	8.35	1.90	1.75	23.04	324	3.08	98.09
2	Sample 2	8.39	1.87	1.95	21.23	325	3.06	98.13
3	Sample 3	8.27	1.85	1.80	22.16	320	3.09	98.14
4	Sample 4	8.47	1.95	1.90	22.18	315	3.10	98.15
5	Sample 5	8.37	1.88	1.85	22.09	316	3.12	98.14
	2- soil with grape pomace	**7.83**	**7.54**	**7.54**	**221.89**	**3260**	**2.6**	**99.98**
1	Sample 1	7.95	7.50	7.58	214.65	3280	2.7	100.10
2	Sample 2	7.75	7.63	7.46	225.65	3240	2.4	99.97
3	Sample 3	7.78	7.50	7.57	222.75	3290	2.3	99.98
4	Sample 4	7.85	7.52	7.56	226.60	3240	2.7	100.00
5	Sample 5	7.82	7.55	7.53	219.80	3250	2.9	99.85

CONCLUSIONS

The current study investigates the use of wine making byproducts to conserve soil structure in context of climate change. Results presented confirm other studies and recommend the use of grape pomace as a soil regenerator. All inorganic soil components registered significant increases, especially organic matter content. Further investigations are required due to grape pomace nutritional value. Single use as a soil fertilizing agent might be wasteful and grape pomace might be used as a soil amendment tool after bioactive molecule extraction processes (polyphenols and anthocyanins etc.).

ACKNOWLEDGMENT

All data used are part of 6.3.21 Research on developing circular models for the valorization of winemaking by-products within the context of bioeconomy development in Romania research project funded by MADR.

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