

ABSTRACT

Soil degradation in vineyards represents a problem of global concern and the current context requires the development and adoption of sustainable technologies to ensure the conservation of natural resources and quality vine production. Different cultivation technologies are applied in vineyards, including various soil management systems, with the main objective of creating optimal conditions for the growth and development of vines.

In Romania, the scientific literature indicates a low number of studies on the interaction between viticultural technologies and soil property dynamics, which justifies the need for an extensive approach, focused also on the new pedoclimatic particularities.

The doctoral thesis, entitled "*The influence of the technologies applied in the vine plantation of Vasile Adamachi Farm, Iasi, on soil quality and production*", is part of this research direction, aiming both to assess the impact of different soil management systems and to identify solutions adapted to the local viticultural context, capable of maintaining the balance between productivity and sustainability. At the same time, by generating relevant and updated data, the present study aims to contribute to the promotion of the concept of sustainability among winegrowers in the north-eastern part of Romania.

The first part of the paper synthesizes the bibliographical background on the topic of the doctoral thesis, while the second part presents the aim and objectives of the research, the material and methodology applied, the description of the natural setting and the analysis of the experimental conditions, as well as the results of the research carried out.

Chapter 1 provides an overview of vine-growing by analyzing its evolution from the past to the present and by identifying the main prospects and directions of development of the vine sector. It also highlights the distribution of grapevine worldwide, with a focus on the main European grape and wine producing countries, as well as current global market trends. Eco-pedoclimatic requirements are presented in relation to their impact on vine development and productivity.

Chapter 2 summarizes the current state of research on the impact of different technologies used in vineyards on soil quality and production, highlighting the main effects of soil management systems on physical, chemical, biological properties and their influence on yield and crop quality.

Chapter 3 presents the aims and objectives of the research conducted, the experimental design, materials and methodology used for the determinations.

The main aim of the research was represented by the necessity to identify technological variants applicable in the context of the current soil and climatic conditions, which would contribute both to the consolidation of the theoretical basis and to the promotion of a sustainable trajectory in the viticultural sector.

The general objective set is to analyze the influence of the application of different vine plantation management technologies on the evolution of some soil physical and hydrophysical properties, as well as on the level and quality of production. In view of the influence on the effects generated by the application of the technological variants, the analysis of the changes detected was based on the evaluation of the variability of the climatic factors specific to the area and period of the study, as well as the soil characteristics of the experimental perimeter.

The experimental setup of the research was divided into two experiments. The first experiment included three experimental variants, each represented by a tillage system applied on the interval between the rows of vines. The second experiment was represented by three methods of weed control on the row.

In order to obtain a technically and scientifically relevant database, various sources of documentation specific to the field of research were consulted (specialized books and treatises, methodologies, online databases, scientific articles). Sampling and analysis of soil samples was carried out with the support of the Institute of Research Institute for Agriculture and Environment - Iasi.

Chapter 4 provides a detailed characterization of the specific natural setting of the area where the research was carried out, including in the analysis also the climatic conditions and the viticultural setting.

The experience was organized within the Vasile Adamachi Research and Student Practice Station in Iasi, subordinated to the "Ion Ionescu de la Brad" Iasi University of Life Sciences.

The horticultural station has 52 ha of land, of which about 15 ha are occupied by vine plantations. In terms of viticultural habitat units, the station's plantations are part of the viticultural zone C I, the Moldovan Hills viticultural region, the Iasi vineyard, the Copou viticultural center.

The Iasi vineyard is located in the north-eastern part of the Moldavian Plateau, on the Iasi Coast, which connects the Central Moldavian Plateau with the Moldavian Hill Plain.

Within the Iași vineyard, seven wine-growing centers were delimited, as follows: Bucium, Uricani, Comarna, Covasna, Galata, Bohotin and Copou wine-growing center, consisting of the vineyards of Valea Lupului, Reditu, Copou-Breazu, Aroneanu, Șorogari.

The main soil types found in the Copou wine-growing center belong to the luvisols and antrisol classes. The cernisols are the most widespread, having a high suitability for viticulture, but also for other agricultural crops.

Chapter 5 presents the analysis of the experimental conditions, with emphasis on the soil characteristics of the experimental field and on the particularities of the thermal and rainfall regime in the analyzed period (2022–2024).

The exploited land is drained, in a north-south direction, by the Podgorenilor stream, which contours through its slopes the shape of an amphitheater with a southern opening. The slopes, roughly symmetrical in the transverse plane, have a gradient ranging from 8 to 25%, and the land elevation varies between 90 and 180 meters above sea level.

The experimental plot was established on the eastern hillside, located within the *Pinot noir* vine plantation. It was planted in 2014 on an area of 0.67 ha. The distance between vine stumps per row is 1.25 m and between rows 2.3 m. Since the establishment, the grass cover system has been used as the vine row spacing management technology. In addition, a rotary harrow is used for superficial loosening of the soil and the control of weeds on the rows of vines.

Based on the morphological characterization and analytical data, the soil was classified as a *cherno-cambic aric anthrosol* formed on deluvial deposits.

The climate analysis for the period 2022–2024 highlighted significant changes in temperature and rainfall patterns specific to the current climate context, confirming that the Copou vine-growing area is also affected by global warming. This period was marked by an atypical climate, with major variations from the long-term mean values, characterized by excessive temperatures, extended periods of drought, and uneven distribution of precipitation, mainly in the form of heavy rains.

In terms of thermal conditions, the mean of air temperature during the experimental period was 12.3°C, with an increase of 2.1°C compared to the last 11 years (2011–2021), and compared to the 1981–2010 mean, the increase was 2.5°C. Regarding the mean temperature recorded during the vegetation period of the vine (april–september), in the 2022–2024 interval it was 19.31°C, with a positive deviation of 1.76°C above the multiannual mean, and the amplitude of variation of annual deviations ranged from 0.99°C to 2.9°C.

The rainfall regime of the experimental period was characterized by large fluctuations in the amount and the pattern of rainfall distribution over the months. The mean amount was about 621.9 mm, 57.4 mm above the 2011–2021 period and 42.4 mm above the 1981–2010 period mean.

Chapter 6 presents the results of experimental research on the influence of technologies applied in the vineyard on the physical and hydrophysical properties of the soil, highlighting the changes recorded in terms of bulk density, penetration resistance, gravimetric moisture content, capillary water capacity, water stability and distribution of structural aggregates and porosity evaluated by X-ray microcomputed tomography.

In terms of the soil management systems applied between the rows of vines, these had a different impact on the evolution of the analyzed parameters, with statistically significant differences. Also, the dynamics of the indicators were also influenced by the complex interaction of factors such as the soil sampling period, depth interval, climatic conditions, timing of maintenance processes, and stage of grass vegetation development.

Regarding the impact of soil management strategies on vine rows to control weeds, it was found that the methods applied significantly influenced the evolution of the analyzed properties, which highlights the fact that additional attention should be paid to the management of this area.

The results obtained highlighted the importance of correlating the technologies applied with the specific soil and climate characteristics of the implementation area, demonstrating that the adoption of rational vineyard management systems can contribute to the conservation of soil productivity.

Chapter 7 presents the influence of vine plantation management technologies on the qualitative and quantitative parameters of grapes, highlighting the variations recorded in the mean yield per stump, yield per hectare, weight of 100 berries, titratable acidity, soluble dry matter content and moisture content at harvest.

A comparative analysis of the quantitative and qualitative parameters of vine production in 2023 and 2024 revealed a low impact of plantation management technologies. This effect was evident both in the systems applied between rows of vines and in the methods used to control weeds in the rows, as confirmed by the insignificant statistical differences between the variants analyzed. In contrast, the climatic variability of each growing season had distinct effects on the quantity and quality of the harvest. In 2024, although grape production was higher than in 2023, it was accompanied by a decline in the main quality indicators, which could affect the quality of the wine produced.

Chapter 8 presents general conclusions on the impact of viticultural technologies on soil quality and production levels, as well as a series of recommendations for optimizing cultivation practices with the aim of promoting the sustainable use of soil resources and increasing the performance of viticultural agroecosystems.

According to data from the literature and research, the soil management systems used in vine cultivation technologies significantly influence the physical and hydrophysical properties of the soil, having a considerable impact on its long-term productive capacity. Each management option has specific advantages and disadvantages, and the particularities of the pedoclimatic factors specific to the implementation area must also be taken into account when adopting an effective system. At the same time, current European policy principles must also be integrated into the soil management strategy.

In the context of the challenges posed by climate change and accelerating trends in agricultural land degradation, minimizing mechanical interventions, maintaining a protective layer of plant residues on the soil surface, and the possibility of implementing mixed soil management systems are viable and sustainable solutions for soil quality conservation.

This study is an important initial step in enhancing the relationship between soil management systems and the dynamics of its physical and hydrophysical properties, providing valuable support for expanding the scientific basis in the field of sustainable soil management. Current research is in a continuous stage of development, with prospects for further exploration through long-term monitoring, the integration of additional analysis parameters, and the testing of modern management technologies. These efforts aim to reduce existing methodological limitations and generate more representative results that accurately reflect the reality in the field and contribute to the formulation of agricultural strategies adapted to the current context of the viticultural ecosystem.