

ABSTRACT

**Keywords: tillage system,
grassed row tillage system, cultivator tillage system,
physical, chemical and mechanical properties of the soil**

The expansion of intensive and super-intensive viticulture in recent decades involves an intense traffic of machinery used to perform mechanical work. Thus, it is important to establish the modification of soil conditions following the traffic performed and the influence of these modifications, especially in the area of vine root development, because the correlation between plant development depending on the physical condition of the soil and the traffic performed by mechanical means is an important factor in increasing soil fertility. Also, the number of works applied and the order of their execution represent the essence of the soil work system.

Given that soil preparation and maintenance work produce immediate and direct, beneficial effects within the framework of grapevine cultivation technologies, they also determine long-term residual effects in the soil, influencing the physical, hydro-physical and mechanical properties of the soil, modifying them.

Among the numerous links in the complex of factors that influence soil production and fertility, the maintenance system contributes greatly and to a large extent to improving the balance of soil nutrients, which undergo changes over time, depending on climatic conditions and the technologies applied.

In this context, the doctoral thesis entitled "The influence of cropping systems and technologies on the quality of the soils of the Bejeneasa Farm, in the Cotnari Vineyard", provides answers through the three objectives addressed, namely: determining the changes in the morphological, physical and chemical properties of the soils on the farm; carrying out a case study on the suitability for vines of the coastal saline soils of the Bejeneasa-Cotnari Farm and analyzing the influence of some tillage systems of the interval between vine rows on some physical, chemical and mechanical properties of the soil.

The doctoral thesis is structured according to the requirements of the Doctoral School of Engineering Sciences of the University for Life Sciences (USV) "Ion Ionescu de la Brad" in Iași and comprises two parts in which six chapters are included.

Part I presents the current study of knowledge, comprising chapters I and II, in which the results of relevant studies on the topic addressed are presented, as well as the description of the natural setting of the research area.

Chapter I summarizes the current state of research on the influence of cropping systems and technologies on the quality of soils in vineyard plantations, presenting the results of studies conducted in the country and abroad on the influence of cropping systems and technologies on parameters such as soil structure, bulk density, degree of compaction, soil porosity, soil water regime and penetration resistance.

Chapter II presents in detail, from the perspective of natural conditions, the Cotnari Vineyard. It is positioned between 47°17' and 47°35' north latitude and 26°5' east longitude, being protected by the Dealu Mare-Hârlău Coast, which makes the transition between the Suceava Plateau to the west and the Moldavian Plain to the east.

The vineyard plantations are grouped into 5 wine-growing centers: Cotnari (the core of the vineyard), Hârlău, Cucuteni, Târgu Frumos and Frumușica, with altitudes varying between 169-237 m, where renowned local varieties are cultivated, such as *Grasă de Cotnari*, *Fetească albă*, *Frâncușă* and *Tămâioasă românească*, for the production of high-quality white wines, semi-dry, semi-sweet and sweet, and aromatic wines.

The great diversity of natural factors on the territory of the Cotnari Vineyard has determined the formation of a complex soil cover, with different soil types, representative of which are cambic chernozems and mesocalcareous chernozems.

The climate is temperate-continental, but is structured into six types of microclimates: plains and meadows, low-sunny slopes, moderately sunny slopes, well-sunny slopes, high hills and plateaus. The multiannual average temperature is 9 °C, the multiannual average of precipitation is 554.7 mm, the average duration of sunshine is 2194.0 hours, and the dynamics of the atmosphere is dominated by air masses from the NW, with a frequency of 31.08%. Autumns are usually long, sunny and dry, providing good conditions for the ripening of grapes and the production of quality wines with a controlled designation of origin.

Part I is presented over 38 pages (23.9% of the volume of the doctoral thesis), which includes 2 figures and 15 tables.

Part II presents, in chapters III, IV, V and VI, the experimental protocol approached, the own results obtained from the research carried out, the conclusions and recommendations.

Chapter III presents the purpose, objectives of the research, the research material and method, the location of the experimental field, as well as a detailed description of the experimental factors and parameters and the research methods in the field and laboratory, the calculation method and interpretation of the results, as well as their statistical interpretation.

The studies were carried out in the vineyards of S.C. Cotnari S.A., Ferma Bejeneasa. This is located on the administrative territory of U.A.T. Balș, the Cotnari-Iași wine-growing area, has an area of 177.30 ha of vines, with varieties such as *Grasă de Cotnari* - 88 ha, *Tămâioasă Românească* - 80 ha, *Busuioacă de Bohotin* - 3.53 ha and *Fetească Neagră* - 5.76 ha.

The purpose of the research was to identify the cropping systems and technologies studied, which determine changes in the morphological, hydrophysical, chemical properties, as well as soil fertility, of the vineyard plantation in the studied wine-growing area.

The objectives of the research in the field of the doctoral thesis were:

determining the changes in the morphological, physical and chemical properties of the soils; case study on the favorability of coastal saline soils for vines within the Bejeneasa-Cotnari Farm; the influence of some tillage systems of the interval between vine rows on some soil properties.

The experimental factors were: factor A. Depth of the tilled soil layer, the two working variants being a1 - cleared vineyard plots (results obtained following a case study) and a2 - cultivated vineyard plot (on fruit); factor B. Soil tillage system, the three working variants being b1 - tilled with a tiller, b2 - grassed row (control variant) and b3 - tilled with a cultivator.

For soil characterization, five soil profiles were opened (dug) in the experimental area. In order to determine the main physical properties of the soil from the five soil profiles, but also from the three soil tillage variants, soil samples were collected using stainless steel cylinders, numbered, with dimensions of 5.1 cm height and 5 cm diameter (volume of 100 cm³), with walls of 0.8-1 mm thickness, sharpened at one end. Soil samples for chemical analyses, but also for determining the water stability were taken in modified placement, starting from the base of the soil profile, on soil horizons or subhorizons, with variable thicknesses between 10 and 15 cm. Soil samples were collected in depth steps, according to the I.C.P.A. methodology.

The following were determined: soil reaction, calcium carbonate content, soil anions and cations, soil structure and texture, bulk density, organic matter and total nitrogen, total porosity, capillary porosity, non-capillary porosity, aeration or drainage porosity, useful porosity, inactive porosity, degree of compaction, field water capacity, wilting coefficient, useful water capacity, instantaneous gravimetric soil moisture, volumetric soil moisture, soil penetration resistance, etc.

The results of the research aim to offer technological alternatives for grapevine cultivation in the Moldavian Hills wine region and beyond, using methods that are as less aggressive as possible on vegetation and soil.

Chapter IV presents the case study on the suitability of coastal saline soils for grapevine cultivation within the Bejeneasa - Cotnari farm.

Studies on the suitability of soils for grapevine cultivation were carried out in a line of six plots in the vineyard plantation established in 2008, latitude 47°1'50" N, longitude 26°59'31" E, altitude 170 m, land slope <5%, western exposure, on carbonate deluvial deposits, with groundwater located in places at 1-1.5 m depth and slow overall drainage.

The plantation was deforested in 2018, as a result of stagnant vine growth and the frequent occurrence of gaps. In order to establish the causes that limited the normal development of the vine trunks, 5 soil profiles were made and analyzed, located in representative locations.

The analysis of the granulometric composition of the representative soil profile from the five studied profiles revealed a fine sand content ranging from 17.8% to 32.2%. The highest values were determined in the soil layer located

between 0 and 10 cm, while in the 55-75 cm deep layer, the values were slightly lower.

The dust content was below 24.5% in the soil layer from 55 to 63 cm and 24.6% in the one from 20 to 30 cm, and the highest values, of 41.5%, were recorded at a depth of 90-110 cm.

Regarding the clay content, the lowest value, 35.1%, was determined in the soil layer from 76 to 86 cm, while the highest, 55%, was found in the middle area of the profile, at a depth of 67-75 cm, which constitutes a barrier to water infiltration into the deeper layers.

The ratio between dust and sand had the lowest value, 0.81%, at a depth of 0-10 cm, and the highest, 1.85%, at 90-110 cm.

In the studied area, the texture of the analyzed profiles falls into the fine class, characterized by medium clayey clay - loamy clay. The identified soil was a salsodic or saline cambic chernozem, affected by sodization processes, which represents a restrictive factor for plant growth, evidenced by the absence of vine roots below a depth of 40 cm.

The soil in the researched area developed on marly-clayey, carbonate-saline parent materials, and the unclogging process led to a redistribution of soluble salts and carbonates from depth to the upper horizons.

The gravimetric humidity on the vine row reached the lowest value, 20.80%, at a depth of 90-100 cm, while the highest value, 29.69%, was determined at a depth of 50-60 cm. Also, behind the tractor wheels, the gravimetric humidity was similar, with the lowest value of 20.80% at 90-100 cm and the highest value, 29.60% at 50-60 cm.

Regarding the penetration resistance, which reflects the physical-mechanical characteristics of the soil and indicates the degree of compaction, the lowest values, between 0.65 and 1.53 MPa, were recorded at a depth of 0-10 cm. The penetration resistance exceeded 3 MPa starting from a depth of 45 cm, which suggests the existence of other chemical limitations, such as salinization and sodization, which affect the penetration and extension of roots.

In Chapter V, a synthesis of the results on the influence of some tillage systems of the interval between vine rows on some soil properties is presented.

From the perspective of the granulometric composition, in the fruit-bearing vineyard plot, at a depth of 0-20 cm, it was observed that a higher content of fine sand was determined in the tiller and cultivator working systems. In contrast, the dust content was higher in the tiller and grassed row working systems, and the clay content was higher in the grassed row systems. At a depth of 20-50 cm, the proportions of the three components, namely fine sand, dust and clay, were, with a few exceptions, similar.

The apparent density of the soil, regardless of the soil tillage system used or the time of measurement, varied between 0.81-1.34 g/cm³. It fluctuated depending on the time of determination, the working system and the depth, usually having

higher values in the autumn season, especially in the grassed row and cultivator working systems, as well as as the soil depth increases.

Total porosity was highest in the tiller system and lowest in the grassed row system. Annual and depth-range variations were also lowest in the grassed row system. The most significant differences in total porosity were observed at a depth of 0-20 cm in the tiller and cultivator systems, as a result of soil mobilization. Total porosity was higher in autumn than in spring at depths greater than 10 cm, regardless of soil tillage system. Gravimetric soil moisture generally presented similar values for the three tillage systems, except for spring 2021, when lower values were recorded for the tiller and cultivator systems, regardless of depth.

Volumetric soil moisture generally followed the same trends as gravimetric moisture. Field water capacity was lowest at 0-20 cm depth, regardless of the time of measurement or the tillage system. The highest field water capacity values in spring were recorded in the tillage systems with grassed rows and cultivated with the cultivator. In autumn, field water capacity values for the three tillage systems were lower than those in spring. Useful water capacity followed similar trends to those observed for field water capacity.

The hygroscopicity coefficient had the lowest values for the tiller system, and these values increased over the 0-50 cm soil interval, ranging from 4.94 to 6.46%. For the tiller and grassed row systems, the hygroscopicity coefficient fluctuated over the 0-50 cm soil interval, from 6.35 to 7.57%.

The wilting coefficient had the lowest values for the tiller system, and the values increased over the 0-50 cm soil interval, ranging from 7.41 to 9.69%. For the tiller and grassed row systems, the wilting coefficient had variable values over the 0-50 cm soil interval, between 9.53 and 11.36%.

The pH values, for the most part, during the research period, were between 7.8 and 8.2, with the largest deviation recorded for the cultivator system in 2022, at a depth of 0-10 cm, where the pH was 7.5. The degree of soil compaction had the lowest values for the cultivator system, followed by the tiller and grassed row systems, the latter also presenting the lowest variations in depth.

Regardless of the soil tillage system, in spring the penetration resistance between the plant row and the tractor track was the lowest at a depth of 0-10 cm, with values ranging from 0.58-3.00 MPa, increasing from 10-40 cm to values between 1.43-3.50 MPa, then varying very little up to a depth of 80 cm, with the highest values being recorded on the tractor track.

Chapter VI summarizes the main conclusions and recommendations drawn from the research conducted.

It can be recommended to expand the use of the grassed row tillage system, because, broadly speaking, certain hydrophysical criteria, such as soil moisture and the hydrostatic stability of soil aggregates, presented values similar to or even higher than those measured in tillage systems with a tiller or cultivator.

By implementing the grassed row system, manual activities, phytosanitary treatment, and grape harvest can be carried out in conditions that are close to optimal, in a shorter time frame after rainfall, unlike the tiller and cultivator systems.

Part II is presented over 121 pages (76.1% of the volume of the doctoral thesis), which includes 13 figures, 18 photographs, and 23 tables.

The doctoral thesis concludes with a selection of the consulted bibliographic titles, 128 in number, and with the annexes represented by the list of figures, list of photographs, list of tables, and list of published scientific papers.