CRITICAL ANALYSIS OF VINEYARD ECOSYSTEM CURRENT STATE THROUGH BIOTOPIC FACTORS AND ENVIRONMENTAL CONSERVATION STRATEGIES

ANALIZĂ CRITICĂ A STĂRII ACTUALE A ECOSISTEMELOR VITICOLE PRIN INTERMEDIUL FACTORILOR BIOTOPICI ȘI A STRATEGIILOR DE CONSERVARE A MEDIULUI

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Abstract.
Grassing the inter-row interval in vineyard plantations, often referred to as "cover cropping" or "inter-row planting," is an environmentally beneficial practice that has been increasingly adopted to enhance sustainability, biodiversity, and ecosystem adaptability. Evaluation of this practice must consider its impact on vegetation status, soil health, water retention, pest and disease regulation, and pollinator habitats. Our study focuses on main vegetation status indices, such as: biodiversity enhancement, soil health improvement and water retention. Our multiannual evaluation identified some improvements in key vegetation indices.
Key words: biotopic factors, soil health, vegetation status

Rezumat.
Înierbarea intervalului dintre rândurile plantațiilor viticole, tehnică cunoscută sub denumirea de „cultură de acoperire” sau „plantare între rânduri”, este o practică benefică mediului, adoptată din ce în ce mai des pentru a spori sustenabilitatea, biodiversitatea și adaptabilitatea ecosistemului. Evaluarea acestor practici trebuie să țină cont de impactul lor asupra statusului vegetativ, stării de sănatate a solului, retenției de apă, prezenței dăunătorilor, a bolilor și a habitatelor polenizatorilor. Studiul nostru se concentrează asupra principalilor indici ai statusului vegetativ: îmbunătățirea biodiversității, ameliorarea sănătății solului și a retenției de apă. Evaluarea noastră multianuală a identificat unele îmbunătățiri asupra indicatorilor cheie pentru statusul vegetativ.
Cuvinte cheie: factori biotopici, sănătatea solului, vegetation status

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INTRODUCTION

Viticulture plays an important role for the agricultural, environmental, and economic sector being deeply rooted in all aspects of European history [Antoce, 2024]. Conventional agricultural practices prioritize vine yields and wine production over any other environmental considerations. The use of tillage and pesticide application, often accelerate soil erosion and also can produce soil and groundwater pollution. These strategies manifest them self via biodiversity loss, secondary effects on auxiliary fauna, and resistance development [Franin et al., 2016; May, 2000; Shapira et al., 2017].

Erosion techniques in agriculture, such as terracing [Zalidis et. al., 2002], or the use of cover crops [Francis et al., 1998; Dabney et al., 2001], break the cycle of processes that lead to soil degradation [Gabriel et al., 2013]. Soil degradation phenomena remain intense in those areas that use traditional intensive processing methods. Advantages of tillage strategies over the use of herbicides in terms of less soil loss and runoff have been documented [Raclot et. al., 2009]. Erosion is responsible for organic matter losses of up to 21g C m^{-2} /y [Ruiz-Colmenero et al. 2011], or up to 19% decrease in total organic carbon in treatments without organic fertilizers [Morlat et.al. 2008], which means that any crop that does not include a change in OM will result in a decrease in soil carbon [Aguilera, et al., 2020].

Most eco-biological methods practiced in viticulture and fruit growing, aim at using inner row space. One of the most effective soil maintenance technologies in vineyards and orchards, is based on weeding the space between the rows. Interval weeding in the vineyards and fruit plantations, contributes to the conservation and enhancement in biodiversity of plantations and adjacent environment, as well as habitat or species protection and reconstruction. Soil physicochemical augmentation results water reserves increases, including maintenance and creation of landscape features from non-productive areas, in the context of climate change. A beneficial contribution of this eco-scheme also aims to ensure favourable conditions for pollinators [Runge et al., 2022].

The viticulture branch of horticulture, provides ideal conditions for inter-row greening. Vineyards are often characterized by their orderly rows of vines, embracing the fundamental needs of this technique (the distance between vine rows depends on the grape variety, soil type and trellis system) [Schultz & Hofmann, 2015; Comba et al., 2015]. Planting various types of plant species (grasses, legumes or even wildflowers) has been proven not only to conserve soil proprieties, but also regulates nutritional balance of the vines, leading to improved grape quality. In addition, these secondary crops sometimes act as a natural deterrent against vine diseases. Adopting row greening strategies has numerous benefits, there some challenges regarding the integration of cover crop species requiring careful planning, which into account factors such as water availability, climate conditions and crop compatibility.

Employing sustainable strategies are crucial in modern viticulture. Cover cropping combined with no herbicide use could ensure low environmental impact while promoting biodiversity [Cataldo et al., 2020].

Our study focuses on main vegetation status indices, such as: biodiversity enhancement, soil health improvement and water retention.

MATERIAL AND METHOD

Experimental protocol for sustainable viticulture was initiated in Bujoru viticultural areal according to climate characteristics.

Since the spring of 2024 whit a continuation throughout 2025, an experimental model was designed for a Merlot variety vineyard plantation.

The experimental device was organized in randomized blocks with the following experimental variants:

V1 - Black field;

V2 - Natural grassing from spontaneous flora;

V3 - Lawn (40% *Lolium perennial*, 33% *Festuca rubra* and 27% *Poa pratensis*);

During experimental conduct, soil, main climate parameters, vegetative cover crops growth were monitored. All data was collected via local monitoring systems or field sampling.

RESULTS AND DISCUSSIONS

In May 2024 at the start of the experimental protocol, soil pH and temperature measurements were carried out to create an image of the experimental conditions.

In order to know soil quality, soil pH and temperature were determined in three repetitions on three determinations (table 1), as follows:

Table 1

Soil pH values and temperature in May 2024-2025

Variant	3 Repetitions	pH	Soil temperature ˚C at 10 cm
2024			
1 / Average	1-3	5.93	18.5
2 / Average	1-3	5.05	18.5
3 / Average	1-3	5.00	19.0
2025			
1 / Average	1-3	5.89	18.0
2 / Average	1-3	5.85	18.7
3 / Average	1-3	5.68	18.5

Climate data analysis reveals drops in rain fall regime, increases in number of days whit temperatures over 30^0C and temperature regime as shown in figures 1 and 2.

As shown by the graph multiannual rain fall values for Bujoru viticultural areal are normally situated around the value of 517 mm. 2023 and 2024 registered significant decreases of water input via precipitations (346 mm-2023 and 362 mm-2024).

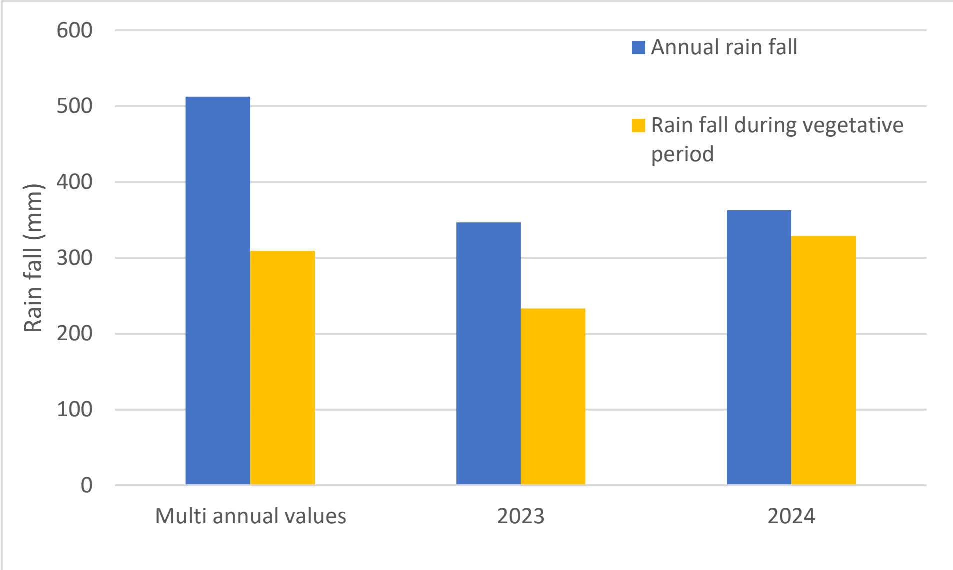

Fig. 1. Annual rain fall and during vegetative periods

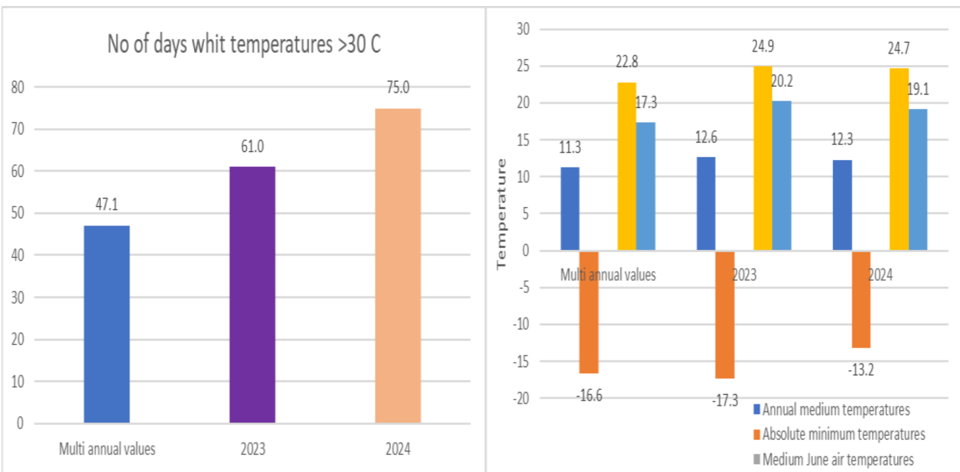

Fig. 2. Temperature variations and no. of days whit temperatures >300C

Analyzing the main climatic elements in 2023 and 2024 compared to multiannual averages, the following aspects can be highlighted:

- increase in the average annual temperature from 11.3 °C (multiannual value), to 12.6 °C (2023), with a thermal surplus of 1.3 °C;
- increase in the values of the thermal balances during the vegetation period and the average temperatures in July, August and September;
- reduction in the amount of annual precipitation and during the vegetation period;

- increase in the number of days with temperatures above 30 °C, from 47.1 days to 61 days in 2023 and 75 days in 2024;

Evaluation of the growth of the plants sown in the intervals between the vine rows was carried out rhythmically, and the following the observations made, an uneven emergence with reduced vegetative growth and frail plants was noted, according to the photos attached below (fig. 3).

Photo 1: V1

Photo 2: V2

Photo 3: V3

Photo 4 V2-in detail

Photo 5 V3- in detail

Fig. 3. Experimental variants seeding

Maximum growth achieved by seeded intercrops was achieved in the first decade of June, after which they dried out under the influence of extremely dry conditions of 2024.

Difficult climate conditions limited vegetative growth for the selected species of cover crops whit little to no impact on vine growth, soil proprieties.

2025 analysis of precipitation and other climatic conditions provides an overview of water resources and climate variability. During the vegetation period, the accumulated precipitation was 200.8 mm, of which 76.2 mm in May and 84.2

mm in July. Insufficient precipitation in April, June, August and September 2025 and air temperatures frequently above 30 °C led to the occurrence of the phenomenon of atmospheric drought followed by pedological drought. If in May no air temperatures higher than 30 °C were recorded, in June there were 11 days, in July 20 days and in August 22 days. Days with temperatures higher than 30 degrees were most often recorded on consecutive days due to the lack of precipitation. The predominant precipitation was between 0.1 mm and 5 mm. The frequency of rains greater than 10 mm (useful rain) decreased with repercussions on the relative humidity of the air, which was in deficit throughout the vegetation period.

Fig. 4. 2025 cover crop variants seeding

Fig. 5. 2025 cover crop Vegetative growth

Replanting of experimental variants was done at the beginning of march, in order to counter act excessive drought phenomena (fig. 4 and fig.5).

In April 2025, fig. 6, following the observations made, good plant emergence and growth was noted.

Fig. 6. 2025 cover crop Vegetative growth April evaluation

Initial data collection for 2025 shows better vegetative growth, fig.7, for the used experimental variants. When compared to 2024 measurements on vegetative growth for the mentioned variants, 2025 showed increases by 39 %.

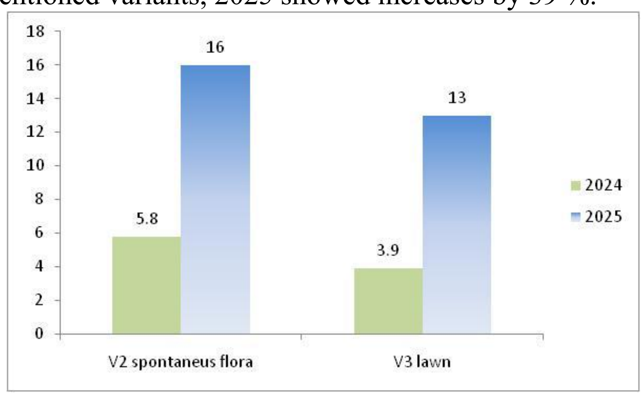

Fig. 7. Cover crops vegetative growth

CONCLUSIONS

In 2024, the main disruptive factor that negatively influenced our experimental variants was the pronounced water deficit. The poor rainfall in January, February, April, May, June, July and August, combined with many consecutive days without usable rainfall (greater than 5 mm), slowed down the vegetative growth

Cover crops sown on the interval, had small growths that subsequently effectively dried in the second decade of June, with no correlation with the productions achieved. In order to continue the project, re-established the experimental variants in the context of 2025 was carried out.

Against the background of maximum air temperatures higher than 30°C recorded in June (22 days), in July (22 days) and with a pronounced soil water deficit throughout the 0-100 cm soil profile caused by deficient precipitation, we can say that the 2023-2024 wine year was a difficult year for grapevine cultivation in the SE area of Moldova.

Current observations for 2025 show promising improvements regarding pH levels towards soil organic carbon ratios, utile fauna density, soil and vine health.

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