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AN OVERVIEW OF THE DIVERSITY AND VARIABILITY OF SPONTANEOUS FLORA IN VITICULTURAL REGIONS

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Abstract

At the global level, studies concerning the variability of spontaneous flora in viticultural areas demonstrate the decisive influence of ecological, pedological, and anthropogenic factors. Monitoring spontaneous flora can provide valuable information regarding the ecological status of viticultural areas and the effectiveness of management methods. The composition of spontaneous vegetation contributes to the protection of soil against erosion, the optimization of soil structure and fertility, as well as the modification of soil moisture. The diversity and variability of spontaneous flora represent important indicators of ecological balance and ensure sustainable management measures for viticultural areas. The objective of the present study is to analyze the diversity and variability of spontaneous flora in viticultural areas from several countries, in order to understand its contribution to maintaining ecosystem health, controlling climatic factors, conserving soil, and supporting biodiversity. The methodology applied is based on the review of specialized literature, using relevant bibliographic sources and scientific articles concerning spontaneous flora in viticultural areas. The data were consolidated and interpreted in order to highlight its ecological role, variability, and diversity.

Key words*: biodiversity, ecosystem, spontaneous vegetation, viticultural region.*

INTRODUCTION

Spontaneous vegetation is characterized by high diversity and variability, resulting from the complex interaction among climatic conditions, soil characteristics, geographical factors, and applied management practices. Floristic composition varies significantly among viticultural regions, highlighting the adaptation of spontaneous species to specific ecological conditions (Luglio et al., 2024).

In recent years, spontaneous flora associated with vineyards has received increasing attention due to growing awareness of its benefits for agroecosystems, soil health, and the provision of multiple ecosystem services (Aguiar et al., 2024).

Within vineyard systems, interactions between grapevine and spontaneous plants may generate positive effects, contributing to ecological balance and ecosystem health. Steiner et al. (2021) demonstrated that spontaneous vegetation in viticultural areas can enhance biodiversity and soil stability. Appropriate management of spontaneous vegetation supports the sustainability and equilibrium of vineyard ecosystems (Ramírez-Pérez et al., 2024).

Spontaneous flora contributes to soil moisture retention, enhances biodiversity within vineyard ecosystems, and does not significantly affect grape yield and quality when properly managed (Virili et al., 2025).

Viticultural areas often induce moderate stress in grapevines through limitations in water and nutrient availability, thereby emphasizing soil and topographic characteristics. A moderate level of stress may be beneficial, and interactions with spontaneous vegetation can support the balance between vegetative growth and production (Reeve et al., 2016; Kesser et al., 2023). Vineyards also contribute to the conservation of agroecosystem biodiversity, as they represent relatively stable and structurally layered systems (Mania et al., 2015).

At the global scale, the intensification of viticulture has increased pressure on spontaneous flora, leading to ecological imbalances. In this context, modern sustainability-oriented strategies aim to restore the ecological role of spontaneous vegetation in maintaining biodiversity and supporting

vineyard ecosystem functioning (Zhao et al., 2021).

Managing spontaneous flora represents an effective alternative to chemical control, supporting sustainable viticultural practices (Tscharntke et al., 2005; Sáenz-Romo et al., 2019). The use of cover crops in vineyards improves soil structure, enhances water retention and nutrient availability, and promotes microbial diversity and beneficial soil microorganisms (Finney et al., 2017; León et al., 2021). Spontaneous vegetation positively influences the abundance and diversity of beneficial arthropods, supporting natural pest control and contributing to ecological balance within vineyards (Rusch et al., 2017; Fiera et al., 2020).

Mediterranean vineyards are particularly vulnerable to soil degradation due to slope and rainfall intensity. The transition to modern soil management systems has intensified soil and mineral nutrient losses (Arnaez et al., 2007).

Protection regimes for spontaneous flora influence biodiversity, while grape and wine quality remain comparable between organic and conventional systems (Döring et al., 2019). The expansion of vineyard plantations and land-use conversion have reduced native spontaneous plant communities, altering natural vegetation patterns (Iriarte-Chiapusso et al., 2017).

The improvement of grapevine varieties and expansion of cultivated areas significantly modify natural ecosystems, often leading to reduced native spontaneous flora and simplified vegetation structure under specialized cropping systems (Droulia & Charalampopoulos, 2022). Ecological agricultural techniques can protect ecosystems, improve soil health, and provide economic advantages due to increasing demand for organic products (Marcelino et al., 2024).

Particular attention has been given to spontaneous vineyard plants, with research focusing on species composition, diversity, variability, and response mechanisms to environmental conditions, resulting in resilience and adaptation to anthropogenic disturbances (Ilie & Cosmulescu, 2023).

Monitoring climate change enables assessment of future impacts and supports proactive adaptation strategies aimed at sustaining viticulture and managing spontaneous vegetation under changing climatic conditions (Chalak & Ghorra Chamoun, 2024). Therefore, the objective of this study is to provide an updated overview of the importance of floristic composition associated with vineyard ecosystems.

MATERIALS AND METHODS

The study was conducted using a documentary research method complemented by comparative analysis of data available in the scientific literature. The scientific analysis was based on bibliographic sources, peer-reviewed scientific articles, botanical monographs, and specialized reports.

Bibliometric analysis and visualization of keyword relationships were performed using the VOSviewer platform, which enabled the identification of major research directions and connections within the literature.

The methodological approach consisted of a synthetic review of studies addressing spontaneous flora in vineyards, focusing on species diversity and ecological variability. Data regarding the role of spontaneous vegetation in maintaining biodiversity, ensuring agroecosystem stability, and shaping ecological interactions between spontaneous plants and grapevine were also evaluated.

The integration and comparison of collected information allowed the identification of key trends concerning floristic biodiversity conservation and supported the formulation of evidence-based conclusions regarding the importance of spontaneous flora in sustainable vineyard management.

RESULTS AND DISCUSSIONS

The study of spontaneous flora in viticultural areas has attracted interest across multiple continents (Figure 1). The selected countries represent reference viticultural regions characterized by significant ecological and floristic diversity. Their inclusion aims to highlight relationships between viticultural practices, biogeographical conditions, and spontaneous flora structure at a global scale. The map was created using the MapChart platform for illustrative purposes.

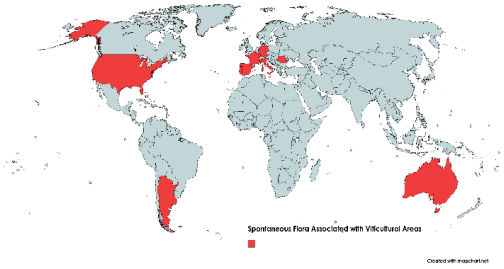

Figure 1. Global distribution of the main traditional viticultural countries included in the analysis of spontaneous flora associated with vineyard areas

According to Bettoni et al. (2016), spontaneous flora plays a crucial role in conserving and improving the physical, chemical, and biological properties of soil, reducing erosion and increasing organic matter. It may influence grape production and quality, particularly when soil cover is implemented during the vine's dormant period, although competition for water and nutrients may occur.

Perennial species adapted to edaphic conditions and producing high biomass can reduce vegetative growth and increase anthocyanin and polyphenol content in wine.

The hydric regime is a fundamental factor underlying these processes, as water availability directly influences physiology and soil-vegetation interactions. According to Costea (2006), vine water relations determine the balance between vegetative growth and reproductive development, with adequate soil moisture being essential for optimal growth and fruit formation. Costea emphasizes that insufficient water negatively affects vegetative growth, yield components, and bud differentiation, whereas excessive moisture can also disturb vine balance and increase disease susceptibility. Research on water availability effects is inconclusive, as some studies report increased soil moisture while others do not. Comprehensive evaluation requires analysis of water dynamics and root activity. Celette et al. (2008) showed that integrated water management in mixed grapevine-cover crop systems allows intercrop integration without compromising grape quality. These outcomes resonate with Costea et al. (2025) conclusions that the vine's response to water availability is nonlinear: slight water deficits can reduce vegetative vigour and improve fruit quality, while severe hydric stress disrupts metabolic processes

Rotchés-Ribalta et al. (2023) emphasize the importance of spontaneous plants in attracting pollinators and supporting agroecosystem functioning.

Although spontaneous species are often viewed as competitors, biodiversity constitutes an essential component of natural heritage. Spontaneous flora influences vine growth through water competition while promoting an optimal balance between vegetative and reproductive growth. Reduced canopy density improves cluster exposure and fruit-zone microclimate, thereby enhancing grape quality (Xi et al., 2011).

Further studies conducted in Canada highlighted that greater abundance of certain species is influenced by seed availability, establishment capacity, biomass production, soil cover, and suppression of competing vegetation. Species used for cover cropping included red clover, pearl millet, and yellow clover (Sharifi et al., 2021). While spontaneous vegetation within cover crop systems increases vineyard biodiversity, inappropriate seed density or composition may reduce vine yield (Miglécz et al., 2015; Donkó et al., 2017).

In viticultural areas of Madrid, soil management practices have contributed to soil erosion, affecting both spontaneous flora and productivity; however, yields remain strongly dependent on irrigation in semi-arid regions (Dorado et al., 2016). Management strategies must therefore balance crop protection with environmental conservation, as outcomes depend on soil and climate conditions, training systems, and grower practices (Pires, 2022).

Mechanical practices are frequently preferred for managing under-row vegetation, using tools such as hoes, cultivators, or discs, which differ in efficiency and degree of soil disturbance (Gagliardi et al., 2023).

A study conducted in Şanlıurfa (Türkiye) identified and documented 184 spontaneous plant taxa present in vineyard areas, based on morphological characteristics and comparison with previously recorded local flora (Balos, 2023). The floristic classification is presented in Figure 2.

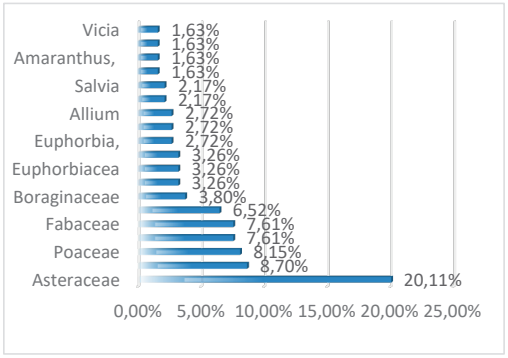

Figure 2. Floristic classification of spontaneous plant taxa identified in the study

Vegetation analysis revealed several botanical families, including some with invasive or potentially harmful species for grapevine cultivation. The most represented family was Asteraceae (37 taxa), followed by Apiaceae (16 taxa) and Poaceae (15 taxa), while other families contributed to overall floristic diversity at lower proportions.

Annual plants provide rapid soil cover, whereas perennial species contribute to nitrogen fixation and soil stabilization, facilitating integration with spontaneous vineyard vegetation (Sharifi & Zolfaghari, 2025).

Incorporating spontaneous flora into agricultural management highlights ecosystem services provided by native species while adaptive control strategies help limit competition for resources (Garcia et al., 2018).

Soil management practices in vineyards often leave partial ground cover, influencing vine growth, nutrient dynamics, soil water content, grape quality, and soil properties. The impact of these practices depends on climate, soil type, and irrigation regime. Studies indicate that leguminous cover crops increase total and mineral nitrogen through biological nitrogen fixation, whereas spontaneous plant communities may reduce total nitrogen levels compared to other plant families (Peoples et al., 2009; Abad et al., 2021).

In Uruguayan vineyards, optimal temperature, water, and soil fertility conditions may promote excessive vegetative growth, creating microclimatic conditions unfavorable for fruit maturation and disease management. Growers commonly use vigorous rootstocks to maintain vegetative balance. In fertile soils and humid climates, limiting resources is challenging. Coniberti et al. (2018) demonstrated that integrating cover crops with supplementary irrigation can regulate vegetative development and improve vineyard sustainability while maintaining wine quality.

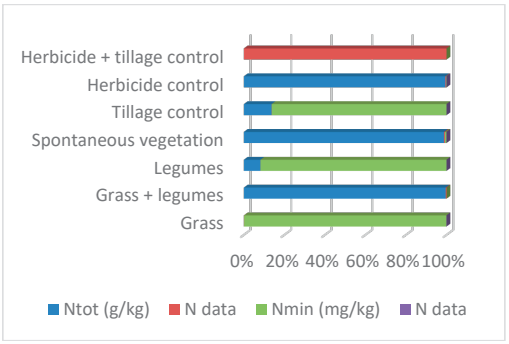

Figure 3. Distribution of mean soil N_{tot} and N_{min} values according to cover crop type

Conversely, Guerra et al. (2022) investigated mulching as an ecological weed-control method in irrigated Mediterranean vineyards. Their three-year study showed that certain management practices reduce invasive species density and biomass without negatively affecting vine growth and productivity. Vizitiu et al. (2023) describe vineyard ecosystems as simplified anthropogenic systems dominated by grapevine, characterized by reduced ecological stability, which may increase vulnerability to biological imbalances. In this framework, spontaneous flora is often regarded as a competitive factor potentially exacerbating water and nutrient stress.

Permanent vegetation between vine rows provides soil protection, enhances fertility, and contributes to vegetation management; however, tillage may stimulate rhizome expansion, indicating the need for integrated management approaches. Abad et al. (2020) and Recasens et al. (2023) highlighted the influence of cover crops on spontaneous vegetation composition, demonstrating effective weed control without compromising grape yield or quality. Sowing cover crops prior to vineyard establishment represents an efficient strategy for managing spontaneous flora and promoting balanced vine development (Bordelon & Weller, 1997).

Vegetation control methods have evolved from intensive tillage to herbicide application. Although herbicides may reduce species diversity, different management approaches can maintain balance between vegetation control and biodiversity conservation (Baumgartner et al., 2007; Fried et al., 2019).

Environmental factors shaping spontaneous plant communities in French vineyards are illustrated in Figure 4. Strong interconnections among abiotic variables highlight their decisive influence on species distribution and density. These relationships facilitate identification of ecological zones where spontaneous flora abundance may affect vineyard ecosystem functioning.

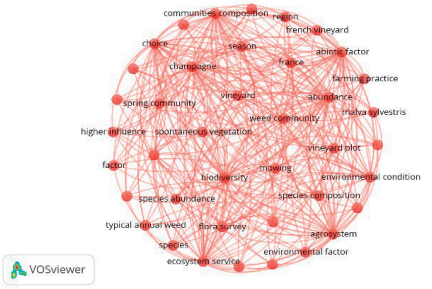

Figure 4. Conceptual representation of factors and interactions within the vineyard ecosystem

The second conceptual model (Figure 5) emphasizes interactions among biodiversity, plant communities, and specific viticultural regions. Close correlations underscore the importance of regional characteristics and management decisions in structuring spontaneous vegetation communities and shaping ecological stability.

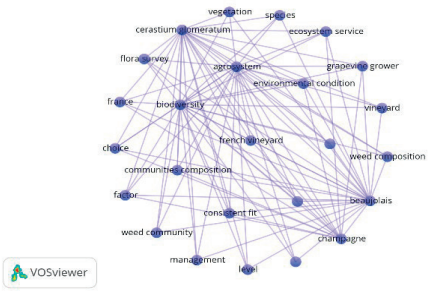

Figure 5. Connections between biodiversity, crop management, and plant communities in French vineyards

Jáuregui et al. (2025) reported that cover crops provide multiple benefits, including improved soil quality, enhanced organic matter content, increased aggregation, better infiltration and water retention, and reduced erosion. They also assist in nutrient cycling and vegetative growth regulation. However, they may compete for water and nutrients, harbor pests, and complicate maintenance procedures. Nevertheless, by occupying ecological niches and competing for resources, cover crops can help regulate spontaneous species and promote ecological balance.

Freund et al. (2013) demonstrated that vegetation diversity between vine rows stimulates arthropod biodiversity, whereas Tesic et al. (2007) highlighted potential competition for water and nutrients under reduced herbicide regimes, emphasizing the importance of balanced vegetation management.

Heavy rainfall can cause soil particle disintegration, erosion, runoff, and excessive vegetative growth. Studies indicate that permanent under-vine vegetation improves soil stability, reduces erosion and nutrient leaching, and enhances soil biological activity, particularly under climate change scenarios (Vanden & Centinari, 2021). While spontaneous flora can prevent erosion and support pest control, it is often removed due to competition for mineral resources. Extensive vegetation management generally favors biodiversity and ecosystem services, although responses depend on species, climate, and soil type (Winter et al., 2018).

Conventional monoculture practices reduce biodiversity and soil fertility, potentially increasing susceptibility to pathogens. Certain perennial plants improve soil structure, diversify microbial communities, and enhance ecosystem functioning (Quintarelli et al., 2022). Results vary: cereals frequently suppress spontaneous flora, while some legumes may stimulate it due to nitrogen enrichment. Reduced light may inhibit germination, whereas increased soil moisture may promote it. Seasonal dynamics and soil operations further influence outcomes (Fernando & Shrestha, 2023).

Mattiello et al. (2023) investigated copper accumulation in five spontaneous species from Mediterranean vineyards across 11 sites. Species such as *Lolium perenne*, *Plantago*

lanceolata, *Rumex obtusifolius*, and *Taraxacum officinale* demonstrated phytoremediation potential, contributing to sustainable vineyard management by reducing soil copper concentrations.

The influence of ground cover depends on climate, soil depth, organic matter, and percentage of coverage. Delpuech and Metay (2018) examined how spontaneous flora affects soil cover, water consumption, vine growth dynamics, and productivity, emphasizing the need for context-specific management to prevent yield losses. Several cover crops tested in vineyards showed positive ecological effects, particularly in tilled soils (Ingels et al., 2005). Although spontaneous flora may reduce vegetative growth and yield, it can enhance biodiversity and soil health; thus, even moderate yield reductions may support long-term sustainability (Karl et al., 2016).

Functional trait-based approaches help explain species responses to agricultural practices and their influence on ecosystem processes, offering valuable tools for diagnosing vegetation community organization and guiding sustainable vineyard management (Kazakou et al., 2016). The climatic and hydric context, including water balance and stress periods, emerges as a defining constraint on vineyard performance, as described by Costea et al. (2023) in his comprehensive analysis of vine water relations

In dry Mediterranean regions, water regulation is essential to prevent excessive vegetative growth and quality decline. Moderate water limitation induced by spontaneous flora may benefit grapevine performance (Tomaz et al., 2017). Soil structure and nutrient availability remain crucial during growth periods (Susaj et al., 2013). Studies in Merlot vineyards showed that spontaneous flora reduced soil moisture but did not significantly affect yield or grape quality, with annual variations largely driven by rainfall rather than soil management (Steenwerth et al., 2016).

A six-year study in central Italy reported that spontaneous vegetation consistently reduced vine vigor and productivity while maintaining must sugar levels. During dry periods, it enhanced polyphenol concentration and berry coloration, accelerated ripening, and reduced disease risk (Palliotti et al., 2005). In Argentina, traditional agricultural practices support biodiversity and organic matter recycling, although transferring such practices to higher-altitude vineyards with distinct flora may alter ecological balance (Abbona et al., 2007).

Monteiro and Lopes (2007) observed that cover crops in Mediterranean vineyards reduced soil moisture and vine vigor without significantly compromising yield, while contributing to soil conservation and improved growth–fruiting balance. Muscas et al. (2017) further reported that spontaneous flora across vineyard surfaces may reduce vine vigor and influence pest dynamics, potentially supporting more sustainable plantation management.

CONCLUSIONS

The reviewed specialized literature demonstrates that the spontaneous flora in viticultural regions is characterized by high diversity and floristic variability, being directly influenced by climatic factors and vineyard management practices. Its capacity to adapt to local conditions is highlighted by the dynamics and predominance of species, emphasizing the complex nature of these ecosystems.

In a balanced approach, it can be observed that spontaneous flora fulfills a dual role: on one hand, it contributes to the preservation of biodiversity and the maintenance of ecological stability, and on the other hand, it influences competitive relationships for resources with the grapevine.

Overall, spontaneous flora represents an important element for the proper functioning of the viticultural ecosystem and for the development of sustainable viticulture, which manages to harmonize production objectives with environmental protection.

REFERENCES

Abad, J., de Mendoza, I. H., Marín, D., Orcaray, L., & Santesteban, L. G. (2021). Cover crops in viticulture. A systematic review (1): Implications on soil characteristics and biodiversity in vineyard. Oeno One, 55(1), 295-312.

Abad, J., Diana, M., Gonzaga, S. L., Félix, C. J., & Ana, S. (2020). Under-vine cover crops: impact on weed development, yield and grape composition: This article is published in cooperation with the XIIIth International Terroir Congress November 17-18 2020,

Adelaide, Australia. Guest editors: Cassandra Collins and Roberta De Bei. Oeno One, 54(4), 975-983.

Abbona, E. A., Sarandón, S. J., Marasas, M. E., & Astier, M. (2007). Ecological sustainability evaluation of traditional management in different vineyard systems in Berisso, Argentina. Agriculture, ecosystems & environment, 119(3-4), 335-345.

Aguiar, F. C., Pires, B. R., & Lopes, C. M. (2024). Evaluation of spontaneous and weedy flora of vineyards for ecosystem services provision using the indicator VIFLORES.

Arnaez, J., Lasanta, T., Ruiz-Flaño, P., & Ortigosa, L. (2007). Factors affecting runoff and erosion under simulated rainfall in Mediterranean vineyards. Soil and Tillage Research, 93(2), 324-334.

Balos, M. M. (2023). Determination of weeds and their floristic investigation in vineyards in some districts of Şanlıurfa (Turkey). International Journal of Nature and Life Sciences, 7(2), 1-17.

Baumgartner, K., Steenwerth, K. L., & Veilleux, L. (2007). Effects of organic and conventional practices on weed control in a perennial cropping system. Weed Science, 55(4), 352-358.

Bettoni, J. C., Feldberg, N. P., Nava, G., Veiga, M. D., & Wildner, L. D. P. (2016). Vegetative, productive and qualitative performance of grapevine" Cabernet Sauvignon" according to the use of winter cover crops. Revista Ceres, 63(4), 538-544.

Bordelon, B. P., & Weller, S. C. (1997). Preplant cover crops affect weed and vine growth in first-year vineyards. HortScience, 32(6), 1040-1043.

Celette, F., Gaudin, R., & Gary, C. (2008). Spatial and temporal changes to the water regime of a Mediterranean vineyard due to the adoption of cover cropping. European Journal of Agronomy, 29(4), 153-162.

Cichi, D.D, Căpruciu, R., Stoica, F., Cichi M., Costea, D.C., Mărăcineanu, L.M. (2024) Ampelographic and bioproductive characteristics of Cabernet sauvignon clones in Oltenia winegrowing region, South-West Romania, Scientific Papers. Series B, Horticulture. Vol. LXVII, (2), 262-269

Chalak, L., & Ghorra Chamoun, Y. (2024, May). A first insight into the flora biodiversity of the Lebanese viticulture. In EHC2024: International Symposium on Viticulture and Winemaking between Tradition and Innovation 1418 (pp. 69-76).

Coniberti, A., Ferrari, V., Disegna, E., Dellacassa, E., & Lakso, A. N. (2018). Under-trellis cover crop and deficit irrigation to regulate water availability and enhance Tannat wine sensory attributes in a humid climate. Scientia Horticulturae, 235, 244-252.

Costea, D.C. (2006). The water regime of the vine, ed. Universitaria Craiova, 183 p,ISBN -973-742-317-8

Costea, D.C., Căpruciu, R., Cichi, D.D, Băducă-Cîmpeanu, C. (2023). Research concerning the reaction of vines to variable climatic conditions. Scientific Papers. Series B, Horticulture. Vol. LXVII, (2), 222-227

Costea, D.C., Cichi, D.D, Băducă-Cîmpeanu, C. (2025), Research on the reaction of the Cabernet Sauvignon grapevine variety to the variability of climatic conditions, Scientific Papers. Series B, Horticulture. Vol. LXVII, (1), 291-297

Delpuech, X., & Metay, A. (2018). Adapting cover crop soil coverage to soil depth to limit competition for water in a Mediterranean vineyard. European Journal of Agronomy, 97, 60-69.

Donkó, Á., Miglécz, T., Valkó, O., Tóthmérész, B., Deák, B., Kelemen, A., Török, P., Zanathy, G., Zsigrai, G., & Drexler, D. (2017). Comparison of species-rich cover crop mixtures in the Tokaj wine region (Hungary). Organic Agriculture, 7(2), 133-139.

Dorado, J., Cabello, F., Saiz, R., Alarcón, MR, Martín, JM, Campos, D., & Fernández-Quintanilla, C. (2016). Effects of soil management on weed flora and the productivity of a vineyard in the Community of Madrid. II Conference on Viticulture of the SECH .

Döring, J., Collins, C., Frisch, M., & Kauer, R. (2019). Organic and biodynamic viticulture affect biodiversity and properties of vine and wine: a systematic quantitative review. American Journal of Enology and Viticulture, 70(3), 221-242.

Droulia, F., & Charalampopoulos, I. (2022). A review on the observed climate change in Europe and its impacts on viticulture. Atmosphere, 13(5), 837.

Fernando, M., & Shrestha, A. (2023). The potential of cover crops for weed management: a sole tool or component of an integrated weed management system? Plants, 12(4), 752.

Fiera, C., Ulrich, W., Popescu, D., Bunea, C. I., Manu, M., Nae, I., Stan, M., Marko, B., Urak, I., Giurginca, A., Penke, N., Winter, S., Kratschmer, S., Buchholz, J., Querner, P., & Zaller, J. G. (2020). Effects of vineyard inter-row management on the diversity and abundance of plants and surface-dwelling invertebrates in Central Romania. Journal of insect conservation, 24(1), 175-185.

Finney, D. M., Buyer, J. S., & Kaye, J. P. (2017). Living cover crops have immediate impacts on soil microbial community structure and function. Journal of Soil and Water Conservation, 72(4), 361-373.

Freund, A., Harnecker, J., Kauer, R., & Reineke, A. (2013). Effects of cover crops and vineyard management strategies on arthropod biodiversity.

Fried, G., Cordeau, S., Metay, A., & Kazakou, E. (2019). Relative importance of environmental factors and farming practices in shaping weed communities structure and composition in French vineyards. Agriculture, Ecosystems & Environment, 275, 1-13.

Gagliardi, L., Fontanelli, M., Luglio, S. M., Frasconi, C., Peruzzi, A., & Raffaelli, M. (2023). Evaluation of sustainable strategies for mechanical under-row weed control in the vineyard. Agronomy, 13(12), 3005.

Garcia, L., Celette, F., Gary, C., Ripoche, A., Valdés-Gómez, H., & Metay, A. (2018). Management of service crops for the provision of ecosystem services in vineyards: A review. Agriculture, Ecosystems & Environment, 251, 158-170.

Guerra, J. G., Cabello, F., Fernández-Quintanilla, C., Peña, J. M., & Dorado, J. (2022). Use of under-vine living mulches to control noxious weeds in irrigated mediterranean vineyards. Plants, 11(15), 1921.

Ilie, D., & Cosmulescu, S. (2023). Spontaneous plant diversity in urban contexts: A review of its impact and importance. Diversity, 15(2), 277.

Ingels, C. A., Scow, K. M., Whisson, D. A., & Drenovsky, R. E. (2005). Effects of cover crops on grapevines, yield, juice composition, soil microbial ecology, and gopher activity. American journal of enology and viticulture, 56(1), 19-29.

Iriarte-Chiapusso, M. J., Ocete-Pérez, C. A., Hernández-Beloqui, B., & Ocete-Rubio, R. (2017). Vitis vinifera in the Iberian Peninsula: A review. Plant Biosystems-An International Journal Dealing with all Aspects of Plant Biology, 151(2), 245-257.

Jáuregui, I., Ancín, M., García-Mina, J. M., Zamarreño, A. M., Iglesias-Sanchez, A., Florez-Sarasa, I., & Aranjuelo, I. (2025). Permanent crop cover as a strategy for drought-resistant viticulture: insights on how rhizosphere metagenomics influences leaf-level-omics for an enhanced overall plant response. Frontiers in Plant Science, 16, 1543171.

Karl, A., Merwin, I. A., Brown, M. G., Hervieux, R. A., & Vanden Heuvel, J. E. (2016). Impact of undervine management on vine growth, yield, fruit composition, and wine sensory analyses in cabernet franc. American Journal of Enology and Viticulture, 67(3), 269-280.

Kazakou, E., Fried, G., Richarte, J., Gimenez, O., Violle, C., & Metay, A. (2016). A plant trait-based response-and-effect framework to assess vineyard inter-row soil management. Botany Letters, 163(4), 373-388.

Kesser, M. M., Joubert, W., Cavagnaro, T. R., De Bei, R., & Collins, C. (2023). Long-term under-vine coverage by spontaneous vegetation changed plant community and soil dynamics without impacting yield at two South Australian vineyards. Agriculture, Ecosystems & Environment, 356, 108629.

León, M., Berbegal, M., Abad-Campos, P., Ramón-Albalat, A., Caffi, T., Rossi, V.,Hasanaliyeva, G.,Naceto, A.P., Wipf, D., Sirca, S., Razinger, J., Fragniere, A.N., Kehrli, P., Ranca, A., Petrescu, A., & Armengol, J. (2021). Evaluation of sown cover crops and spontaneous weed flora as a potential reservoir of black-foot pathogens in organic viticulture. Biology, 10(6), 498.

Luglio, S. M., Bucalossi, G., Lisci, R., Frasconi, C., Lombardo, S., Vieri, M., Pagliai, A., & Sarri, D. (2024). A Biodiversity Monitoring Case Study in Viticulture: Manual and Digitalized Collaborative Methodology to Pursue the European Commission's Sustainable Challenges. Sustainability, 16(8), 3469.

Mania, E., Isocrono, D., Pedullà, M. L., & Guidoni, S. (2015). Plant diversity in an intensively cultivated vineyard agro-ecosystem (Langhe, North-West Italy). South African Journal of Enology and Viticulture, 36(3), 378-388.

Marcelino, S. M., Gaspar, P. D., do Paço, A., Lima, T. M., Monteiro, A., Franco, J. C., Santos, E.S., Campos, R., & Lopes, C. M. (2024). Agricultural practices for biodiversity enhancement: evidence and recommendations for the viticultural sector. AgriEngineering, 6(2), 1175-1194.

Mattiello, A., Novello, N., Cornu, J. Y., Babst-Kostecka, A., & Pošćić, F. (2023). Copper accumulation in five weed species commonly found in the understory vegetation of Mediterranean vineyards. Environmental Pollution, 329, 121675.

Miglécz, T., Valko, O., Török, P., Deak, B., Kelemen, A., Donko, A., Drexler, D., & Tóthmérész, B. (2015). Establishment of three cover crop mixtures in vineyards. Scientia Horticulturae, 197, 117-123.

Monteiro, A., & Lopes, C. M. (2007). Influence of cover crop on water use and performance of vineyard in Mediterranean Portugal. Agriculture, ecosystems & environment, 121(4), 336-342.

Muscas, E., Cocco, A., Mercenaro, L., Cabras, M., Lentini, A., Porqueddu, C., & Nieddu, G. (2017). Effects of vineyard floor cover crops on grapevine vigor, yield, and fruit quality, and the development of the vine mealybug under a Mediterranean climate. Agriculture, Ecosystems & Environment, 237, 203-212.

Palliotti, A., Cartechini, A., Petoumenou, D., Silvestroni, O., Mattioli, S., & Berrios, J. G. (2005, September). Long-term effects of seeded cover-crop on vegetative characteristics, yield and grape and wine composition of'grechetto'grapevines in central Italy. In International Workshop on Advances in Grapevine and Wine Research 754 (pp. 515-521).

Peoples, M. Á., Brockwell, J., Herridge, D. F., Rochester, I. J., Alves, B. J. R., Urquiaga, S., Boddey, R. M., Dakora, F. D., Bhattarai, S., Maskey, S. L., Sampet, C., Rerkasem, B., Khan, D. F., Hauggaard-Nielsen, H. & Jensen, E. S. (2009). The contributions of nitrogen-fixing crop legumes to the productivity of agricultural systems. Symbiosis, 48(1), 1-17.

Pires, BFR (2022). Influence of vineyard soil management on floristic communities: contribution to the Alentejo Wines Sustainability Plan (Master's thesis, University of Lisbon (Portugal)).

Quintarelli, V., Radicetti, E., Allevato, E., Stazi, S. R., Haider, G., Abideen, Z., Bibi, S., Jamal, A., & Mancinelli, R. (2022). Cover crops for sustainable cropping systems: a review. Agriculture, 12(12), 2076.

Ramírez-Pérez, P., López-Granados, F., León-Gutiérrez, J. M., Mesas-Carrascosa, F. J., Pérez-Porras, F., & Torres-Sánchez, J. (2024). Influence of soil management on vegetative growth, yield, and wine quality parameters in an organic "Pedro Ximénez" vineyard: field and UAV data. Agronomy for Sustainable Development, 44(1), 10.

Recasens, J., Valencia-Gredilla, F., Cabrera-Pérez, C., Baraibar, B., & Royo-Esnal, A. (2023). Dynamics of Cynodon dactylon and weed community composition in different cover crops in a vineyard. Weed Research, 63(4), 261-269.

Reeve, A. L., Skinkis, P. A., Vance, A. J., Lee, J., & Tarara, J. M. (2016). Vineyard floor management influences 'Pinot noir'vine growth and productivity more than cluster thinning. HortScience, 51(10), 1233-1244.

Rotchés-Ribalta, R., Marull, J., & Pino, J. (2023). Organic farming increases functional diversity and ecosystem service provision of spontaneous vegetation in Mediterranean vineyards. Ecological Indicators, 147, 110023.

Rusch, A., Delbac, L., & Thiéry, D. (2017). Grape moth density in Bordeaux vineyards depends on local

habitat management despite effects of landscape heterogeneity on their biological control. Journal of Applied Ecology, 54(6), 1794-1803.

Sáenz-Romo, M. G., Veas-Bernal, A., Martínez-García, H., Ibáñez-Pascual, S., Martínez-Villar, E., Campos-Herrera, R., Marco-Mancebon, S.V., & Pérez-Moreno, I. (2019). Effects of ground cover management on insect predators and pests in a Mediterranean vineyard. Insects, 10(12), 421.

Sharifi, M., & Zolfaghari, Z. (2025). Companion Crops as Catalysts for Sustainable Cover Cropping in Vineyards - A Critical Review and Research Agenda. Plants, 14(19), 3056.

Sharifi, M., Vanvolkenburg, H., Vasseur, L., & Rosa, D. (2021). Screening Cover Crop Species For In-Row And Inter-Row In Canadian Organic Vineyards.

Steenwerth, K. L., Calderón-Orellana, A., Hanifin, R. C., Storm, C., & McElrone, A. J. (2016). Effects of various vineyard floor management techniques on weed community shifts and grapevine water relations. American Journal of Enology and Viticulture, 67(2), 153-162.

Steiner, M., Grace, J. B., & Bacher, S. (2021). Biodiversity effects on grape quality depend on variety and management intensity. Journal of Applied Ecology, 58(7), 1442-1454.

Susaj, L., Susaj, E., Belegu, M., Mustafa, S., Dervishi, B., & Ferraj, B. (2013). Effects of different weed management practices on production and quality of wine grape cultivar Kallmet in North-Western Albania. J. Food Agric. Environ, 11(1), 379-382.

Tesic, D., Keller, M., & Hutton, R. J. (2007). Influence of vineyard floor management practices on grapevine vegetative growth, yield, and fruit composition. American Journal of Enology and Viticulture, 58(1), 1-11.

Tomaz, A., Pacheco, C. A., & Coleto Martinez, J. M. (2017). Influence of cover cropping on water uptake dynamics in an irrigated Mediterranean vineyard. Irrigation and Drainage, 66(3), 387-395.

Tscharntke, T., Klein, A. M., Kruess, A., Steffan-Dewenter, I., & Thies, C. (2005). Landscape perspectives on agricultural intensification and biodiversity–ecosystem service management. Ecology letters, 8(8), 857-874.

Vanden Heuvel, J., & Centinari, M. (2021). Under-vine vegetation mitigates the impacts of excessive precipitation in vineyards. Frontiers in Plant Science, 12, 713135.

Virili, A., Carlesi, S., Antichi, D., & Barberi, P. (2025). Soil management shapes the functional diversity of the inter-row vegetation in Mediterranean vineyards.

Vizitiu, D. E., Sardarescu, I. D., Buciumeanu, E. C., Guta, I. C., Dincă, L., Bălăcenoiu, F., Toma, D., Crișan, V., & Din, A. (2023). The Influence of Groves on Aboveground Arthropod Diversity and Evolution in a Vineyard in Southern Romania. Sustainability, 15(23), 16543.

Winter, S., Bauer, T., Strauss, P., Kratschmer, S., Paredes, D., Popescu, D., Landa, B., Guzman, G., Gomez, J. A., Guernion, M., Zaller, J.G., & Batáry, P. (2018). Effects of vegetation management intensity on biodiversity and ecosystem services in vineyards: A meta-analysis. Journal of Applied Ecology, 55(5), 2484-2495.

Xi, Z. M., Tao, Y. S., Zhang, L., & Li, H. (2011). Impact of cover crops in vineyard on the aroma compounds of *Vitis vinifera* L. cv Cabernet Sauvignon wine. Food Chemistry, 127(2), 516-522.

Zhao, Y., Sun, Q., Zhu, S., Du, F., Mao, R., Liu, L., Tian, B., & Zhu, Y. (2021). Biodiversity of non-Saccharomyces yeasts associated with spontaneous fermentation of Cabernet Sauvignon wines from Shangri-La wine region, China. Scientific reports, 11(1), 5150.