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Copper toxicity emerges as major threat to vine health and winemaking

Vinetur report details impacts of metallic elements on vine health and environmental sustainability

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A newly published report by Vinetur, titled "Metallic Elements in Vineyard Soils: Balance, Challenges, and Sustainable Strategies for the Future of the Sector", highlights a critical issue facing the wine industry: the rising impact of metallic elements in vineyard soils. The report, which synthesizes current research and expert recommendations, presents a comprehensive overview of how essential and toxic metals interact with vineyard ecosystems, influencing vine health, grape quality, and environmental sustainability.

The natural presence of metals like copper, zinc, iron, and manganese plays an essential role in vine physiology, from photosynthesis to nutrient transport. However, the report stresses that historical and ongoing agricultural practices, particularly the widespread use of copper-based fungicides since the late 19th century, have led to significant accumulation of metals in vineyard soils. This accumulation poses risks not only to vines but also to soil microbiota and, ultimately, to the quality and safety of the wine produced.

Legacy contamination in historic wine regions, combined with the impacts of climate change on soil chemistry and metal mobility, exacerbates the problem. Rising temperatures and altered precipitation patterns can change metal speciation, solubility, and plant uptake, increasing the risk of toxicity. Inorganic arsenic, cadmium, lead, and nickel—elements once introduced through fertilizers, pesticides, and atmospheric deposition—now persist in soils and may enter the food chain.

Copper toxicity, the most pressing concern, manifests in reduced vine growth, root damage, impaired photosynthesis, and iron chlorosis. Elevated copper levels also threaten yeast performance during fermentation, potentially affecting the entire winemaking process. Although vines tend to limit metal translocation to grapes, residues from foliar treatments can introduce metals into the must and, subsequently, the wine. The International Organisation of Vine and Wine (OIV) and European Union regulations have established strict maximum levels for metals in must and wine, including copper (1 mg/L in wine), zinc (5 mg/L), lead (0.2 mg/L), cadmium (0.01 mg/L), and arsenic (0.2 mg/L).

The report outlines several proactive strategies for vineyard management to mitigate metallic imbalances. These include comprehensive soil monitoring, strategic use of organic matter, biochar applications, soil pH adjustments, targeted fertilization, and fostering biological activity, particularly through the promotion of arbuscular mycorrhizal fungi (AMF) and plant growth-promoting rhizobacteria (PGPR). Cover cropping and reduced copper usage in fungicides are emphasized as key practices for maintaining soil health and minimizing further contamination.

The regulatory landscape is evolving, with the European Union proposing a Soil Monitoring Law to better track soil health parameters, including heavy metal contamination. However, the report notes the importance of establishing region-specific soil reference values, as natural geogenic metal levels vary significantly among different winegrowing regions.

The report concludes that sustainable viticulture in the face of metallic element challenges demands a shift from reactive to preventive management. Climate change, emerging contaminants like microplastics, and ongoing soil degradation require a coordinated, science-based effort among viticulturists, winemakers, researchers, and policymakers. Only through integrated strategies and a commitment to soil stewardship can the wine industry ensure the production of safe, high-quality wines for future generations.