

Agroecological frameworks for optimizing grapevine defense mechanisms against fungal pathogens through biodiversity integration and bio elicitors

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INTRODUCTION & AIM

The cultivation of *Vitis vinifera* L. currently confronts unprecedented physiological and phytosanitary provocations exacerbated by the intensifying global climate crisis. In traditional viticultural regions, the synchronization of erratic rainfall patterns with prolonged heatwaves has fundamentally altered the epidemiology of devastating fungal pathogens, most notably *Plasmopara viticola* and *Erysiphe necator*. This research aims to evaluate the transition from conventional, chemical-intensive plant protection models toward holistic agroecological frameworks. The primary objective is to investigate how strengthening the natural immunity of the vineyard ecosystem can mitigate the impact of climatic volatility while maintaining agricultural productivity.

These findings highlight that fostering a balanced, symbiotic interaction between the host plant and beneficial microbiota is a vital determinant for stabilizing viticultural production in an increasingly warming world. Ultimately, this transition not only lowers the toxicological pressure on the vineyard ecosystem but also enhances intrinsic resilience through improved ecosystem services and the activation of systemic plant defense mechanisms.

METHOD

The analytical approach evaluates the strategic integration of functional cover cropping and the promotion of spontaneous biodiversity as primary ecological tools. These methods are designed to modulate the canopy microclimate and suppress soil-borne inoculum levels through competitive exclusion. Furthermore, the study examines the efficacy of specific botanical extracts and antagonistic microorganisms, functioning as sustainable bio-elicitors within an integrated pest management (IPM) system. These biological alternatives are assessed for their capacity to trigger systemic acquired resistance (SAR) in the host plant, potentially replacing synthetic fungicidal applications.

CONCLUSION

The research concludes that prioritizing ecosystem-based services over conventional synthetic inputs is essential for the long-term viability and sustainability of the viticultural sector. By focusing on the complex synergy between functional biodiversity and the optimization of plant immunity, viticulturists can establish a resilient production model capable of withstanding escalating environmental volatility. This shift toward biological complexity serves as the cornerstone for developing sustainable plant protection programs tailored to the dynamic challenges of the current global agricultural sector.

RESULTS & DISCUSSION

Comprehensive synthesis of longitudinal field data indicates that agroecological interventions can effectively reduce the environmental chemical footprint by up to 40%. Empirical evidence suggests that both grape quality and yield stability are strictly preserved, even when subjected to the physiological pressures of moderate drought stress.

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