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COPPEREPLACE. Copper applications in organic viticulture are a real challenge today. Part 2 - Technical and practical implementation

Mario de la Fuente[1,2], António Graça[3], José Manso[3], Ivone Tomás[3], Natacha Fontes[3], Caroline Gouttesoulard[4], Bartosz Tylkowski[5], Magdalena Olkiewicz[5], Josep M. Montornes[5], Elena Sánchez[6], Emilio Gil[6]; Ruth Pereira[7,8], Anabela Cachada[8,9], Cristiana Paiva[7,8], Beatriz Fernandes[7,8], Verónica Nogueira[8,9], Cátia Santos[10], Leonor Pereira[10], Luís Marcos[10], David Fernández Calviño[11]

[1] CEIGRAM-Polytechnic University of Madrid, Spain
[2] Spanish Wine Technological Platform, Spain
[3] Sogrape, Portugal
[4] Institut Français de la Vigne et du Vin, France
[5] Eurecat, Centre Tecnològic de Catalunya, Unitat de Tecnologia Química, Spain
[6] Barcelona School of Agri-Food and Biosystems Engineering, Universitat Politècnica de Catalunya, Esteve Terradas, 8, 08860, Castelldefels, Spain
[7] GreenUPorto & INOV4Agro - Centro de Investigação em Produção Agroalimentar Sustentável, Portugal
[8] Departamento de Biologia, Faculdade de Ciências da Universidade do Porto, Rua do Campo Alegre 4169-007 Porto, Portugal
[9] CIIMAR - Centro Interdisciplinar de Investigação Marinha e Ambiental, Portugal
[10] Associação para o Desenvolvimento da Viticultura Duriense – ADVID, Portugal
[11] Universidade de Vigo, Departamento de Bioloxía Vexetal e Ciencia do Solo, Facultade de Ciencias, As Lagoas s/n, 32004 Ourense, Spain

In grape and wine production, one of the main relevant and recurrent diseases is downy mildew, caused by the fungus *Plamospara viticola*. It is frequently present in wine production worldwide, with a significant high annual incidence in some regions. Since the discovery of Bordeaux mixture (copper sulphate and lime) in the 1880's, many formulations based on copper (Cu) have been developed and used in viticulture production.

➥ https://coppereplace.com/

Work packages and activities description

Six Work Packages (WPs) were developed in the project. Using results from initial WPs[1], WP4 aimed at developing, validating and implementing an integral protection strategy against downy mildew in vineyards in order to reduce the environmental impact of copper usage.

An experimental protocol was co-created, agreed upon and deployed in real-sized commercial vineyards in three EU regions according to certified organic and integrated production modes: i) Bordeaux (France): 2.8 ha, organic, Merlot cv., ii) Narbonne (France): 1.5 ha, organic, Grenache cv., and iii) Douro (Portugal) 3.3 ha, integrated, Tinta Roriz cv.

The protocol was based on three strategies against downy mildew: i) new treatment protocol (NTP) using alternatives (copper gluconate and orange essential oil), ii) usual treatment protocol (UTP) with copper-based protection strategy[2], and iii) untreated control (CTL) to evaluate the severity of natural disease. Each treatment had three replicates with three full vine rows (>135 plants/row); sampling was carried out in the middle row (Figure 1). All sampling site soils (1 kg per row) were analysed (pH_{H2O}, pH_{KCl} % organic matter, organic carbon, total copper content and texture) before and after the treatments.

Relevant data (weather, phenology, sanitary) were also obtained.

Sprayer efficiency was tested with hydro-sensitive paper and the sprayer adjusted until adequate coverage was achieved.

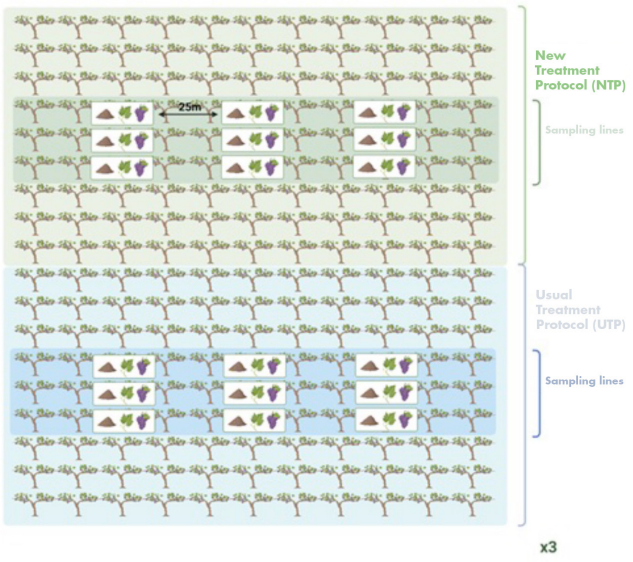


FIGURE 1. Experimental design of the field trials (soil, leaf and berry sampling).

WP5 developed a feasibility study that provided support for the adoption and implementation of project solutions. The results of a regulatory study were used to propose measures for policymaking. Economic, environmental and social data were obtained from questionnaires designed for both farmers and vineyards on environmental practices, yield/income, costs, investments and social indicators. The first questionnaire (2021) allowed a baseline diagnosis to be carried out, before implementation of the project's solutions, and the second questionnaire (2022) surveyed partners involved in field trials of new treatment protocols to establish the observed variation.

Finally, a stakeholder network was established (WP6) with a view to evolving into a community of practice and serving as a platform for dialogue with public authorities and policymakers. This will provide a clear vision of the project's progress, challenges and potential solutions, thus allowing regulatory adjustments to be made to promote the adoption of copper-smart viticulture practices.

Results

Very low downy mildew pressure was observed in the Narbonne and Douro sites (2 sprayings instead of the usual 5, copper reduction up to 75 % in UTP), and thus production was unharmed until harvest and no relevant results were obtained.

At the Bordeaux trial site, 6 sprayings were applied according to the observed risk level. At flowering, no signs of infection on the bunches were observed for any of the treatments (including CTL), nevertheless, they appeared on leaves, but with no significant differences among treatments. At bunch closure, UTP bunches had higher intensity and frequency of infections than NTP, a pattern also observed on leaves (Figure 2).

Regarding copper deposition in the vineyards (Figure 3), UTP appeared to have significantly higher Cu accumulation in leaves than NTP in both sampling periods, but no differences were found in grape or soil content.

In 2022, hail struck the Bordeaux site just before veraison, leading to a severe outbreak of downy mildew that fully destroyed the crop that had been treated with both CTL and NTP treatments. The UTP treatment was able to save 35 % of the bunches. Until this moment, copper doses were 3.493 (kg/ha) in UTP versus 1.913 (kg/ha) in NTP.

Therefore, NTP was effective under moderate downy mildew pressure but showed inadequate protection against the outbreak caused by hail damage, leading to catastrophic production loss.

A feasibility study (WP5) was executed to analyse the different solutions using different scenarios of technological investment, production and vineyard typology depending on the specific conditions of each region. A questionnaire was developed in order to characterise the vineyard and cellar. The study addressed the three pillars of sustainability: environmental (copper reduction capacity, soil erosion and contamination, water contamination and effects on biodiversity); economic (employability indicators, yield/income, costs

The translation of this article into English was offered to you by Moët Hennessy. Moët Hennessy

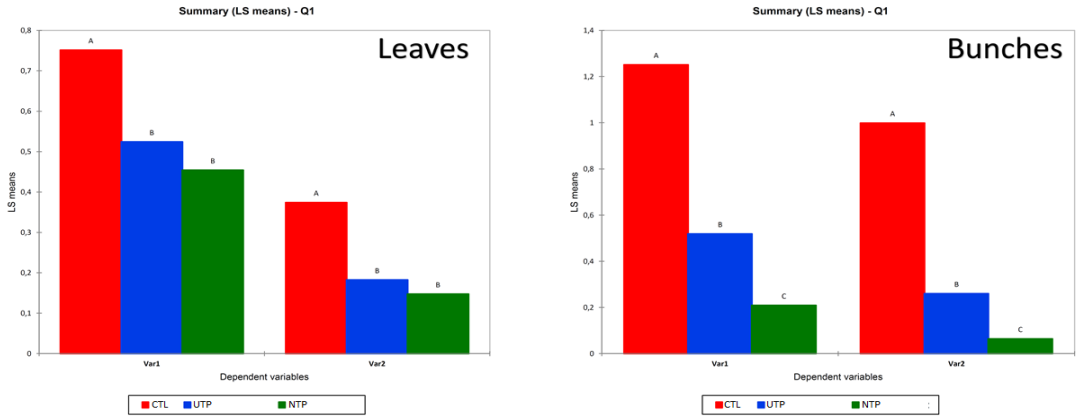


FIGURE 2. Statistical significance (LS means) analysis of differences between treatments in leaves and bunches at bunch closure phenological stage in the Bordeaux trial. ANOVA-Tukey HSD, Fischer LSD, Neuman-Keuls SNK tests; different letters a top bar mean statistical differences.

and investments, etc.) and social (worker safety and well-being, food safety, community impacts, technological conversion of rural areas).

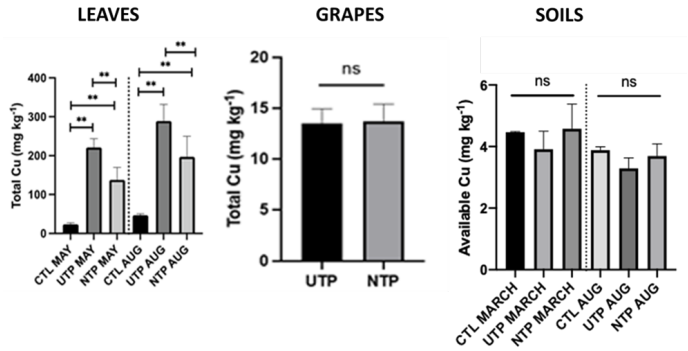


FIGURE 3. Total Cu (mg/kg) deposition on leaves, grapes and soils per treatment in the Bordeaux trial (2022). CTL = untreated control, NTP = new treatment protocol and UTP = the usual protocol.

The results obtained from both questionnaires (2021and 2022) show that:

➡Integrated production already allows for a low-copper approach to control downy mildew.

➡In organic production, a potential copper reduction of 40 to 60 % is possible when combined with smart spraying techniques. Coupling alternative substances with precision technologies[3] shows promise, inducing the requalification of farm labour and overcoming remoteness and depopulation in rural areas, thereby enhancing employment.

➡However, this approach could be less successful in years with high disease pressure, thus requiring the formulation of contingency plans. Cost of new treatments depends on disease pressure, being potentially more expensive than conventional ones in the case of high disease pressure. Nevertheless, they do not incur additional costs (equipment, labour or training). In the case of low to moderate disease pressure, profitability remains unaffected. However, winegrowing regions were found to differ considerably in terms of cost (Figure 4), indicating that there are different and specific solutions for reducing Cu according to context. Farmers were generally concerned about reducing their copper use. They were also concerned about the lack of effective strategies to deal with high disease pressure and by the higher cost of the alternatives. Better lower-impact copper formulations seem to be a way of lowering dispersion in the environment.

➡The adoption of innovations can come up against hurdles; e.g., legal constraints, associated costs and product supply challenges. Adoption is currently slow due to the inexistence of a standardised legal framework for plant protection product (PPP) homologation across EU member-states.

➡Any new product or protocol is only implemented after field validation (≥ 3 years is recommended). Soil analysis showed pH as the most influential parameter in copper bioavailability and toxicity. More tests are needed that take into account more soil types.

In WP6 (policymaking and technical stakeholder group), results were validated during workshop sessions (policies and technology) and a communication strategy was developed. Some remarks made:

1. Need for standardised labelling using the same units for product dosage. Current dosage information for copper was revealed as potentially misleading for farmers.
2. Need to increase the integrated use of sustainable agricultural practices (e.g., phyto-depuration, cover cropping, etc.).
3. Incentivise training and knowledge transfer, including on farms (and for wine tourism staff). This is of particular importance regarding new technologies (e.g., variable rate application) for end-users, small companies, farmers, viticultural workers and technicians. The need for better and more focused technical and academic education was noted. Participants considered that the costs associated with being sustainable are not transferable to shelf price.
4. Remove identified hurdles (i.e., the limits to testing new bio-based extracts or products) between countries and their national registers (different legislation) at EU level.
5. Better results are needed in real-scale field trials.
6. The need for an active SUDOE Stakeholder Network of Knowledge (SNK) to coordinate transfer actions and maximise impacts was identified.

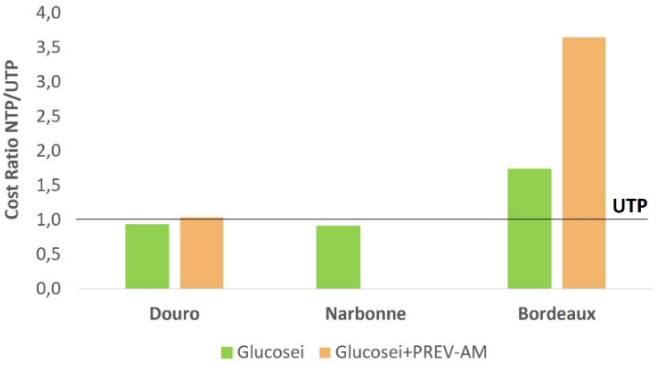


FIGURE 4. Comparison of costs when applying the new treatment protocol (NTP) with and without essential orange oil (PREV-AM) and the usual protocol (UTP) across three trial sites.

A European conference on copper in late 2024 is being planned to inform the European Commission and Parliament of the efforts being made in viticulture to meet European targets. ■

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1 COPPEREPLACE 1. Copper applications in organic viticulture are a real challenge today. Part 1 - Scientific Activities. *IVES Technical Reviews.* https://doi.org/10.20870/IVES-TR.2024.8242

2 Bordeaux site: Bordeaux mixture and copper hydroxide; Narbonne site: copper sulphate; Douro site: fluocopilide with fosetyl-al and copper oxychloride with mandipropamid.

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