CLIMED-FRUIT

Adaptation to climate change and mitigation for perennial crops in Mediterranean Area

HORIZON-CL6-2021-GOVERNANCE-01-23 _ CSA
PROJECT 101060474

Oct.2022 – Sept.2025

Deliverable 3.2 12 additional extended practice abstracts, including cost/benefit analysis

Start date of the project	01/10/2022
Duration of project	36 months
Deliverable n° & name	D3.2 : 12 additional extended practice abstracts, including cost/benefit analysis
Version	1
Work package n°	3
Due date of Deliverable	30th May 2025
First date of publication	30th May 2025
Second date of publication	30th September 2025
Participant responsible	UNE
Main authors	N.Blazquez & M.Gomez & M.Sanzo

Nature of the deliverable		
R	Document, report (excluding the periodic and final reports	X
DEM	Demonstrator, pilot, prototype, plan designs,	
DEC	Websites, patents filing, press & media actions, videos, etc.	
OTHER	Software, technical diagram, etc.	
Dissemination Level		
PU	Public, fully open, e.g., web	X
SEN	Sensitive, limited under the conditions of the Grant Agreement	
CO	Confidential, restricted under conditions set our in Model Grant Agreement	
CI	Classified, information as referred to in Commission Decision 2001/844/EC	

	Quality procedure			
Date of delivery	Version	Date of review	Reviewers	Comments
30/05/2025	V1	29/05/2025	Clara Gérardin	
30/09/25	V2	29/09/25	Clara Gérardin	

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Acknowledgement

This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No. 101060474 (CLIMED-FRUIT). This output reflects only the author's view, and the European Union cannot be held responsible for any use that may be made of the information contained therein.

More information on the project can be found at project website.

Project summary

CLIMED-FRUIT aims to share knowledge ready for practice, collected from different Operational Groups (OG) across Europe, for a better adaptation to climate change and mitigation, in perennial crops in the Mediterranean Area (grape vine, olive, fruits). The project builds on the results of a core group of 9 OG coordinated by a multi-actor consortium members (advisors, farmer organisations, research and education institutes, standardisation organisation), covering several Mediterranean crops in 7 different countries (France, Spain, Portugal, Greece, Italy, Croatia, Serbia). Best practices collected and shared range from (i) soil conservation and carbon storage, (ii) improving resilience of crops facing climatic hazards (frost, hail), (iii) innovative practices for adapting water stress management, (iv) adaption of food chain processes to climate change and diversification, and (v) preserving biodiversity for a better resilience to climate change issues and pests. These groups will share their experience through a combination of innovative digital formats, cross-visits and interactive local dissemination events. In addition, new knowledge and practices will be gathered more widely by organising an open contest. Participants from other European projects, other EIP OGs or even international projects from the Mediterranean area will be invited to propose abstracts. The most applicable solutions will be selected and pitched in a broad online conference. Participants will be invited to rank the best presentations according to cost/benefit ratio, which will then be widely disseminated and shared. Social media channels, videos, podcasts, crowd writing contests will be used to spread the knowledge. Specific editorial partnerships will be established with most popular technical reviews. The network will host a forum to capitalise on existing OG experiences and aims to foster new OGs to spread and explore new practical knowledge in relation to adaptation to climate change.

Objective and executive summary

The goal of deliverable D.3.2 is to develop 12 additional extended practice abstracts, including cost/benefit analysis for the new selected best practices from the Open contest winners with the purpose of disseminating the practical knowledge of the practices. The templates for the EPA and CBA were produced under WP 1.

The EPA structure consists of a presentation of the practice and the CBA conducted, as well as a presentation of the OG or researcher who developed the practice. Each section includes a bibliography to help users find out more, as well as other useful resources. Contact information is also provided for both the practice description and the OG presentation, since these can be read separately.

A specific cost/benefit analysis has been conducted on the 12 new selected practices, according to the methodology already defined in D1.6 and implemented under Task 2.3 on material from the OG core group.

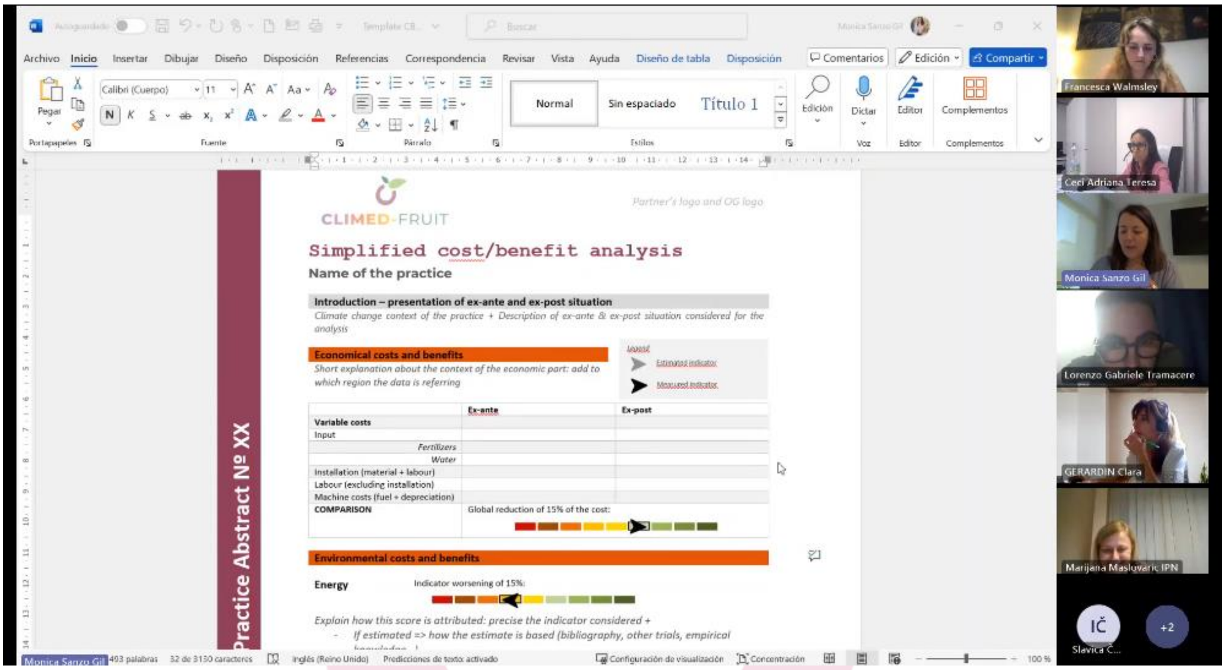
As a first step a Mentoring workshop was organised to explain objective of this deliverable, how the cost/benefit analysis (CBA) was produced and how the Open contest winners shall complete their CBA based on the info collected when implementing their best practice.

Once the Open contest winners completed the CBAs they have been reviewed by the consortium and sent back the Open contest winners with proposals for modifications, to complete data, bibliography details and to clarify any specific point.

Mentoring workshop

The list of the 12 Open contest winners was produced in D3.1. and it is included in annex 1.

On July 10th, 2024 a Mentoring workshop was organised with the Open contest winners to explain the goals of this activity and show them how to complete the CBA. The participants posed different questions that were solved during the workshop.



The recording of the workshop has been uploaded in the platform for future consultations.

Support to Open contest winners for CBA revision

Once the Open contest winners completed the CBA. The documents were reviewed by the consortium to assess the quality of the data included, to provide clarifications on specific items, to incorporate bibliography details, comments and proposals for modification to the OCWs when relevant.

The final OCWs CBAs are included in annex 2.

Challenges

In some cases, the OCW faced difficulty to complete all the information on the CBA template as there were no data available, no collected information or traceability because of the experimentation time of the practices or the difficulty to measure some of the values. Therefore, it is recommended to raise awareness about the CBA methodology in the early stages of the best practice implementation.

The Open contest winners committed themselves, on a voluntary basis, to complete the EPA, and the consortium made big efforts to get the contributions and support the OCW. Nevertheless 1 OCW (N.12, see annex 1) has not been able to prepare its relevant EPA and abandoned. And 1 OCW (N.9, see annex 1) has no data or related bibliography to complete the CBA, he focused on completing its digital story.

To mitigate this situation and in order to provide the maximum practices in the EPA format the consortium prepared 1 additional EPA: Improving the shelf life of organic table grapes through an innovative packaging system endowed with a breathable device (BlowDevice® Technology) included in D 4.3.

ANNEX 1

List of final 12 winners of the Open Contest and relevant EPA

OG	Represented by	EPA number
Introduction of disease-resistant/tolerant grape varieties for sustainable winemaking, enhanced occupational health and to address climate change	Boselli Emanuele - Free University of Bozen-Bolzano, Italy	**11**
Integrated management of olive anthracnose disease	Tsitsigiannis Dimitrios - Agricultural University of Athens, Greece	**12**
Innovative biostimulant and biofertilizer formulations of natural origin allocated for use in conventional and organic agriculture	Mulet Salort José Miguel - Instituto de Biología Molecular y Celular de Plantas (IBMCP), Universitat Politècnica de València-Consejo Superior de Investigaciones Científicas, Valencia, Spain	**13**
Kuhl's pipistrelle bat and its relation to the European grape vine moth Lobesia Botrana	Martinez Juan - Cavanilles Institute of Biodiversity and Biology of the University of Valencia, Bodegas Enguera, AVA-ASAJA, Spain	**14**
The use of a self-reseeding cover crop under the rows: an agroecological solution to reduce tillage and herbicide use in vineyards	Tramacere Lorenzo Gabriele - University of Pisa, Italy	**15**
Kaolin effect on vine development and wine quality in Mediterranean vineyards	Martinez Juan - Center of Research in Desertification (CIDE) and Bodegas Enguera, Spain	**16**
The new threat to Mediterranean viticulture: the grape leafhopper (Jacobiascalybica and Empoasca Vitis)	Martinez Juan - Institute Cavanilles of Biodiversity and Biology of University of Valencia, Bodegas Enguera, Association of Organic Farming of Valencia Community (SAEM), Spain	**17**

Effect of different soil and vegetation management of vineyards on arthropod diversity and physiological characteristics of the vine	Maia Gabriela - Departamento de Agronomia, Universidade de Trás-os-Montes e Alto Douro, 5000-801 Vila Real, Portugal	**18**
Tillage and frost in the vineyard: how can we anticipate practices to avoid increasing risks?	Delanoue Guillaume - Institut Français de la Vigne et du Vin, France	**19**
Shading net – a multifunctional tool to counteract the environmental adversities in vineyard	Cola Gabriele - Università degli Studi di Milano, Italy	**20**
Novel solutions for termination of winter cover crops in vineyard aimed at increasing drought resilience under Mediterranean conditions	Poni Stefano - Department of Sustainable Crop Production, Università Cattolica del Sacro Cuore, Piacenza, Italy	**21**
Operationalizing the "eddy covariance" technique to certify carbon farming in vineyards	Pitacco Andrea - University of Padua - DAFNAE, Italy	**22**

ANNEX 2

Additional extended practice abstracts, cost/benefit analysis

The following pages contain 9 open contest winners' EPAs, each consisting of a description of the practice, the CBA, and a description of the OG that implemented the practice.

The EPA structure consists of a presentation of the practice and the CBA conducted, as well as a presentation of the OG or researcher who developed the practice. Each section includes a bibliography to help users find out more, as well as other useful resources. Contact information is also provided for both the practice and the OG presentation, since these can be read separately.

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Risk management and worker wellbeing on PIWI farms

Extended Practice Abstract Nº 11

Challenge

Agriculture is a high-risk sector in terms of work injuries. Worker turnover and seasonal work are critical points for farm management. Therefore, worker well-being, both family workers on family farms and paid workers, is essential for efficiency and social sustainability.

Solution

The cultivation of resistant varieties, such as PIWI, can lead to limited chemical exposure, reduced risk of injury related to tractor and mechanical tool use and a healthier work environment. By planting resistant varieties, farmers reduce treatments in the field, working time, emissions and soil compaction.

Benefits

Higher worker satisfaction — including family workers — will support lasting engagement in climate sustainable practices, such as reducing chemical and fuel use reduction in agriculture.

Applicability box

Theme
Adaptive management
Energy efficiency
Pest management
Soil health
Value chain

Context
Grape production in challenging areas (cool climates, logistical challenges, pest management in touristic areas)

Application time
Any time

Required implementation time
Not identified

Period of impact
Not identified

Equipment
No specific equipment is required.

Practical recommendation

Part of the overall sustainability and support environmental pillar is social sustainability. The workforce must be actively engaged in achieving this kind of sustainability, and there are several areas that influence workplace well-being, according to worker statements. Useful practices are:

- Reducing injuries through resistant varieties and careful pest management
- Providing security plans and individual safety devices
- Security training and specific courses in addition to consolidated security practices
- Managing working time management and following plans, avoiding overload and exhaustion
- Involving workers in decision-making, planning and defining strategies
- Gender sensitivity and equal opportunity practices
- Providing opportunities for personal and professional development such as training, internships, exchanging practices as well as days off to experience something new and different
- Assuring sufficient income, in line with the cost of living

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Extended Practice Abstract Nº 11

Figure 1: A harvest day at a PIWI farm

Further information

Videos

[Events – Home (wordpress.com)]

Web links

[Home (wordpress.com)]

Further reading

[Publications – Home (wordpress.com)]

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Project partners: South Tyrol wineries

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Extended Practice Abstract Nº 11

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Simplified cost/benefit analysis

PIWI grape variety performance

Introduction – presentation of ex-ante and ex-post situation

PIWI grape varieties are resistant or more tolerant to certain fungal diseases. In specific contexts, such as mountainous or marginal lands, cultivating PIWI varieties could offer several advantages, especially considering that the quality of the wines produced from these grapes is now good. The resistance to particular pathogens, introduced either through traditional breeding programs or advanced techniques like assisted evolution and biotechnological strategies, would enable PIWI varieties to reduce the number of crop protection treatments during grape cultivation. This is significant, as these treatments are among the primary sources of environmental impact in the grape-wine supply chain. Reducing them can also lead to savings in both costs and labour and limiting the rural population's exposure to xenobiotic products. A comparative study was conducted in South Tyrol (46–47° N), a winegrowing region where viticulture is practiced from 220 m a.s.l. to over 1000 m a.s.l., to evaluate the performance of PIWI and non-PIWI varieties.

Economical costs and benefits

For the economic evaluation, the estimations are based on data from the farmer advisory organisation Beratungsring[1] and refer to a typical family-run farm in South Tyrol. The typical farm has two permanent employees and additional support during peak work periods. It cultivates 3 ha of vineyards, yielding 10 t/ha·yr. In terms of costs, integrated and organic management practices are considered equivalent.

Legend

Estimated indicator

Measured indicator

	Ex-ante	**Ex-post**
Crop protection	€2066.57/ha·yr About 16% of total annual costs	
Material (fungicides, insecticides, acaricides)	About 53% of annual material costs Materials account for 11% of total annual costs	About 25% of ex-ante
Machines and equipment (fixed + variable costs)	Account for 26% of total annual costs	About 50% of ex-ante regarding diesel consumption and 40% regarding maintenance costs
Labour	About 5.5% of annual labour costs Labour accounts for 63% of total annual costs	About 2.5% of ex-ante
COMPARISON	Expected cost reduction >27%:	
Economical benefits: The reduction in variable costs related to crop protection relies on limiting the number of treatments required. Assuming that PIWI varieties allow treatments against fungal pests to be reduced by 50%, the associated reduction in labour and material costs would be approximately 2.5% and 25%, respectively. As far as machinery is concerned, diesel consumption would decrease by 50%, with an estimated 40% reduction in maintenance costs. Considering the impact of these factors on total annual costs, the overall reduction exceeds 27%.		

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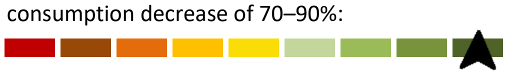
Environmental costs and benefits

Data refer to a two-year period (2022 and 2023) and were collected from four farms located in South Tyrol. The operations considered include crop protection and fertilisation. The number of treatments ranged from three (PIWI) to 20 (organic farm) in a production season. In 2023, the summer was slightly rainier, leading to an increase in treatments on organic farms only. At the provincial level, the rainfall in the April–September period for the areas studied was between 400 and 800 mm/year; at the provincial level again, an anomaly of negative rainfall was recorded in 2022 (-28 mm) and positive in 2023 (+132 mm). In particular, in some of the areas studied in 2023, the rainfall in the months of July and August was approximately double that of the same months in 2022.

The following findings should be considered preliminary and not generalisable. Due to the inherent variability in agricultural systems, further observations will be necessary, both across a wider geographical area and over a longer timeframe.

Energy	Fuel consumption decrease of 70–90%: 
In 2022, the PIWI vineyard required 80% less diesel compared to the vineyard with highest consumption (using a tractor with similar power) and 70% less than the non-PIWI vineyard on the same farm. In 2023, diesel consumption for treatments was reduced by 90% compared to the vineyard with maximum consumption (similar tractor, different farm) and 80% less than the non-PIWI vineyard on the same farm. This significant reduction is due to the need for fewer treatments as compared to non-PIWI varieties in the observed data, but the effect of the tractor's power should also be noted.	
Water	Further observations are required: 
In 2022, a 60% variation was observed in the amount of water used for crop protection treatments, with high amounts required for the PIWI variety. In 2023, non-PIWI varieties showed a 25% increase in water use with respect to 2022, while PIWI varieties registered a reduction between 40% and 57%.	
Soil	Unmeasured impact: 
This aspect was not studied in deep detail in the present research to allow for quantification.	
Air	Global worming 40%, Particulate 60%: 
Based on life cycle assessment (LCA)[2] conducted using observed data referring to 1 ha of cultivated land (ReCiPe Midpoint H method), the reduction in *Global warming* impact is around 40%, while *Fine particulate matter formation* is reduced by around 60%, both with respect to the worst non-PIWI variety performer of the dataset considered. This latter indicator, in the specific context, is largely influenced by diesel consumption, which depends on tractor operating hours, power and working conditions.	

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Biodiversity	Not measured:

No direct biodiversity measurements were carried out in the project. However, some results are reported on ecotoxicity indicators and values of plant protection products used, derived from the data processed in the project. It is hoped that sharing this information will be useful for future studies, including the planning of direct field measurements using the appropriate biodiversity indicators.
Based on LCA conducted using observed data referring to 1 ha of cultivated land (ReCiPe Midpoint H method), the reduction in Freshwater and Marine ecotoxicity indicators is about 50%. *Terrestrial ecotoxicity* in PIWI varieties is even lower. The reduction is observed in respect of the worst performer (integrated production) and is very high also thanks to the synergic effect of organic farming practices. This last indicator, in this specific context, largely depends on diesel consumption, which depends on the tractor's operating hours, power and working conditions. Fuel consumption information is compatible with 5- to 12-year-old tractors equipped with turbo engines with thermal efficiency ranging from 34% to 37%. In vineyard conditions, engine loads vary between 50% and 80% of the tractors' rated power, with field efficiency indices varying between 65% and 75%. The working context of the vineyards considered is characterised by inter-rows with an average width of 2.2 m and slopes between 10% and 18%.
The data indicate a significant reduction in pesticide use for the PIWI vineyard, with a decrease of up to 99% in total active ingredients, 83% for copper and 98% for sulphur. The amount of sulphur used was halved, even though both the copper and sulphur were organically managed. However, it should be noted that these figures are highly dependent on seasonal trends.

Bibliography and sources

(1) Centro di Consulenza per la fruttiviticoltura dell'Alto Adige: https://www3.beratungsring.org/it/home
(2) ReCiPe LCIA Method: https://www.rivm.nl/en/life-cycle-assessment-lca/recipe

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Extended Practice Abstract Nº 11

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SUWIR - Prospects for wines from disease-resistant grape varieties (PIWI wines) in South Tyrol to support sustainability, climate adaptation, corporate social responsibility: a scientific basis for regulatory update

Short description of the project

The project aims to explore the potential of PIWI wines in South Tyrol by comparing their quality and impact with conventional wines. Its key objectives include understanding consumer attitudes, assessing social, environmental and economic impacts for wineries, and developing policy recommendations to support sustainable wine production. The challenges are the different quality characteristics, legislative aspects, consumer awareness of these products, their degree of acceptance, and the assessment of social, environmental and economic impacts for neighbouring businesses also.

Benefits

Wines produced from PIWI varieties may help reduce crop protection operations in vineyards and improve the quality of work in areas with difficult logistics, such as marginal mountain environments.

Stage of implementation

The project is in progress and the data are currently being analysed. The project is scheduled for completion in early 2025.

Key data box

Theme
Grapes; climate change adaptation, wines, value chain, pest management

Context
Grape production in challenging areas (cool climates, logistical challenges, pest management in touristic areas)

Duration
3 years

Partners involved
Free University of Bozen-Bolzano (Italy):
Faculty of Agricultural, Environmental and Food Sciences
Faculty of Education
Faculty of Engineering
Competence Centre on Plant Health
South Tyrolean wine producers (conventional and PIWI)

Particularity
A multidisciplinary approach involving agricultural aspects, chemical instrumental and sensory analysis, engineering and social sciences

Main achieved or expected results

1. *Comparative chemical and sensory analyses of at least 10 wines from disease-resistant grape varieties and their blends versus conventional wines under similar agronomic and technological conditions, providing insights into quality and performance.*
2. *Evaluation of the potential reduction in the use of pesticides and other environmentally harmful practices in vineyards cultivating these varieties.*

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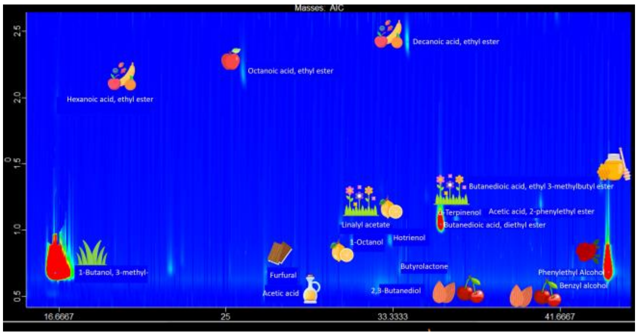
3. *Understanding consumer attitudes and acceptance towards wines from disease-resistant grape varieties (PIWI wines).*
4. *A systematic study of the opinions of producers to understand their perspectives on cultivating these varieties.*
5. *Evaluation of the social, environmental and economic impacts of using disease-resistant grape varieties for wineries, focusing on sustainability benefits.*
6. *Development of policy recommendations to support local stakeholders in transitioning to sustainable viticulture practices and eco-friendly wine production systems.*

Figure 1: Landscape of South Tyrol (Italy)

Figure 2: Solaris' genealogy (white resistant grape variety)



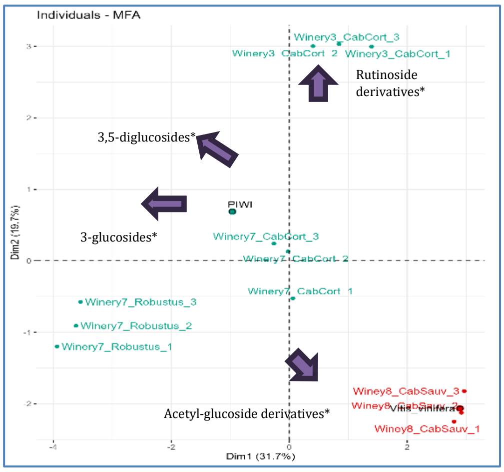


Figure 3: Quality characteristics of PIWI wines: volatile (left) and anthocyanin profiles (right)

Existing materials

Videos: [Events – Home (wordpress.com)]

Website of the Project: [Home (wordpress.com)]

Further Reading: [Publications – Home (wordpress.com)]

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Project partners: South Tyrol wineries

This extended practice abstract was elaborated in the CLIMED-FRUIT project.
Project website: https://climed-fruit.eu/

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Extended Practice Abstract Nº 12

Integrated smart system for olive anthracnose management using predictive models and targeted IPM treatments

Challenge

The GleoControl project operates primarily in Western Greece, where climatic conditions such as increased humidity favour the spread of anthracnose. The project includes extensive sampling from various regions and microenvironments to tailor disease management solutions.

The project addresses the growing threat of olive anthracnose, a disease intensified by climate change factors such as rising humidity and temperature fluctuations.

Solution

The GleoControl project develops integrated pest management (IPM) by combining chemical and biological treatments, resistant olive cultivars and predictive modelling combining meteorological data with disease patterns to optimize treatment timing.

Benefits

GleoControl will equip farmers with an eco-friendly solution combining a weather-based predictive model with strategic rotation of biological and chemical treatments.

Applicability box

Theme

1. Pest management
2. Adaptive management
3. Climate change adaptation
4. Digital technologies

Application time

The GleoControl practice is primarily applied during high-risk periods in spring (flowering), late summer (fruit setting) and autumn (ripening). Adjustments are made based on real-time weather conditions and disease risk indicators throughout the cultivation cycle.

Required implementation time

Implementing the GleoControl practice requires ongoing monitoring throughout the cultivation season, with treatment applications typically taking a few hours per treatment. Each intervention is conducted only as needed based on predictive model alerts, minimizing total treatment time across the year.

Period of impact

The GleoControl practice is expected to have an impact throughout the cultivation season, with cumulative benefits evident in crop yield and olive oil as well as table olive quality by harvest time.

Equipment

Standard spraying equipment is needed for treatment applications, in addition to weather stations with access to meteorological data and a decision support system with a prediction model application.

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Practical recommendation

• Monitor meteorological data
Regularly check meteorological data through the predictive model to identify high-risk periods for anthracnose outbreaks, focusing on humidity, temperature and rainfall.

• Assess crop condition and growth stage
Evaluate the olive crop's growth stage and overall plant health, as disease susceptibility varies; prioritise stages such as flowering and ripening.

• Implement IPM programs for disease control
Apply targeted treatments only when the model indicates favourable conditions for the disease. Alternate between fungicides with different active substances and mode of action to minimise pathogen resistance (Figure 1).

• Use biological plant protection products
Integrate biological fungicides where possible, especially during pre-harvest stages, to reduce chemical residues and protect the environment.

• Monitor IPM programme effectiveness
Continuously assess the treatment impact on disease severity and adjust methods as needed.

Months	T (◦C)	RH(%)	Max.no. of applications	Suggested PPPs that showed high efficacy in all the experimental procedures
April	Mild (14-25◦C)	-	1	Synthetic PPPs (e.g. Priori Top®, Ortiva top®, Insignia®), Copper compounds, bioPPPs
May			1	
August	Low (<30◦C)	mild/ high	1	Synthetic PPPs (e.g. Score®), Copper compounds, bioPPPs
September	Mild (14-25◦C)	mild/ high	1 or 2	Copper compounds, Synthetic PPPs (e.g. Syllit®, Score®), bioPPPs
October (ripening)	High (>10-14◦C)	mild/ high	1 or 2	bioPPPs
November (ripening)	High (>10-14◦C)	mild/ high	1 or 2	bioPPPs

Figure 1. *IPM programmes. The treatment schedule outlines targeted applications aligned with meteorological data, ensuring sprays are used only when disease risk is high, optimising crop protection and minimising environmental impact.*

Further information

Videos: https://www.youtube.com/watch?v=DQs9WcMXON0&t=3s

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Extended Practice Abstract Nº 12

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Project partners: Agricultural cooperative – Union of Agrinio (https://www.e-ea.gr/)

This extended practice abstract was elaborated in the CLIMED-FRUIT project.

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Extended Practice Abstract Nº 12

CLIMED-FRUIT

AGRICULTURAL UNIVERSITY OF ATHENS

Simplified cost/benefit analysis

Integrated smart management system for olive anthracnose

Introduction – presentation of ex-ante and ex-post situation

Climate change has intensified the prevalence of olive anthracnose in the Mediterranean Basin, with increased humidity and temperature fluctuations creating optimal conditions for the disease to spread. In the ex-ante situation, farmers rely on conventional pesticide applications based on fixed schedules without considering weather predictions, often leading to the excessive and untimely use of chemicals. This management not only risks environmental degradation but also affects the quality of the produced olives, as excessive pesticide use may result in harmful residues when/if applied near harvest. Furthermore, there is the added risk that without knowing the right application timing, farmers might delay applications, potentially allowing the disease to spread quickly, causing significant crop damage.
In the ex-post scenario, the GleoControl project incorporates: 1) meteorological data with a predictive model so that treatments are applied only when necessary, reducing pesticide application frequency and enabling precise, timely intervention for a more effective disease management; 2) optimal use of efficient biological and chemical plant protection products; and 3) use of either tolerant or resistant olives cultivars to anthracnose disease.

Economical costs and benefits

Legend

Estimated indicator

Measured indicator

The economic context of this analysis focuses on olive growing in the Mediterranean region, where olive anthracnose is a notable challenge, causing reduced yields and a decline in olive oil quality. The GleoControl project applies integrated pest management (IPM) management, including weather-based predictive models and strategic pesticide rotation, to help reduce crop losses and improve economic outcomes for farmers. It is important to note that there are no specific economic data records available for Greece, nor does the GleoControl project aim to gather such economic data. Instead, this context is based on findings from existing literature on similar IPM applications in the Mediterranean, which demonstrate improvements in crop protection, optimised treatment timing, reduced chemical input and the resultant benefits for product quality.

	Ex-ante	**Ex-post**
Variable costs		
Yield losses	€300 million worth of product losses yearly [1]	€120–240 million worth of product losses yearly [2]
COMPARISON	Global reduction of 20% of the cost:  Reduction in total costs due to efficient pesticide use, which generates economic and ecological benefits for farmers by reducing losses	

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Environmental costs and benefits

<table>
<tr><td>Energy</td><td>Indicator improvement of 20%:
</td></tr>
<tr><td colspan="2">Improvement due to lower fuel consumption due to fewer pesticide applications. This reduction is also caused using tolerant cultivars.
This indicator is estimated through fuel consumption and application frequency obtained in similar GIP trials and empirical results that demonstrate lower fuel use due to targeted spraying[3].</td></tr>
<tr><td>Water</td><td>Approximate indicator improvement around 10%:
</td></tr>
<tr><td colspan="2">This indicator is estimated through empirical knowledge; water quality improves as runoff polluted with pesticides is reduced, thus reducing the pollution of local waters.</td></tr>
<tr><td>Soil</td><td>Indicator improvement up to 15%:
</td></tr>
<tr><td colspan="2">Soil health is considered for this indicator, measured as organic matter content and microbial biodiversity. In this case, this indicator improves because reducing the input of chemical products maintains microorganisms and soil structure, as has been seen in related studies[4].</td></tr>
<tr><td>Air</td><td>Approximate indicator improvement around 20%:
</td></tr>
<tr><td colspan="2">This indicator is estimated through empirical knowledge. There is a positive impact due to reducing emissions from chemical applications and promoting the use of biological treatments.</td></tr>
<tr><td>Biodiversity</td><td>Indicator improvement up to 15%:
</td></tr>
<tr><td colspan="2">This indicator considers the presence and diversity of beneficial soil organisms. It is estimated through the literature consulted, where it has been observed that biodiversity improves with IPM[5] since the dependence on pesticides is reduced and beneficial organisms are favoured, promoting ecological balance.</td></tr>
</table>

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Bibliography and sources

(3) Kolainis S, Koletti A, Lykogianni M, Karamanou D, Gkizi D, Tjamos SEl. (2020) An integrated approach to improve plant protection against olive anthracnose caused by the *Colletotrichum acutatum* species complex. PLoS ONE 15(5). https://doi.org/10.1371/journal.pone.0233916

(4) Pretty, J., & Bharucha, Z. P. (2014). Sustainable intensification in agricultural systems. Annals of Botany, 114(8), 1571-1596. https://doi.org/10.1093/aob/mcu205

(5) Lamichhane, J. R., Dachbrodt-Saaydeh, S., Kudsk, P., & Messéan, A. (2016). Toward a reduced reliance on conventional pesticides in European agriculture. *Plant Disease*, 100(1), 10-24.

(6) Pretty, J. N., Williams, S., & Toulmin, C. (2012). Sustainable intensification: increasing productivity in African food and agricultural systems. Routledge. https://doi.org/10.4324/9781849776844

(7) Chen, B., Liu, E., Tian, Q. et al. Soil nitrogen dynamics and crop residues. A review. *Agron. Sustain. Dev.* 34, 429–442 (2014). https://doi.org/10.1007/s13593-014-0207-8

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Extended Practice Abstract Nº 12

GleoControl Operational Group: integrated smart management system for olive anthracnose

Short description of the OG

GleoControl is an operational group focusing on the development of an integrated management system to control olive anthracnose, a major disease affecting olive crops, especially in western Greece. This project aims to implement biological and chemical methods and disease prognostic models to monitor and control the spread of the disease, thereby enhancing productivity and sustainability for Greek olive producers.

The GleoControl project employs an innovative approach, developing integrated pest management (IPM) systems that combine chemical and biological pesticides to manage olive anthracnose. Additionally, it identifies olive varieties that are either sensitive or resistant to the disease — a previously unavailable insight that significantly aids with managing and reducing the disease's impact on olive crops. The project also utilises precision agriculture technologies by integrating meteorological data with epidemiological information, enabling targeted and timely interventions that enhance both ecological and economic outcomes for farmers.

Benefits

The GleoControl project provides farmers with a cutting-edge, integrated management system for effectively controlling olive anthracnose, resulting in healthier olive crops.

Stage of implementation

The project is currently in progress and is scheduled for completion in September 2025.

Key data box

Theme

1. Adaptive management
2. Climate change adaptation
3. Digital technologies
4. Pest management

Context

GleoControl operates primarily in Western Greece, where climatic conditions such as increased humidity favour the spread of anthracnose. The project includes extensive sampling from various regions and microenvironments to tailor disease management solutions.

Duration

The project is set to run for 36 months until September 2025.

Partners involved

1. Agricultural cooperative–Union of Agrinio: Agricultural organisation, pilot field testing, data collection, outreach
2. Agricultural University of Athens: Research institution, laboratory and field experiments

Budget

Total budget for the action: €144,999.98

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Main achieved or expected results

The GleoControl project aims to manage olive anthracnose, a disease that significantly impacts olive yield and quality (Picture 1). Key achievements include the isolation of > 100 unique strains of *Colletotrichum* spp. from Western Greece, revealing substantial morphological and genetic diversity. Many strains demonstrated resistance to various chemical pesticides, implying tailored disease management strategies. A primary goal is to validate a predictive model that links disease progression to environmental factors such as temperature and humidity, helping farmers anticipate outbreaks and optimise treatment timing. The project also promotes integrated pest management (IPM) solutions, combining chemical and biological control methods. Efficacy trials on olive drupes showed promising results, with certain biological plant protection products reducing disease severity by over 20% and spore production by more than 50%. Chemical treatments were also effective, achieving up to 77% inhibition of spore production. Resistance evaluations across six olive varieties indicated that cv. Mastoides is the most resistant, while cv. Koroneiki is more susceptible. The field studies in 2024 will further validate these findings and refine treatment recommendations.

***Picture 1**. Olive drupes severely infected by* Colletotrichum acutatum

Existing materials

Videos https://www.youtube.com/watch?v=DQs9WcMXON0&t=3s

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CLIMED-FRUIT

Evaluation of the effects of the biostimulant Calbio on Mediterranean crops subjected to abiotic stress such as drought and low fertilisation

Challenge

The Mediterranean region is feeling the effects of climate change. The increase in temperatures and the low availability of water resources make it necessary to study new cultivation methods that are more efficient and adapted to these conditions.

Solution

The use of biostimulants based on natural and seaweed extracts provide crops with stress tolerance conditions, activating plant response mechanisms and protecting them against heat episodes or deficit irrigation.

Benefits

- Increase in soil organic matter
- Increase in biological relationships between soil microorganisms
- Increased synthesis of protective hormones in plant roots
- Crop more resistant to drought, salinity or heat due to the induction of defences
- Reduction of the cost of cultivation by reducing the water and fertilizer needed
- Increase in the final harvest

Applicability box

Theme
Mediterranean crops, efficient management, drought, salinity, heat, biostimulants, algae

Context
Mediterranean production area, especially with a risk of water availability in the future

Application time
From March to September

Required implementation time
1 day

Period of impact
Immediately after applying the biostimulant

Equipment
Specific irrigation equipment is required for incorporation into water or for foliar application

Practical recommendation

- For application via irrigation, the soil must be wetted beforehand. After application, an extra irrigation must be carried out to incorporate the product into the deepest areas of the roots.
- The field must be prepared beforehand, eliminating weeds and levelling the ground if necessary.
- Avoid making applications, either foliar or via irrigation, where there is the possibility of subsequent rain.
- Avoid mixing the biostimulant product with copper-based phytosanitary products.
- Periodically check and recalibrate irrigation, as it will almost certainly be necessary to reduce the previous water allocation. It is advisable to install capacitance probes in the plot to control the wet front and the need for irrigation water.
- It is recommended to evaluate the efficacy of the tested product by tree fruit counting or non-destructive evaluations, such as SPAD, NDVI, etc.

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Picture 1. *Field evaluation of broccoli trial*

Picture 2. Broccoli rows with salinity and biostimulant

Picture 3. Avocado size measurement applied to avocados

Picture 4. Tomatoes in greenhouses under drought conditions

Further information

Web links

Project website:

https://www.larazon.es/comunidad-valenciana/hallan-producto-que-aumenta-rentabilidad-lechuga-brocoli-terrenos-sequia_20241014670ce340e2e54f0001801aae.html

Further reading

Effects and application of the product on avocado crop.

https://www.youtube.com/watch?v=P1CtzThDofQ&feature=youtu.be

https://www.youtube.com/watch?v=UEoD15IcLGk&list=PLqU_4ysqg2QmO7plsRi5r5C_M4mMFuVwW&index=1&t=1s&ab_channel=CLIMED-FRUIT

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This practice abstract was elaborated in the CLIMED-FRUIT project.

Project website: https://climed-fruit.eu/

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Extended Practice Abstract Nº 13

CLIMED-FRUIT

Simplified cost/benefit analysis

Use of the new biostimulant Calbio® on Mediterranean crops subjected to abiotic stress such as drought and low fertilization

Introduction – presentation of ex-ante and ex-post situation

The effects of climate change are directly affecting crop productivity. Drought or salinity of irrigation water or soil are increasingly common phenomena in our region. Therefore, many crops have been displaced or have seen their yields reduced. In the context of global population growth and a reduction in the availability of natural resources used in agriculture, it is very important to find biotechnological solutions to increase the tolerance of crops to these abiotic stresses. Biostimulants are substances or microorganisms whose function stimulates plant processes related to nutrient absorption, nutrient efficiency, tolerance to abiotic stresses or the quality characteristics of the agricultural products obtained. Product development is focused on evaluating the agronomic efficacy of a combination of natural extracts in different Mediterranean crops under water and salinity stress conditions.
Under conventional management, the ex-ante situation considers a summer and winter vegetable crop in the Mediterranean zone. The ex-post situation considers the same crop, but with the biostimulant product applied and the irrigation dose reduced. The calculations have been made for a typical plot of 1 hectare.

Economical costs and benefits

The data refer to Valencia, a province located in the Mediterranean region of Spain. The seaweed part of the biostimulant products tested in the field comes from northern Europe. The microorganisms and natural extracts are prepared at the IBMCP facilities in Valencia and CALDIC's headquarters. The company that markets the biostimulant product will define its cost to the farmer.

Legend

Estimated indicator

Measured indicator

	Ex-ante	Ex-post
Variable costs	**€7000/ha**	**€6740/ha**
Input		
Soil preparation	€300	€300
Seeds	€1000	€1000
Fertilisers	€800	€640
Phytosanitary products	€600	€600
Irrigation water	€500	€400
Labor	€2500	€2500
Machinery and fuel	€700	€700
Other indirect expenses	€600	€600
COMPARISON	Global reduction of 4% of the cost: 	

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Environmental costs and benefits

Energy	Indicator improvement of 20%: 
The energy used to extract irrigation water was measured to obtain this indicator, either from a well or from the plot itself. No extra energy cost is considered in the ex-post analysis since the product is applied to the irrigation water.	
Water	Indicator improvement of 20%: 
The amount of water used for irrigation was measured in ex-ante and ex-post situations. These data were obtained through measurements made by the sensors used in the experimental plots, in parallel with other technologies such as automatic and flow meters.	
Soil	Indicator improvement of 15%: 
Incorporating biostimulants together with microorganisms helps to increase the organic matter content and the microbial populations of the soil, as well as the processes that occur in it. Improving soil structure helps to improve water retention. This indicator has been estimated with referenced literature data and checked with the Soil Department of the Polytechnic University of Valencia[4] [5] [2].	
Air	Not affected: 
Studies show no direct changes in air quality with biostimulant products. Nevertheless, if a yield increase is obtained with the same inputs due to stress alleviation, the amount of CO_2 per kg of the product decreases, diminishing the CO_2 footprint[3].	
Biodiversity	Indicator improvement of 15%: 
The application of biostimulant products based on algae extracts and microorganisms improves soil biodiversity, either due to the incorporation of the product itself or by improving the health and properties of the soil, favouring its establishment and the biological processes that occur in the initial centimetres of the soil. The indicator has been estimated from existing literature[1].	

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CLIMED-FRUIT

Bibliography and sources

(8) Castiglione, A.M., Mannino, G., Contartese, V., Bertea, C.M., Ertani, A. Microbial. (2021). Biostimulants as Response to Modern Agriculture Needs: Composition, Role and Application of These Innovative Products. *Plants,* 10, 1533. https://doi.org/10.3390/plants10081533

(9) Da Silva, B. A., Silva, J. de S., da Silva, T. I., da Costa, R. S., de Castro, C. S., de Oliveira, L. K. B., de Sousa, T. R. M., Rodrigues, C. Y. A. C., Cardoso, F. B., & Mesquita, R. O. (2024). Bioestimulant with Ascophyllum nodosum and fulvic acids as mitigating factors of salinity damage in soybean1. *Revista Brasileira de Engenharia Agricola e Ambiental,* 28(4). https://doi.org/10.1590/1807-1929/agriambi.v28n4e278961

(10) Gan, Y., Liang, C., Hamel, C. et al. Strategies for reducing the carbon footprint of field crops for semiarid areas. (2011). A review. Agron. Sustain. Dev, 31, 643–656. https://doi.org/10.1007/s13593-011-0011-7

(11) Ozbay, N., & Demirkiran, A. R. (2019). Enhancement of growth in ornamental pepper (Capsicum Annuum L.) plants with a commercial seaweed product, Stimplex®. *Applied Ecology and Environmental Research,* 17(2), 4361–4375. https://doi.org/10.15666/aeer/1702_43614375

(12) Villa e Vila, V., Marques, P. A. A., Rezende, R., Wenneck, G. S., Terassi, D. de S., Andrean, A. F. B. A., Nocchi, R. C. de F., & Matumoto-Pintro, P. T. (2023). Deficit Irrigation with Ascophyllum nodosum Extract Application as a Strategy to Increase Tomato Yield and Quality. *Agronomy*, 13(7). https://doi.org/10.3390/agronomy13071853

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CLIMED-FRUIT

MODELCALBIOSTRESS –

Evaluation of the effects of a biostimulant on Mediterranean crops

Extended Practice Abstract Nº 13

Short description of the OG/project

The main objective of the project is to evaluate and characterise the biostimulant effect of the Calbio product, alone or combined with microbial biostimulants, in crops of high agronomic interest under conditions of abiotic stress such as drought, soil salinity or nutrient deficiency.

The data obtained allows us to characterise and quantify the effect of Calbio at an agronomic, physiological and molecular level to provide new products useful to farmers to maintain yield under adverse environmental conditions. Calbio is being tested for this purpose, both alone and combined with microbial biostimulants, in tomato, lettuce and pepper crops under greenhouse conditions, as well as in eggplant, pepper, onion, broccoli and avocado under field conditions. The stress conditions in the trial are drought, salinity and nutrient deficiency, and abiotic stresses that are increasingly common in agriculture.

Benefits

One of the benefits this project seeks is to increase the production of crops subjected to different abiotic stresses, as well as to reduce the use of agrochemicals, replacing them with biostimulants, not only in organic farming but also in conventional agriculture.

Stage of implementation

In progress; field trial development

Applicability box

Theme
Vegetables, broccoli; adaptive management; biotechnological technologies; energy efficiency; water-use efficiency

Context
Horticultural production area, especially at risk of water availability in the future.

Application time
All year

Required implementation time
1 month

Period of impact
Immediately after confirming the effect of the biostimulant for drought tolerance

Equipment
System for product application, via irrigation or foliar spraying

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Main achieved or expected results

- The application of the biostimulant Calbio, alone or in combination with microorganisms, stimulated the production of tomato and lettuce, not only under normal conditions, but also under salt stress. Of particular interest is the combination of Calbio with the bacterial strain *Bacillus* BM08, which resulted in a production increase of over 40% under salt stress.
- In addition, it was observed that combined treatment with the biostimulant Calbio and the bacterial strain BM08 stimulated the antioxidant regulation of lettuce and tomato plants under salt stress, as well as the production of isopentenyladenosine, a hormone from the cytokinin family related to the regulation of abiotic stress.
- In the current development of avocado trials, it is expected that foliar application of Calbio will improve avocado fruit set and reduce abiotic stress due to climatic conditions and soil properties.
- In the eggplant assays, currently in development, it is expected applying Calbio through fertigation will increase fruit production and quality under drought conditions, as well as its osmotic, antioxidant and hormonal defence.

Picture 1. Broccoli trial

Picture 2. Field evaluation

Picture 3. Greenhouse tomato trial

Existing materials

Web links

Project website:

https://www.larazon.es/comunidad-valenciana/hallan-producto-que-aumenta-rentabilidad-lechuga-brocoli-terrenos-sequia_20241014670ce340e2e54f0001801aae.html

Further reading

Effects and application of the product on avocado crop.

https://www.youtube.com/watch?v=P1CtzThDofQ&feature=youtu.be

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Extended Practice Abstract Nº 13

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Extended Practice Abstract Nº 14

CLIMED-FRUIT

Enguera Bodegas

Effect of bat *Pipistrellus* spp. in the biological control of *Lobesia botrana*

Challenge

Lobesia botrana (grapevine moth) is a major pest in viticulture worldwide. This pest can be effectively controlled with pheromones; however, this method only works when the vineyard is over 5 ha and is an expensive treatment (€100–300/ha depending on dose).

Solution

Increasing the biological control of *Lobesia botrana* could be a solution for small producers in areas with low pressure from this pest. Installing bat boxes is of particular interest in Mediterranean viticulture where non-irrigated vineyards are abundant. Water scarcity makes it difficult to successfully introduce biodiversity to help beneficial insects in this agricultural system. Therefore, bats are the most suitable predators to increase the biological pest control of *Lobesia botrana* in Mediterranean viticulture.

Benefits

A reduction of *Lobesia botrana* levels in vineyards with high bat population levels (40–60 bats per hectare).

Applicability box

Theme

Biodiversity

Natural resource conservation

Pest management

Grapes

Context

Climatic limitation

Application time

Although the best time is between late September and early November, bat boxes can be installed throughout the year

Required implementation time

It depends on the number of bat boxes, the equipment and the workers available. For example, 20 bat boxes on 10 poles across a 10-hectare area take 4 hours with 4 workers and 1 digger.

Period of impact

This depends on the initial bat population. In our conditions, we see an effect on the pest 5 years after bat boxes were installed.

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Extended Practice Abstract Nº 14

Equipment

Pole (5 m height; 12 cm diameter), bat box, digger

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Practical recommendation

- Choose a proper model of bat box, otherwise, bats will not use them. They need a gap between 1.7 and 2 cm wide.
- Distribute the bat boxes around the crop. Try to install 2 bat boxes per hectare.
- Use high-quality materials to build your bat box. You can protect a wooden box with an external aluminium sheet to extend its lifetime.
- Install the bat box on a pole and insert it between 70 and 100 cm into the ground. The height of the bat box is an important parameter. Make sure the bat box is positioned 4 m above the ground. The orientation of the bat box generally does not matter, although if it is installed in a cold climate, try to install it facing south or west.
- If the bat box is installed in a warm climate, avoid installing it on the wall of a building that faces south or west. Bats can die inside the bat boxes during a heat wave.
- If the colony includes 20–150 bats, avoid disturbing them. This is particularly important during breeding time, which takes place between May and July.
- The entrance of the bat box should not be more than 2 cm wide.

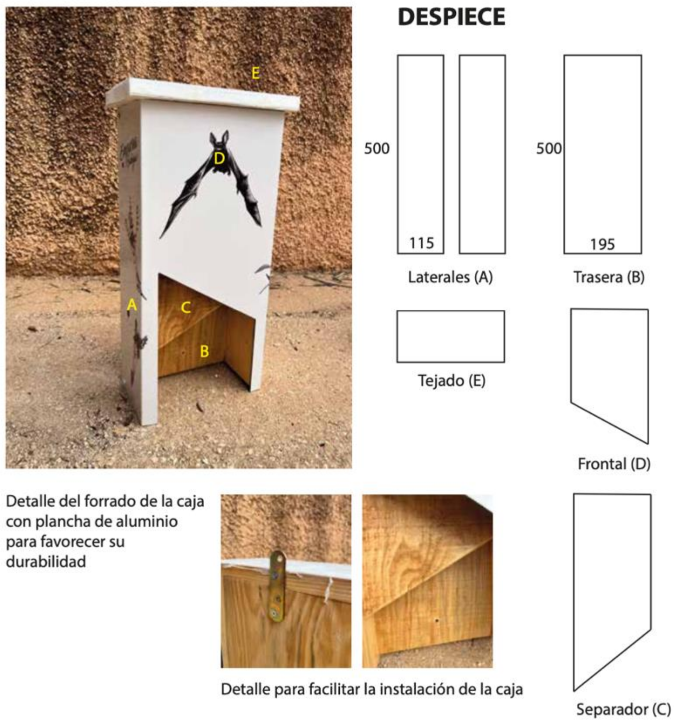

Figure 1: Example of a bat box protected with an aluminium sheet.

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Existing materials

Videos

https://www.youtube.com/watch?v=dUQlBsUgVG0&t=6s

https://www.youtube.com/watch?v=dA1-dkkua0A

https://www.youtube.com/watch?v=Nk7b4LNgtqQ&t=257s

https://www.youtube.com/watch?v=qkpqLmjVCNI

https://www.youtube.com/watch?v=ckAthWa6qbI&t=1s

https://www.youtube.com/watch?v=e6PYtaObJgs

Web links

https://bodegasenguera.com/conservacion-de-murcielagos/

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This extended practice abstract was elaborated in the CLIMED-FRUIT project.

Project website:

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CLIMED-FRUIT

Enguera Bodegas

Simplified cost/benefit analysis

Effect of bat *Pipistrellus* spp. in the biological control of *Lobesia botrana*

Introduction – presentation of ex-ante and ex-post situation

Lobesia botrana (grapevine moth) has always been present in the southern part of the province of Valencia and the northern part of Alicante, in Spain. In organic and conventional farming, this pest is controlled with pheromones. These pheromones are distributed in the vineyard with emitters that release them throughout the season. Although this is a very effective treatment to control *Lobesia botrana*, it can only be used in vineyards over 5 ha and it is expensive. There is increasing interest among organic farmers in using bats to control the grapevine moth because bats are voracious insectivores and have been shown to be able to control this pest in the Mediterranean region. The use of bats to control this pest is beginning to have an impact in some of the vineyards where farmers are not using any other treatments for controlling the pest. These vineyards have a density of 15 bats/ha.

Economical costs and benefits

Legend

Estimated indicator

Measured indicator

The project took place in the southern part of the province of Valencia. Costs are calculated per hectare.

In the ex-ante situation, installation costs occur every year, while in the ex-post situation, costs occur every 7 years, the duration of the bat boxes and poles in the vineyard.

	Ex-ante	Ex-post
Installation materials		
Pheromones 250 emitters/ha	€100	
2 bat boxes/ha and 1 pole/ha		€160
Installation labour	€10	€6.25
Total	**€110**	**€166.25**
COMPARISON	Global reduction of 79% of the cost:	

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Environmental costs and benefits

Energy	Not measured but a positive impact can be considered:
Slight energy saving as there is no need for transport across the vineyard to install the pheromones.	
Water	Unmeasured impact:
No direct relationship between the practice and the indicator in question.	
Soil	Unmeasured impact:
No direct relationship between the practice and the indicator in question.	
Air	Unmeasured impact:
No direct relationship between the practice and the indicator in question.	
Biodiversity	Indicator improving > 75%
To better understand the effect of bats in the vineyard, bat detectors are put in place monthly from March to October. Bat abundance and diversity have increased significantly thanks to the bat boxes. The vineyards have increased their bat density from none to 15 bats/ha on average.	

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Extended Practice Abstract Nº 14

Project on introducing bats in vineyards in the biological control of *Lobesia botrana*

Short description of the project

The general objective of the project is to determine the effect of bats in the biological control of *Lobesia botrana.* The specific objectives are:

7. Establish bat boxes in the vineyard and monitor the bat population in the shelter.
8. Monitor bat activity in vineyards with and without bat boxes.
9. Monitor the population of and damage from *Lobesia botrana* in the vineyard.
10. Determine bat activity in the vineyards using ultrasound recorders.
11. Determine bat diet using DNA barcoding analysis.

Benefits

One bat can eat between 1,000 and 3,000 insects per night, and their capacity to control pests such as *Chilo suppressalis* in the Mediterranean region has been demonstrated.

Stage of implementation

The project ended in 2022 but we still monitor bat activity in the vineyards.

Key data box

Theme

Biodiversity

Natural resource conservation

Pest management

Grapes

Context

Climatic limitation

Duration

2019–2022

Partners involved

Instituto Cavanilles de Biodiversidad y Biología Evolutiva (ICBIBE), AVA-ASAJA, Bodegas Enguera

Budget

€233,735

Particularity

DNA barcoding for bat diet analysis

Main achieved or expected results

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(13)Since the 157 bat boxes were installed in 2019, the bat population has been growing year on year, reaching a peak of almost 1,000 bats in August. The occupation rate is still around 80%.

(14)Bat activity is higher in vineyards with bat boxes, reaching more than 300 passes per recorder per night. Bats live and hunt 500 metres around the bat box.

(15)*Lobesia botrana* is among the bats' diet, but they also eat other pests such as *Thaumetopoea pityocampa*, *Bactrocera oleae*, *Prays oleae* and *Cydia pomonella.* No parasitoids or pollinators were found in the bats' diet.

(16)The dissemination activities of this project include the creation of two wines in homage to the bats. The winery allocates part of the profits from these wines to bat conservation activities. Moreover, over the past 2 years, the winery has held around 50 bat nights, sharing the project with more than 1,200 people.

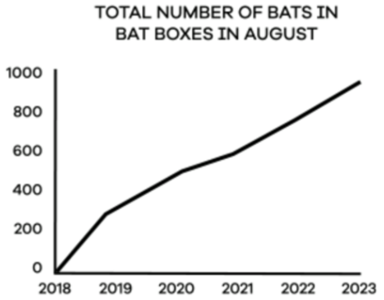

Figure 1: Evolution of the total number of bats in August

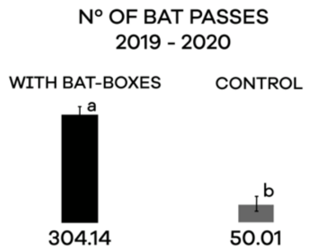

Figure 2: Bat activity in vineyards with and without bat boxes

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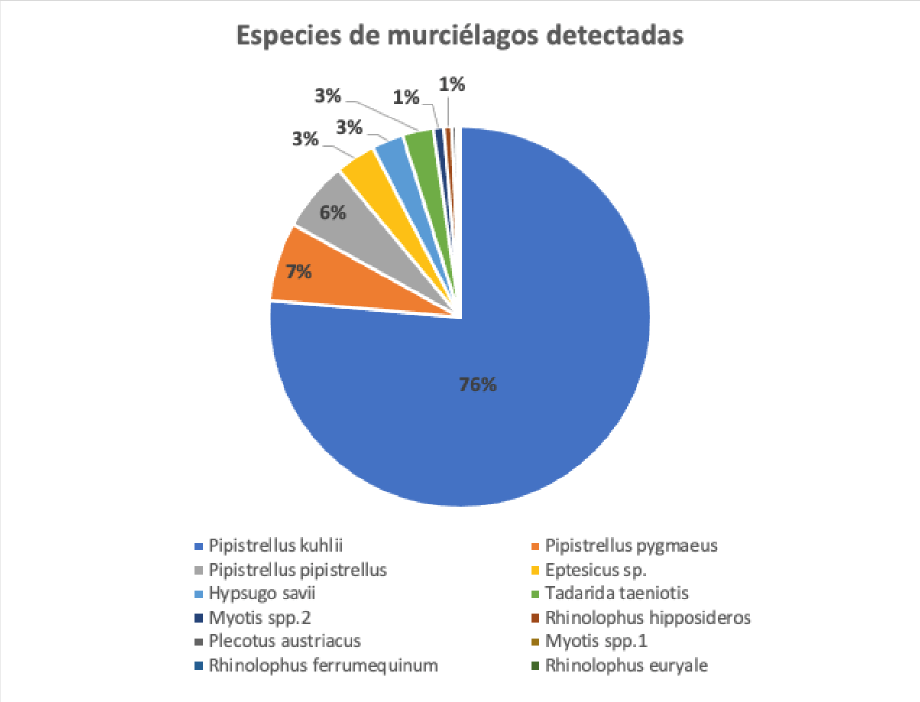

Figure 3: Bat species detected

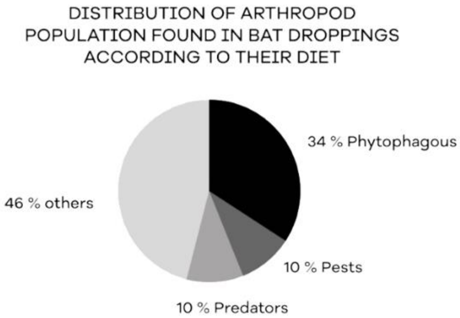

Figure 4: Distribution of arthropods found in bat droppings according to their diet

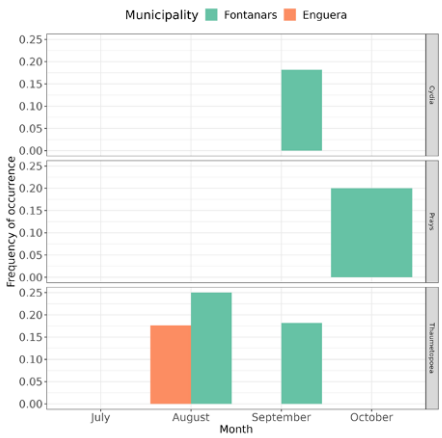

Figure 5: Frequency of pests 16W in bats' diet

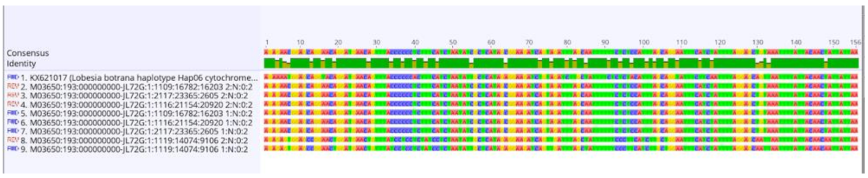

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Figure 6: Consensus Identity Lobesia botrana *found in bat droppings*

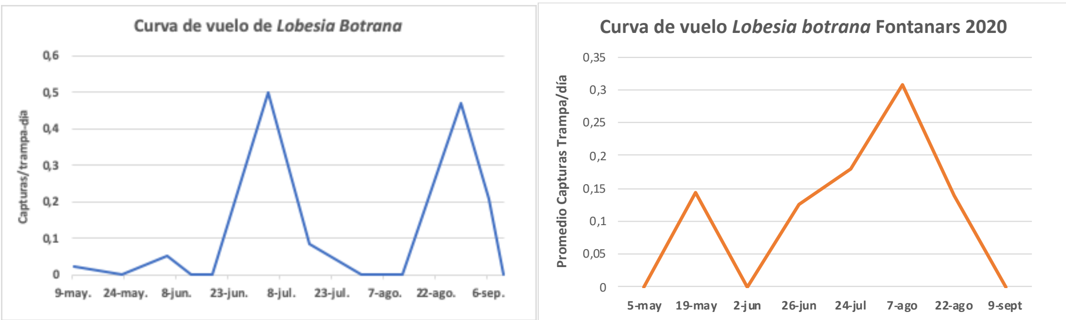

Figure 7: Lobesia botrana *adult curve in 2019 and 2020*

Fig 8: Installing and repairing bat boxes

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Figure 9: Dissemination activities ('bat nights')

Figure 10: Presentation of the results of the project and the wine Aliats ('allies') as a tribute to the bats.

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Existing materials

Videos

https://www.youtube.com/watch?v=dUQlBsUgVG0&t=6s

https://www.youtube.com/watch?v=dA1-dkkua0A

https://www.youtube.com/watch?v=Nk7b4LNgtqQ&t=257s

https://www.youtube.com/watch?v=qkpqLmjVCNI

https://www.youtube.com/watch?v=ckAthWa6qbI&t=1s

https://www.youtube.com/watch?v=e6PYtaObJgs

Web links

https://bodegasenguera.com/conservacion-de-murcielagos/

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This extended practice abstract was elaborated in the CLIMED-FRUIT project.

Project website:

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Extended Practice Abstract Nº 15

Sowing subterranean clover, a self-reseeding cover crop, in the under-row area of the vineyard

Challenge

In Tuscany, Italy, vineyard soil and weed management is based on mechanical treatments between rows and herbicide application under the row, with a negative impact on soil fertility, soil conservation and biodiversity. Intensive tillage systems and harsh climate events due to climate change increase erosion phenomena.

Solution

The innovative approach involved introducing an annual self-reseeding legume cover crop under the rows, complemented by a perennial grass-legume mixture sown in the inter-rows. Specifically, a subterranean clover (*Trifolium subterraneum* spp. *brachycalicinum* L.) was sown under the rows once in late summer/early autumn and lasted for 3 to 4 years thanks to its self-reseeding capacity.

Benefits

The clover biomass serves as living mulch in autumn, winter and spring, transitioning to dead mulch in summer, thus minimising competition with grapevines for water and nutrients and reducing drought stress thanks to the soil coverage during the summer. At the end of summer, the spontaneous germination of clover seeds initiates a new biological cycle under the rows, offering benefits such as suppressing weed emergence and improving soil fertility.

Applicability box

Theme

Biodiversity, carbon sequestration, climate change adaptation, cover crops, erosion control

Context

Vineyard management in the Tuscan hills is shifting towards more sustainable practices.

Application time

All year

Required implementation time

The practice requires the time needed for crop establishment after sowing, around 1–2 months.

Period of impact

3–4 years

Equipment

Manually we obtained the best results, but it is important to improve the mechanization of this practice for a wider scalability

Practical recommendation

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- The subspecies *brachycalicinum* has evolved to tolerate dry soils and is better suited to sub-alkaline, silty clay loam soils.
- Sowing subterranean clover requires careful (but not deep) soil preparation in the under-row area during the first year. The soil should be adequately prepared to ensure germination and support the plant's development during the initial, more delicate growth stages.
- If weather conditions allow, sowing should preferably be carried out after the grape harvest (early autumn). This way, the plants can germinate and grow before winter, providing good ground cover at the onset of the vine growing season.
- Even when sowing is delayed to early spring in challenging years, favourable weather conditions can still ensure the successful establishment of subterranean clover.

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Extended Practice Abstract Nº 15

Figure 1. *An overview of the experimental plots where subterranean clover was sown at the Monterosola farm, which is the subject of this abstract and one of the farms involved in the OG Ioconciv.*

Further information

Videos

https://www.ioconciv.it/video/

Web links

https://www.ioconciv.it/documentazione/

Contact information

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Extended Practice Abstract Nº 15

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Simplified cost/benefit analysis

Sowing subterranean clover in the under-row area in the vineyard

Introduction – presentation of ex-ante and ex-post situation

Mechanical weed control between rows and herbicide application under the vine rows negatively impact soil fertility and conservation, reducing agroecosystem biodiversity. Moreover, vineyards in Tuscany are mostly located in hilly soils, where erosion is exacerbated by intensive tillage systems and extreme climate events due to climate change, such as heavy rainfall and prolonged drought periods.

The use of cover crops in viticulture is considered an agroecological strategy to cope with climate change, improving the sustainability of conventional and organic viticulture. In fact, cover crops can deliver important agroecosystem services, e.g., improving soil fertility, reducing soil erosion and weed presence, increasing carbon and nitrogen input and biodiversity.

The ex-ante situation analysed here is based on an organic farm that performs weed control through repeated mechanical weeding under the rows, while the proposed innovation consists of sowing self-reseeding subterranean clover under the rows, which can re-seed itself for up to 4 years. The clover biomass will cover the soil in autumn, winter and spring as a living mulch, and in summer, when it completes its cycle, it will act as a dead mulch, avoiding competition with vines for water and nutrients. This practice offers benefits in terms of weed suppression, soil fertility improvement, reduced greenhouse gas emissions, decreased soil erosion and lower costs for the farmer.

Economical costs and benefits

Legend

Estimated indicator

Measured indicator

The analysis covers a period of four years (2019–2023) and considers 1.25 ha on an organic farm involved in our Operational Group (OG). Although the proposed innovation proved highly advantageous (considering the work needs to be done once every 4 years), it was carried out manually, as the seeder designed to simultaneously sow both the inter-row and under-row areas and built for the project was not efficient. Therefore, the next step, particularly for farmers managing large areas, is to achieve the mechanisation of this practice.

	Ex-ante	**Ex-post**
Variable costs		
Input		
Installation *(material + labour)*		€712.50
Labour (excluding installation)	€435.47	€112.50
Machine costs (fuel + depreciation)	€6629.84	
TOTAL	**€7065.31**	**€825.00**
COMPARISON	Global reduction of 90% of the cost:	

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Extended Practice Abstract Nº 15

Environmental costs and benefits

Energy	Indicator improvement > 75 %:
Considering that in terms of time, the manual preparation of the seedbed takes around 4–6 hrs/ha, and the clover lasts for 4 years, the fuel savings per ha are very significant.	
Water	Not measured but a positive impact can be considered:
As reported by authors who worked in a similar pedoclimatic context, in Tuscany, the cover crops showed a higher water conservation capacity from the early vegetative growth stage in spring to post-harvest in autumn. The cover crop mulching, especially during the summer, played a conservative role, which means that it kept more water in the soil and built a reservoir that increased water availability for the vine row. Consequently, the cover increased the soil water availability for the vine row, while it modified the microclimate conditions of the vine row by lowering its sensible heat[(1) (2)].	
Soil	Indicator improvement of 20%:
The presence of clover in the under-row area for 4 consecutive years seems to have induced some slight modifications in the soil characteristics. In particular, it appears to have increased the total nitrogen content of the soil in that area, demonstrating it to be a practice that also made it possible to keep the soil organic matter at the initial levels (unlike the farm's standard technique). To estimate this indicator, we took our results into account and referenced the bibliography from studies conducted in similar conditions, in Tuscany[(3)].	
Air	Indicator improvement > 75 %:
Avoiding mechanical weed control for 4 years, we saved 184 kg CO_2 per year.	
Biodiversity	Indicator improvement of above- and below-ground diversity of 20%:
Implementing cover crops in vineyards increases plant biodiversity. As reported in the literature[(4)], extensive vegetation management generally enhances both above- and below-ground biodiversity compared to intensive management. Organic management, along with practices that avoid herbicides, has a stronger positive effect on ecosystem services and biodiversity than soil tillage.	

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Extended Practice Abstract Nº 15

Bibliography and sources

12. Puig-Sirera, À.; Antichi, D.; Warren Raffa, D.; Rallo, G. (2021). Application of Remote Sensing Techniques to Discriminate the Effect of Different Soil Management Treatments over Rainfed Vineyards in Chianti Terroir. Remote Sens, 13, 716. https://doi.org/10.3390/ rs13040716

13. Warren Raffa, D.; Antichi, D.; Carlesi, S.; Frasconi, C.; Marini, S.; Priori, S.; Bàrberi, P. (2021). Groundcover Mulching in Mediterranean Vineyards Improves Soil Chemical, Physical and Biological Health Already in the Short Term. Agronomy, 11, 787. https://doi.org/ 10.3390/agronomy11040787

14. Warren Raffa, D.; Antichi, D.; Carlesi, S.; Puig-Sirera, À.; Rallo, G.; Bàrberi, P. (2002). Ground vegetation covers increase grape yield and must quality in Mediterranean organic vineyards despite variable effects on vine water deficit and nitrogen status. European Journal of Agronomy, 136. https://doi.org/10.1016/j.eja.2022.126483

15. Winter, S.; Bauer, T.; Strauss, P., Kratschmer, S.; Paredes, D., Popescu, D.; Landa, B.; Guzman, G.; Gomez, J.A.; Guernion, M.; Zaller, J.G.; Batary, P. (2018). Effects of vegetation management intensity on biodiversity and ecosystem services in vineyards: a meta-analysis. Journal of Applied Ecology, 55, 2484–2495. https://doi.org/10.1111/ 1365-2664.1312

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Extended Practice Abstract Nº 15

Go-ioconciv: a sustainable approach to reduce tillage and herbicide use in vineyards

Short description of the OG/project

The project focused on weed control in vineyards, aiming to reduce herbicide application and soil disturbance, enhancing soil fertility through the promotion and evaluation of alternative and sustainable methods for managing inter- and intra-row spaces. Cover crops were explored as an agroecological solution to improve the sustainability of both conventional and organic viticulture. Implemented from 2019 to 2023 on four farms in Tuscany, Italy, the innovative approach involved introducing an annual self-reseeding legume cover crop under the rows, specifically a subterranean clover, complemented by a perennial grass-legume mixture sown in the inter-rows.

Benefits

Providing agroecosystem services such as enhanced soil fertility, reduced soil erosion and weed presence; increased carbon storage, nitrogen inputs and biodiversity

Stage of implementation

The project has finished; its completion date was in May 2023.

Key data box

Theme

Biodiversity, carbon sequestration, climate change adaptation, cover crops, erosion control

Context

Vineyard management in the Tuscan hills is shifting towards more sustainable practices.

Duration

4 years

Partners involved

CAICT Formazione srl, CIRAA (UniPi), Ri.Nova, Podere Spazzavento farm Bellesi Alberto farm, La vite farm, Tenuta Monte Rosola farm, CfGC (UniFi)

Budget

€355,175.76

Particularity

Self-reseeding legume cover crop sown under the row in vineyards

Main achieved or expected results

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The subclover was proven to be competitive against weeds in a long-term context; in fact, it reseeded itself for four years, reducing grape yield only slightly, at most less than 9% in the wettest year, and having no influence on the berry nitrogen content, compared to the farm standard strategy, namely herbicides or mechanical weeding. Moreover, we observed a reduction in tillage and herbicide spray costs, and we should have had a reduction in greenhouse gases, increase in carbon sequestration, reduction in soil erosion and herbicide leaching, although further studies are needed to investigate these aspects in depth. A future challenge involves improving clover establishment in the first year. To address this, the project team developed a prototype mechanical drilling machine capable of sowing different cover crops in intra- and inter-row spaces. However, the seeder machine presented limitations in seed distribution, and to obtain a good result, some farmers decided to carry out sowing manually. Therefore, further collaboration with farmers and the machinery industry is essential to adapt and improve the machine, as well as exploring locally adapted clover cultivars or other similar species to increase its widespread application.

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a)

b)

c)

__Figure 2.__ Pictures (a) and (b) show the subclover at its maximum vegetative stage, while (c) shows the subclover after it has died, continuing to cover the soil as dead mulch.

Existing materials

Videos

https://www.ioconciv.it/video/

https://www.youtube.com/watch?v=VHEc0I_WJEM&list=PLqU_4ysqg2QmO7plsRi5r5C_M4mMFuVwW&index=6&ab_channel=CLIMED-FRUIT

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Web links

https://www.ioconciv.it/documentazione/

Contact information

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This extended practice abstract was elaborated in the CLIMED-FRUIT project.

Project website: https://www.ioconciv.it/

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CLIMED-FRUIT

Enguera Bodegas

Extended Practice Abstract Nº 16

Measuring the effect of kaolin on vine development and wine quality in Mediterranean vineyards

Challenge

Climate change is causing tremendous damage to Mediterranean viticulture. The effect is seen not only in direct damage to the fruit and vine from heavy floods, but also in reduced grape quality. Extremely high temperatures in summer contribute to a quick accumulation of sugar content in berries, while tannin and anthocyanin production are blocked. As a result, wines are more alcoholic and poor in structure and aromatic compounds.

Solution

The use of kaolin sprayed on the vineyard creates a layer that protects the vine from direct sun radiation. Several authors report a reduction of 5°C to 10°C in berries and vine leaves. This temperature reduction can reduce heat stress considerably, which will increase grape quality significantly.

Benefits

The project helps us to better understand the effect of kaolin on vine physiology and wine quality. Kaolin is particularly beneficial for increasing aromatic compounds in wines, but it does not affect other parameters of wine quality in heavy drought conditions.

Applicability box

Theme
Climate change
Grapes

Context
Climatic limitation

Application time
5% and 10% kaolin treatment at pre-veraison and post-veraison

Required implementation time
Early in the morning

Period of impact
The same year

Equipment
Airblast sprayer – Kaolin 95%

Practical recommendation

Although more years of trial would be needed to confirm these results, our practical recommendation is to monitor the effect of kaolin on a case-by-case basis because many authors report great benefits due to the use of kaolin.

It is important to consider that kaolin is only useful for high-quality vineyards because it has a particularly high cost, and its benefits are more related to overall wine quality and not to an increase in yield.

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Existing materials

Videos

https://www.youtube.com/watch?v=kz-h-LNcqeM&t=55s
https://www.youtube.com/watch?v=5Ivqa9gAbPc

Web links

https://bodegasenguera.com/protector-solar/

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Project website:
https://bodegasenguera.com/protector-solar/

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Simplified cost/benefit analysis

Effect of kaolin on vine development and wine quality in the Mediterranean vineyards

Introduction – presentation of ex-ante and ex-post situation

Climate change is causing serious damage to Mediterranean viticulture. In terms of quality, aromatic compounds, tannin and anthocyanin concentration have been drastically reduced[(1)]. The use of water irrigation can adapt the crop to heat stress, but only 42% of the vineyards in Spain have water irrigation[(2)], and it is particularly difficult to find water supplies in the central and southern parts of the country.

Kaolin particle film can potentially adapt the vine to climate change by reflecting solar radiation, reducing the berry and leaf surface temperature by up to 10°C[(3)].

Economical costs and benefits

The project takes place in the southern part of the province of Valencia. In the ex-ante situation, kaolin was not used to reduce the effect of climate change in this vineyard.

In the ex-post situation, two applications of kaolin were carried out with a dose of 50 kg/ha. The applications were made just before and after veraison, with a time lapse of 30 days between treatments.

Legend

Estimated indicator

Measured indicator

	Ex-ante	Ex-post
Variable costs		
Input		
kaolin	No chemical application of product	€4.54/kg (dose: 50 kg/ha) → €227/ha 2 sprays: €227 × 2 = €454/ha
Labour (excluding installation)		€15/ha
Machine costs (fuel)		€2/ha
TOTAL	0	€244–€471/ha
COMPARISON	Global increase of 1-24% of the cost:  The increase in costs relies on the increase in the number of passes and in the amount of product required.	

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Environmental costs and benefits

Energy	Not measured, but a worsening of the impact can be considered:
There is an increase in energy consumption due to the fuel required to spray the kaolin twice a year.	
Water	Indicator not affected:
Although transpiration is reduced with the application of the product, no clear effects were found in the vineyard water status.	
Soil	Indicator not affected:
Although the increase in tractor passes causes an increase in soil compaction, the 2 passes due to kaolin were not found to be significant enough to modify this indicator.	
Air	Unmeasured impact, but a worsening of the impact can be considered:
No direct relationship between the practice and the indicator in question, but a worsening of it can be considered due to emissions from each pass to apply the product.	
Biodiversity	Indicator not affected:
No direct relationship between the practice and the indicator in question.	

Bibliography and sources

(1) Caputi, L.; Carlin, S.; Ghiglieno, I.; Stefanini, M.; Valenti, L. y Vrhovsek, U. 2011. Relationship of changes in rotundone content during grape ripening and winemaking to manipulation of the 'peppery' character of wine. *J. Agric. Food Chem*. 59, 5565_5571.

(2) ESRYCE 2023. Encuesta sobre Superficies y Rendimientos Cultivos (ESYRCE). Encuesta de Marco de Áreas de España. https://www.mapa.gob.es/es/estadistica/temas/estadisticas-agrarias/agricultura/esyrce/

(3) Frioni, T., Tombesi, S., Luciani, E., Sabbatini, P., Berrios, J. and Palliotti, A. 2019. Kaolin treatments on Pinot Noir grapevines for the control of heat stress damages. *Bio Web of Conferences 13*, 04004 (2019).

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Extended Practice Abstract Nº 16

Project to study the use of kaolin in Mediterranean vineyards

Short description of the project

The general objective of the project is to study the effect of kaolin particle film on climate change adaptation of Mediterranean viticulture. The specific objectives are to:

- Determine the effect of kaolin on vine physiology.
- Determine the effect of kaolin on yield and grape composition.
- Determine the effect of kaolin on wine quality.

Benefits

The project has identified that kaolin sprayed three weeks before the beginning of the major peak of the pest is an effective treatment to control leafhoppers.

The results show that kaolin has no effect on the main parameters of grape and wine quality, although it helps increase some aromatic compounds.

Stage of implementation

2022–2023

Key data box

Theme
Grapes

Context
Climatic limitation

Duration
2022–2023

Partners involved
Centro de Investigación sobre Desertificación (CIDE-CSIC-UV), La Baronía de Turís CoopV., Federació de Cooperatives (FECOAV), Bodegas Enguera

Budget
€100,000

Particularity
Innovative way to adapt viticulture to climate change

Main achieved or expected results

1. Although many authors report on the effect of kaolin on stomatal conductance and water potential, in this project there are no differences in these parameters.

2. Kaolin does not affect yield or grape quality. The product did not affect °Brix, pH or total acidity, among other parameters.

3. Wines made with grapes treated with kaolin did not have higher or lower levels of tannins, but they did have higher amounts of some aromatic compounds such as volatile phenols and vanillin.

4. Extremely severe drought and high temperatures during summer 2023 may reduce the potential effect of kaolin on plant development.

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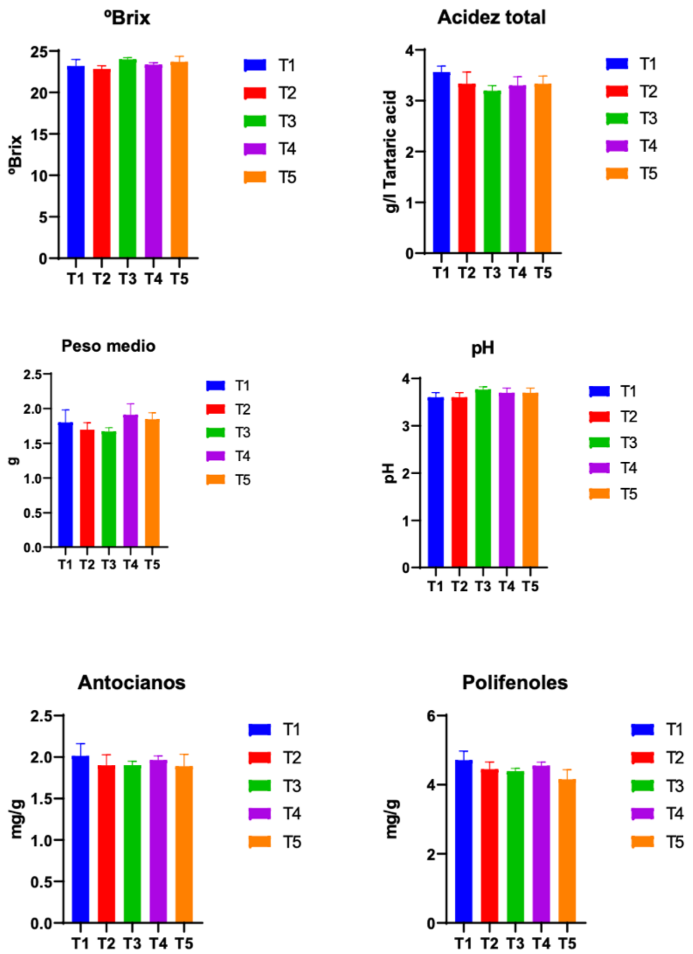

Figure 1: *Effect of kaolin on the main grape ripening parameters of the Tempranillo variety*

Table 1: *Effect of kaolin on the means of the main parameters analysed in Tempranillo wines*

General parameters	Control	Kaolin 10%	F-Ratio	p-Value
Alcoholic degree	12,76 ± 0,82 a	12,78 ± 0,37 a	0,01	0,93
pH	4,08 ± 0,20 a	3,84 ± 0,06 a	4,09	0,11
Total Acidity	3,48 ± 0,27 a	3,98 ± 0,17 a	7,5	0,05
Volatile Acidity	0,69 ± 0,04 a	0,64 ± 0,03 a	2,88	0,17
Glucose/Fructose	021 ± 0,04 a	0,25 ± 0,05 a	2,47	0,19

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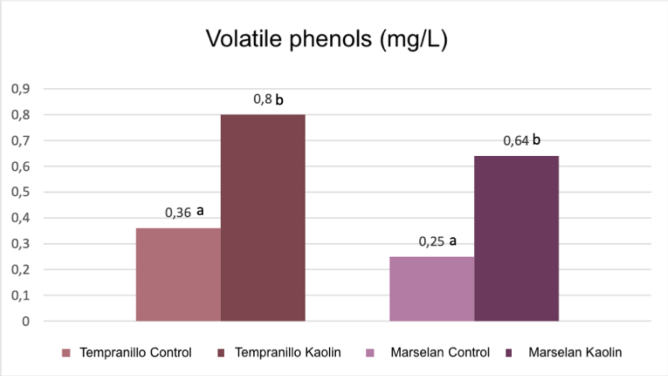

Figure 2: *Volatile phenols in wines made from grapes with and without kaolin*

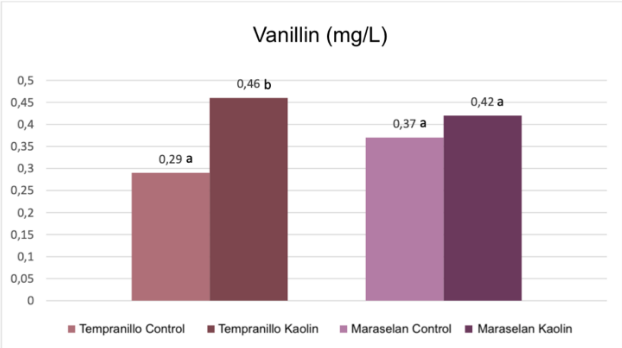

Figure 3: *Vanillin in wines made from grapes with and without kaolin*

Existing materials

Videos

https://www.youtube.com/watch?v=kz-h-LNcqeM&t=55s
https://www.youtube.com/watch?v=5Ivqa9gAbPc

Web links

https://bodegasenguera.com/protector-solar/

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Project partners: Instituto Cavanilles de Biodiversidad y Biología Evolutiva (ICBIBE), AVA-ASAJA, Bodegas Enguera

This extended practice abstract was elaborated in the CLIMED-FRUIT project.
Project website:
https://bodegasenguera.com/protector-solar/

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CLIMED-FRUIT

Enguera Bodegas

Study on the biology of the grape leafhopper

Extended Practice Abstract Nº 17

Challenge

The grape leafhoppers *Jacobiasca lybica* and *Empoasca vitis* are very unfamiliar pests for many farmers, but have experienced a rapid expansion. When their population levels are high, they can cause the defoliation of the vineyard even when the fruit is unripe. This not only results in a qualitative loss but also reduces the vigour in the next season.

Solution

The use of kaolin sprayed on the vineyard creates a layer that protects the vine from the insects biting and significantly reduces the damage to the crop. Kaolin does not create resistance in the leafhoppers.

Benefits

The project helps us to better understand the pest and identify the species that are affecting the vineyards in our region. The use of kaolin sprayed three weeks before the peak (pre-veraison) at a dose of 5%–10% can reduce the percentage of affected leaves by more than 30%.

Applicability box

Theme
Biodiversity
Natural resources conservation
Pest management
Grapes

Context
Climatic limitation

Application time
For grape leafhopper treatment, it is crucial to treat before the damage is done, depending on the area (early May–early June).

Required implementation time
Early in the morning

Period of impact
The same year

Equipment
Airblast sprayer – Kaolin 95%

Practical recommendation

For conventional farmers:

- Begin the treatments of the leafhoppers early. Do not wait until you see 200 adults per trap per week to begin the treatment. Begin the treatments once you see 50 adults/trap/week.
- Alternate acetamiprid and cyhalothrin or another synthetic pyrethroid to avoid creating resistance.
- Keep treating the vineyard after harvest. The insecticides change the pattern of the curve, and the peak usually takes place once the conventional farmer stops the treatments. This can happen even in late October, reducing the migration of the resources right before dormancy.

For organic farmers:

- Identify the species of pest you have through molecular methods. In 2024, there are no taxonomers in Europe able to identify this insect. Another way to deduce the species you have is through the most abundant parasitoid in your vineyard.
- Identify the main beneficial insects in your vineyard. The strategy will change depending on whether you want to increase the population of predators or parasitoids.
- Look for plants that benefit from the presence of your most abundant natural enemies. For example, if *Empoasca vitis* is the most abundant leafhopper in your vineyard and *Anagrus* spp. is your main parasitoid, you can plant *Salvia officinalis*, *Mentha spicata*, or *Nepeta x faassenii*, which are particularly useful to attract *Eupteryx melissae,* another leafhopper that has no effect on vineyards but is a pest of aromatic plants. This new leafhopper will offer *Anagrus* an overwinter refuge.

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- Control the pest with kaolin without any fear of affecting natural enemies. Kaolin, as a mineral, has no effect on parasitoids, only creating a layer that disturbs leafhopper nymphs.

Existing materials

Videos

https://www.youtube.com/watch?v=QEBc9FgBTmQ&t=20s
https://www.youtube.com/watch?v=OVDdY9zVLbA

Web links

https://bodegasenguera.com/enemigos-naturales-papel-de-la-biodiversidad/

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Simplified cost/benefit analysis

The new threat to Mediterranean viticulture: the grape leafhopper (*Jacobiasca lybica* and *Empoasca Vitis*)

Introduction – presentation of ex-ante and ex-post situation

The leafhopper is causing serious damage in viticulture, particularly in the Mediterranean region. Since 2023, it has been necessary to spray crops to avoid the devastating effects of this pest. Considering that this pest depends on high temperatures and that the summer of 2024 in the region was colder in comparison to previous seasons, it is likely that the leafhopper will become an annual pest, and therefore several treatments must be done to control it.

There is one effective way to reduce leafhopper damage without affecting natural enemies: the use of kaolin. Kaolin treatments can reduce damage by over 30% if the treatment takes place before the damage is evident and the pest levels rise. Moreover, a reduction in leaf damage will have a tremendous impact on parameters associated with grape quality such as ºBrix, titratable acidity, pH, total anthocyanins, total tannins and several aromatic compounds, among other parameters. The trial was developed in a vineyard in Valencia (Spain).

Economical costs and benefits

Legend

Estimated indicator

Measured indicator

It is crucial to do at least one treatment with kaolin (50 kg/ha) before the pest level reaches 50 adults/trap per week (standard yellow traps 10x25 cm) and to repeat the treatment after heavy rain.
Costs are estimated on a per-hectare basis.

	Ex-ante	**Ex-post**
Variable costs		
Input		
BASF Kaolin Surround* ****There are other kaolins that are 10 times cheaper, but so far, they cannot be used in viticulture.***	Organic vineyards are not usually sprayed against this pest. In conventional viticulture, 1–2 sprays are required per season.	€4.54/kg (dose: 50 kg/ha) → €227/ha No. of treatments needed: - Low pressure from leafhopper: €454/ha (2 treatments) - High pressure from leafhopper: €1,135/ha (5 treatments)
Machine costs (fuel + depreciation)		2.0
Total		456.0–1137.0
COMPARISON	Global increase from 25% to 49% of the cost:  Despite the increase in cost, the leafhopper can reduce yield, wine quality and wood maturity, with indirect effects on the next harvest, and even kill the plant if it is not treated.	

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Extended Practice Abstract Nº 17

Environmental costs and benefits

Energy	Not measured, but a worsening of the impact can be considered:
Energy consumption increases due to each product application pass that must be made, compared to not treating the pest.	
Water	Unmeasured impact:
There is no direct relationship between this practice and the indicator in question.	
Soil	Unmeasured impact:
No direct relationship between this practice and the indicator in question.	
Air	Unmeasured impact, but a worsening of the impact can be considered:
No direct relationship between this practice and the indicator in question, but a worsening of it can be considered due to emissions for each pass to apply the product.	
Biodiversity	Unmeasured impact:
No direct relationship between the practice and the indicator in question.	

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Extended Practice Abstract Nº 17

Project on the grape leafhopper: the new threat to Mediterranean viticulture

Short description of the project

The general objective of the project is to study the biology of the grape leafhopper. The specific objectives are to:

- Identify the leafhopper species in the Autonomous Community of Valencia.
- Understand the pest's life cycle.
- Evaluate the damage in the vineyards of the Autonomous Community of Valencia.
- Describe the pest control strategies implemented.

Benefits

The project has identified that kaolin sprayed three weeks before the beginning of the major peak of the pest is an effective treatment to control leafhoppers.

Stage of implementation

The project ended in 2023. Considering the results, the research team is organising the methodology to continue the project in 2025.

Key data box

Theme
Biodiversity
Natural resources conservation
Pest management
Grapes

Context
Climatic limitation

Duration
2022–2023

Partners involved
Instituto Cavanilles de Biodiversidad y Biología Evolutiva (ICBIBE), SAEM, La Baronía de Turís CoopV., Bodegas Enguera

Budget
€100,000

Particularity
DNA Barcoding for leafhopper species analysis

Main achieved or expected results

5. Although the sample size is moderate, *Empoasca vitis* and *Jacobiasca lybica* are the most prevalent species present.

6. The leafhopper population develops exponentially at the end of June, reaching its peak in the middle of August.

7. The grape leafhopper is a pest in 7 out of 10 vineyards, particularly in the southern part of the region.

8. Conventional insecticides create resistance that can reduce their effectiveness. The use of 5% kaolin can reduce leafhopper damage by more than 30% and does not create resistance or negatively affect beneficial insects.

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Figure 1: Location of the study area

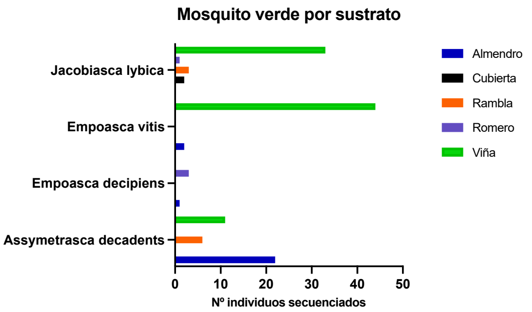

Figure 2: Leafhopper species found in different crops and ecological infrastructures around the blocks

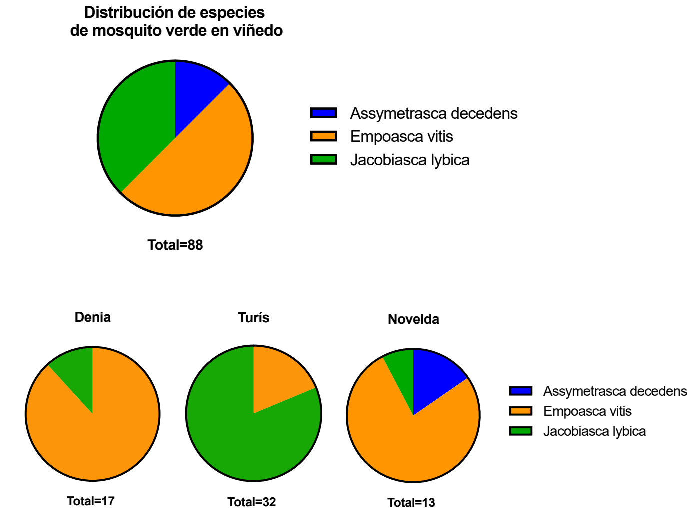

Figure 3: Distribution of leafhopper species in the vineyards and the three properties with the most DNA sequences analysed

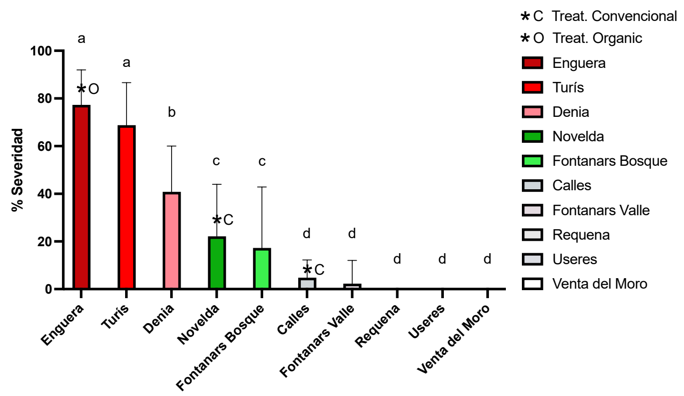

Figure 4: Leafhopper damage expressed in percentage of leaf affected

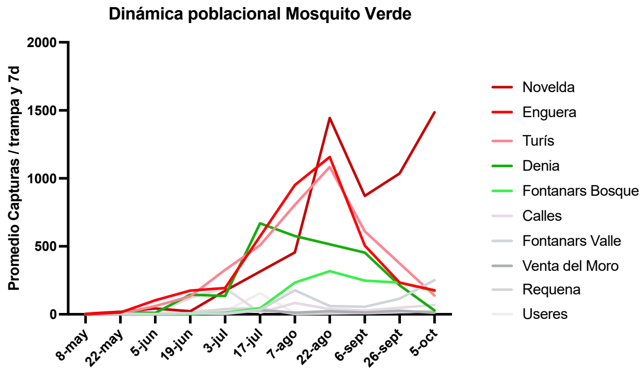

Figure 5: Leafhopper population dynamics

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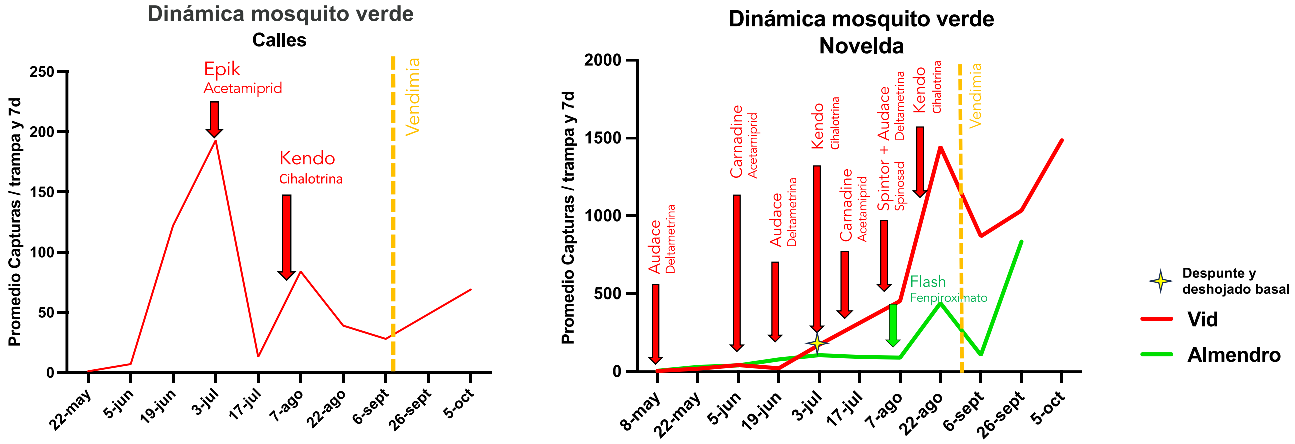

Figure 6: Conventional treatments and their effect on leafhopper population dynamics

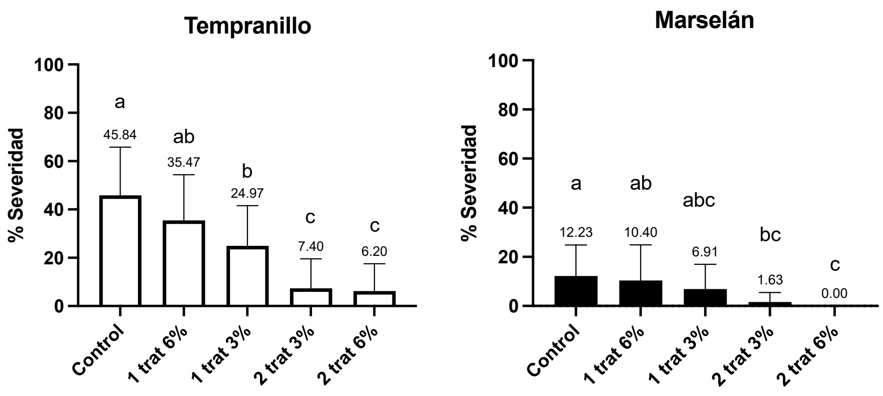

Fig 7: Effect of kaolin on reducing leafhopper damage in Marselan and Tempranillo vineyards

Existing materials

Videos

https://www.youtube.com/watch?v=QEBc9FgBTmQ&t=20s
https://www.youtube.com/watch?v=OVDdY9zVLbA

Web links

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Extended Practice Abstract Nº 18

CLIMED-FRUIT

How ground cover management impacts arthropod biodiversity and grapevine characteristics in the Douro Demarcated Region

Challenge

The use of ground cover is a recommended practice in sustainable viticulture. However, in some dry areas, such as the Douro Demarcated Region (DDR), the fear of water competition limits wine-growers from adopting this practice. Tilling is a practice still largely implemented by DDR farmers, promoting **soil erosion**, **reduced soil fertility and water holding capacity**, **biodiversity loss** and other alterations in ecosystems due to the impacts of extreme climate events.

Solution

Cover crops represent a sustainable solution to mitigate some of these challenges. They use native or seeded vegetation, controlled by machinery (roller or mower equipment), allowing the soil surface to be protected from direct exposure to environmental conditions (extreme weather events), enhancing functional biodiversity and promoting soil health.

Benefits

Under the conditions in the DDR, ground cover modalities (rolled, mowed) promoted more soil biodiversity and did not induce more water stress in vines than the tilled modality, nor did they impact production or grape quality parameters. These results contribute to a better understanding of the impact of soil management practices, in order to select those that contribute more to soil health and, therefore, to promote a more sustainable viticulture.

Main benefits identified:

- reduces erosion and runoff (particularly relevant in steep-slope viticulture regions such as the DDR)
- improves soil biodiversity
- does not compete with the crop for water
- increases water infiltration
- decreases soil temperature during the summer
- increases soil structure
- increases trafficability
- increases crop sustainability

Applicability box

Theme
Climate change and adaptation, adaptive soil management, cover crops, biodiversity, soil health

Context
Rainfed vineyards located in the Douro Demarcated Region (northeastern Portugal)

Year 2023: Total annual rainfall: 654 mm; rainfall from March to harvest: 200 mm; average annual temperature: 17.1°C; average temperature from March to harvest: 21°C; average temperature in July: 23.8°C; average temperature in August: 25.4°C; max temperature registered: 45°C in August

Application time
2023

Required implementation period
One year (2023)

Period of impact
Plant cover or its remains should be present throughout the year.

Equipment
Machinery (tractor with a roller or mower equipment)

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Practical recommendation

Considering the practices that farmers traditionally perform in the DDR setting, three mechanical interventions were carried out in mid-March and mid-June in an experimental design conducted to assess the impact of different types of inter-row soil management (tillage, mowing, rolling) on vine performance, grape quality and soil functional biodiversity:

- in the **tilled modality**, a superficial scarification was carried out and spontaneous vegetation was left to grow between interventions (Fig. 1a);
- in the **mowed modality**, the soil vegetation was cut using a hammer crusher, at a height of 7–8 cm (Fig. 1b);
- in the **rolled modality**, a roller was used to flatten the vegetation (Fig. 1c).

a) b) c)

Figure 1. a) TILL – tilled soil, b) MOW – mowed vegetation, c) ROLL – rolled vegetation

Main results and recommendations

Our results suggest that under the conditions of this experiment in the DDR, ground cover modalities (rolled or mowed) promoted more functional biodiversity and did not induce more water stress than the tilled modality, and they had no impact on production and grape quality parameters either (Maia et al., 2024).

Considering these results, these sustainable practices can be achieved by **maintaining and promoting the growth of spontaneous ground cover or by sowing mixtures of plant species**. According Gonçalves et al. (2020), the use of spontaneous vegetation appears to be the most efficient practice to guarantee more resilience in the DDR, being more adapted to local conditions and possibly requiring lower maintenance than sown species, while sowing mixtures can potentially have the advantage of accelerating floristic-structural recovery under stressed environmental situations.

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Extended Practice Abstract Nº 18

Existing material

Videos

Practice presentation:
https://www.youtube.com/watch?v=kCghF6cUIvA&list=PLqU_4ysqg2QmO7plsRi5r5C_M4mMFuVwW&index=13&ab_channel=CLIMED-FRUIT

Further Reading

Technical factsheet – Enrelvamento
https://www.advid.pt/uploads/DOCUMENTOS/Subcategorias/apoio-fitossanitario/1%20-%20Enrelvamento.pdf

Technical Guide 'Diferentes estratégias para controlo de infestantes em viticultura de encosta'
https://www.advid.pt/uploads/DOCUMENTOS/Subcategorias/Comunicacao/MANUAL_INFESTANTES_FINAL_WEB.pdf

References of publications related to the data presented

- G. Maia; F. Gonçalves; I. Oliveira; M. Nóbrega; M. Rui; C. Carlos (2023). Efeito de diferentes formas de gestão da vegetação do solo da vinha na biodiversidade funcional do solo. Livro de resumos *12º Encontro Nacional de Proteção Integrada* (ENPI)**.** Escola Superior Agrária de Elvas/ Instituto Politécnico de Portalegre, Elvas, 30 e 31 de Outubro de 2023 (pp. 30-31) (oral communication).

- G. Maia, F. Gonçalves, C. Maia, I. Oliveira, M. Nóbrega, I. Gonçalves, R Menezes, A. Pereira, M. Rui, C. Carlos (2023). Efeito de diferentes formas de gestão da entrelinha da vinha na biodiversidade funcional do solo e no estado hídrico da videira. Livro de resumos das VII *Jornadas de Engenharia Agronómica*, Universidade de Trás os Montes e Alto Douro, 23 de novembro de 2023 (p. 11) (oral communication).

- G. Maia, F. Gonçalves, C. Maia, I. Oliveira, M. Nóbrega, I. Gonçalves, R Menezes, A. Pereira, M. Rui, C. Carlos (2023). How soil management impacts vines and soil biodiversity?. Livro de resumos do *2º Congresso Nacional sobre Alterações Climáticas*, 21, 22 e 23 fevereiro de 2024, Universidade de Trás os Montes e Alto Douro, Vila Real (pp. 30) (oral communication).

- G. Maia, F. Gonçalves, C. Maia, I. Oliveira, M. Nóbrega, I. Gonçalves, R Menezes, A. Pereira, M. Rui, C. Carlos (2023). How soil management impacts vines and soil biodiversity?. Livro de resumos do *Climed Fruit Web Conference*, 12 e 13 de março de 2024 (oral communication, available on https://www.youtube.com/watch?v=kCghF6cUIvA&list=PLqU_4ysqg2QmO7plsRi5r5C_M4mMFuVwW&index=13&ab_channel=CLIMED-FRUIT, premiado pela organização para futura publicação de história digital).

- Carlos C., Maia G., Ferreira M., Magalhães D., Martins M., Gonçalves I., Soares R., Nóbrega M., Oliveira I., Falco V., Crespí A., Torres L., Pinto R., Gonçalves F. (2024). "How soil management impacts vineyard performance, grape quality and biodiversity. Case-studies of Douro Demarcated Region vineyards", Book of abstracts *13th International Symposium Oenoviti International Network*, Asti, Turim, 14 May 2024, source-work-id: cv-prod-id-4236545 (pp. 46-57) (oral communication C. Carlos).

- Gonçalves F., Maia G., Rui M., Maia C., Dinis L., Pinto R., Crespí A., Oliveira I., Gonçalves I., Nobrega M., Soares R., Torres L., Carlos C. (2024). Abordagens agroecológicas na gestão do solo em viticultura: casos de estudo em vinhas da Região Demarcada do Douro. Livro de resumos XIII Encontros Vínicos dos Vinhos Verdes, 10-11 maio 2024, 4-6 (oral Communication F. Gonçalves).

- G. Maia (2024). Efeito de diferentes formas de gestão da vegetação do solo da vinha na biodiversidade de artrópodes e características fisiológicas da videira. Dissertação de mestrado Engenharia Agronómica. UTAD, Vila Real. 90 pp.

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Extended Practice Abstract Nº 18

CLIMED-FRUIT

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CLIMED-FRUIT

Simplified cost/benefit analysis

Ground cover management in Douro Demarcated Region vineyards

Introduction – presentation of ex-ante and ex-post situation

The use of ground covers, either native or seeded, is a recommended practice in sustainable viticulture, particularly in steep situations, to control soil erosion. However, in some dry areas such as the Douro Demarcated Region (DDR), the risk of water competition creates limitations for the adoption of this practice and, therefore, tilling remains as widely implemented practice. In the last 10–15 years, the use of green covers between vineyard rows has spread in the DDR as a result of the agro-environmental implementation measures promoted through the common agricultural policy rural (CAP) development programme (PDR2020). In the ex-ante situation, four shallow tillage passes were carried out with a scarifier from May to September. In the ex-post situation, the ground covers along the vineyard alley were mowed four times, using a shredder or a knife roller, from the end of May to September. Cover crops were seeded when needed. In both situations, a pruning wood crusher was used before budburst (mid-February/mid-March).

Economical costs and benefits

Legend

Estimated indicator

Measured indicator

This analysis uses data collected in the DDR by Sogevinus.

The values indicated in the table below consider the costs of hiring a service provider to carry out the soil management activities mentioned (calculated on an annual basis).

	Ex-ante	Ex-post
Pruning wood crusher	**€80/ha**	Option 1 – native cover crops: **€80/ha** Option 2 – seeding cover crops: **€80/ha**
Tilling operation (scarification 4 times/year)	**4 × €45/ha**	Option 1: **€0/ha** Option 2: **€0/ha**
Mechanical cover crop management (mowed 2–3 times/ year)	**€0/ha**	Option 1: 2–3 × €52.50 = **€105–€157.50/ha** Option 2: 2–3 × €52.50 = **€105–€157.50/ha**
Seeding cover crops Soil preparation (scarification + roller) + seeds + labour to seed	**€0/ha**	Option 1: **€0/ha** Option 2: €45 + €45 + €136 + €17.50 = **€243.50/ha** (sowing costs were amortised over 10 years)
Total costs per year	**€260/ha**	Option 1 – native cover crops: **€185–€237.50/ha** Option 2 – seeding cover crops: **€209.35–€259.85/ha**
COMPARISION	Indicator improvement of 0-40% (option 1) and 0-20% (option 2): 	

Economical benefits: Under the conditions of our study, the use of cover crops did not significantly impact grape yield and quality parameters. However, some tendencies should be mentioned. A 16% reduction in yield (from 1.93 to 1.62 kg/plant) was quantified in the cover crop modality compared to the tillage modality. In contrast, quality parameters measured by tannins, anthocyanins and polyphenols increased by 17–22%, 6–19% and 12–19%, respectively, in cover crop modalities compared to the tillage modality (11). Long-term benefits include

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improved soil health, increased future productivity and significant environment advantages that can translate into economic benefits. Fraga and Santos investigated the effects of mulching in a typical Mediterranean climate region in southern Portugal under future climate change scenarios, and their results suggest that mulching can mitigate the adverse effects of a warmer and drier climate and extreme events, expressed as an estimated yield increase of 10–25% compared to a bare soil vineyard(7).

Environmental costs and benefits

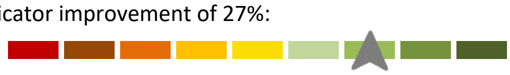
Energy

Indicator improvement of 22%:

In a trial conducted in the DDR comparing three soil management modalities (conventional tillage, spontaneous cover and seeded cover), it was found that spontaneous cover was the modality with the lowest energy consumption and lowest carbon emissions(13). The energy cost to produce one kg of grapes was 0.89 MJ in spontaneous cover crop, 1.14 MJ in conventional tillage and 1.23 MJ in seeded cover. The mechanical management of a spontaneous cover crop represented a 22% decrease in energy consumption compared to tillage. The operation of seeding a cover crop represented a 38% increase in energy consumption and carbon emission compared to a spontaneous cover crop.

Water

Indicator improvement of 27%:



Under the conditions of our study, the use of cover crops did not induce more water stress than the tilled modality(11). As the vegetation dries out from the end of May, under the conditions in the DDR, the protective layer of dry vegetation works as a mulch, promoting a reduction in soil temperature and water evaporation in similar studies conducted in other regions of Portugal(10).

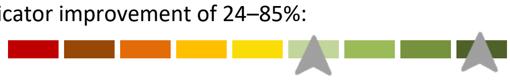
Under Mediterranean conditions, competition for water was pronounced in the spring, decreasing after blooming(14). Furthermore, vine activity in summer is highly dependent on the water content in deep soil layers rather than superficial ones(6). It seems that permanent crops and herbaceous vegetation for the most part consume water from different soil layers. Soil vegetation can force the vine root system to explore deeper soil layers, thereby partly avoiding direct competition for water resources(12).

Soil cover has a beneficial effect on increasing water infiltration and reducing water runoff and soil loss, and cover crops lead to 27% reduction in runoff coefficient compared to tillage(4)(14).

The use of cover crops is a strategy that can positively influence water use efficiency by reducing excessive vine vigour in fertile soils or by promoting root growth in deeper layers of soil. However, in vineyards with low vigour, poor fertile soils and in dry environments, water competition must be monitored properly to avoid negative effects on grape yields(14).

Soil

Indicator improvement of 24–85%:



Cover crops led to a 24% reduction in soil loss compared to conventional tillage in Douro vineyards(5). In a study conducted on an experimental farm in the DDR, the date of intervention was found to be a

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determining factor for erosion control. Delaying ground cover management by 1 or 2 months helped to reduce soil loss by 31% to 52% of the rate found in conventional systems, where spring weed control is performed at the beginning of the vine growing season[5]. In no-till systems, keeping high levels of ground cover control residues on the soil resulted in very effective soil loss reduction (74% compared to conventional systems, where residue cover after tillage is low)[5].

In olive groves, no-till plots demonstrated a reduction in soil loss of up to 50%, and the impact was considerably higher during erosion events associated with higher amounts of rainfall in late fall and winter, when no-till plots achieved a reduction in soil loss of up to 85%[15]. Cover crops can have a positive effect on reducing soil temperature, increasing soil organic carbon and improving fertility[1][3]. However, when considering the option of sowing the cover crop in vineyards, the farmer must also consider the impact of soil preparation ('seeding bed') on soil erosion and overall soil health characteristics, an impact that is not considered in the case of using native cover crops.

Air	Indicator improvement of 12.3%: 

A study carried out in the DDR revealed that the spontaneous vegetation cover treatment presented lower CO2eq emissions (2,057 kg CO2eq ha-1) than the seeded cover and conventional tillage treatments, which presented similar emissions (2,325–2,345 kg CO2eq/ha). In both scenarios, soil management was carried out mechanically using diesel tractors and their implements. This represents a 12.3% reduction in emissions with the use of spontaneous vegetation cover compared to conventional tillage or seeded cover[13].

Biodiversity	Indicator improvement of 62–344%: 

Vegetation covers have been shown to enhance biodiversity in vineyards[2][8][9][11][16]. In this study, cover crops enabled epigeic arthropods to increase by up to 344% compared to tillage. In the case of predators (mainly *Aranea* and *Carabidae*) the increase was by up to 77% [11].

It was also found that the abundance and richness of soil-living arthropods, represented mainly by *Acari* and *Collembola*, were positively affected by cover crops, increasing, respectively, by about up to 100% and 77%[8].

Soil cover also positively affected the biological soil quality index (QBS-ar), obtained from data on soil-living arthropods, which increased by approximately 62% [8]. Well-adapted microarthropod groups such as *Symphyla, Protura, Diplura, Palpigradi*, and *Pseudoscorpionida* were absent in tilled soil[8].

Cover crops also increased plant material breakdown; by using tea bags containing green tea or rooibos, it was found that the breakdown in both cases increased, by up to 6% and 19%, respectively, in the cover crop modalities compared to tillage, making it possible to infer a greater microbial activity in these

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modalities [11]. The parasitism rate of the European grapevine moth (*Lobesia botrana*) increased by 50% in vineyards with ground cover compared to vineyards with bare soil[2].

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Extended Practice Abstract Nº 18

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Bibliography and sources

(17) 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.

(18) Carlos C, Gonçalves F, Villemant C, Paredes D, Salvação J, Torres L. (2022). Parasitoids of Lobesia botrana (Lepidoptera: Tortricidae) in the Douro Demarcated Region vineyards and the prospects for enhancing conservation biological control. *Bulletin of Entomological Research*, 112(5):697-706. doi:10.1017/S0007485322000116

(19) Costa, J. M., Egipto, R., Aguiar, F. C., Marques, P., Nogales, A., & Madeira, M. (2023). The role of soil temperature in mediterranean vineyards in a climate change context. *Frontiers in Plant Science*, 14, 1145137.

(20) Figueiredo, T. (2015). Proteção do solo em viticultura de montanha: manual técnico para a região do Douro. Vila Real: ADVID - Associação para o Desenvolvimento da Viticultura Duriense.

(21) Figueiredo T., Hernández Z., Fonseca F. & Poesen J. (2017). Eficácia no controlo da erosão de medidas de gestão do solo baseadas em coberturas herbáceas: simulações para a viticultura do Douro, Portugal. IX Congresso Ibérico de Agroengenharia. Instituto Politécnico de Bragança, Portugal. http://hdl.handle.net/10198/15912

(22) Figueiredo T. D., Fonseca F., & Hernández Z. (2020). Terraced vineyards of the Douro wine region, Portugal: A soil and water management perspective. *Pirineos*, 175, e058-e058.

(23) Fraga, H., Santos, J. A. (2018). Vineyard mulching as a climate change adaptation measure: Future simulations for Alentejo, Portugal. Agric. Syst. 164, 107–115. doi: 10.1016/j.agsy.2018.04.006

(24) Gonçalves F., Nunes C., Carlos C., López Á., Oliveira I., Crespí A., Teixeira B., Pinto R., Costa CA., Torres, L. (2020). Do soil management practices affect the activity density, diversity, and stability of soil arthropods in vineyards? *Agriculture, ecosystems & environment*, 294, 106863.

(25) Gonçalves F., Villemant C., Paredes D., Salvação J., & Torres L. (2022). Parasitoids of Lobesia botrana (Lepidoptera: Tortricidae) in the Douro Demarcated Region vineyards and the prospects for enhancing conservation biological control. *Bulletin of Entomological Research*, 112(5), 697-706.

(26) Lopes, C., 2016. Cover Crop competition in vineyards: Case studies in mediterranean terroirs. XI International Terroir Congress, July 2016, McMinnville. Oregon (USA).

(27) Maia, G., 2024. Efeito de diferentes formas de gestão da vegetação do solo da vinha na diversidade de artrópodes e nas características fisiológicas da videira. Dissertação de Mestrado em Engenharia Agronómica. Universidade de Trás-os-Montes e Alto Douro, Vila Real, 90p.

(28) Martins A., Raimundo F., Borges O., Linhares I., Sousa V., Coutinho J., Gomes-Laranjo J., Madeira M. (2010). Effects of soil management practices and irrigation on plant water relations and productivity of chestnut stands under Mediterranean conditions. *Plant Soil* 327, 57–70. https://doi.org/10.1007/s11104-009-0031-0

(29) Moutinho-Pereira, J.M. (2015). Relatório Final do Projeto “Greenvitis - Efeitos da gestão do solo na produtividade e sustentabilidade do sistema vitivinícola duriense”. ProDer - 43879, RefªIF 0018. UTAD. 47 pp.

(30) Novara A., Cerda A., Barone E., Gristina L. (2021). Cover crop management and water conservation in vineyard and olive orchards. *Soil and Tillage Research*, Volume 208, 104896, https://doi.org/10.1016/j.still.2020.104896

(31) Santos R., Fonseca F., Baptista P., Paz-González A., & de Figueiredo T. (2023). Erosion Control Performance of Improved Soil Management in Olive Groves: A Field Experimental Study in NE Portugal. *Land*, 12(9), 1700. https://doi.org/10.3390/land12091700

(32) Simões M.P., Belo A.F., Pinto-Cruz C., Pinheiro A.C. (2014). Natural vegetation management to conserve biodiversity and soil water in olive orchards. *Spanish Journal of Agricultural Research*, 12(3): 633-643.

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Extended Practice Abstract Nº 18

CLIMED-FRUIT

A project to link cover management, arthropod biodiversity and grapevine characteristics in the Douro Demarcated Region

Short description of the OG/project

This work was funded by the project UIDB/04033/2020 developed at CITAB (Centre for the Research and Technology of Agro-Environmental and Biological Sciences) in its line of research 'Sustainability of Agri-food and Forestry Ecosystems in a Changing Environment'. This line aims to deliver integrated analytical and modelling frameworks to detect agricultural, forestry and ecological changes in rural landscapes.

Benefits

Reinforces the importance of soil vegetation cover in increasing soil functional biodiversity and some ecosystem services without impairing vineyard physiology and production.

Assessed parameters and stage of implementation

The work started in 2023 (March–October 2023).

During the 2023 season, several parameters were assessed related to biodiversity (flora, soil-surface arthropods, decomposition of plant material in the soil and feeding activity of microfauna and mesofauna). The water status of vines was assessed through predawn leaf water potential during the ripening period. Production and grape quality parameters were assessed at harvest and pruning wood was weighted and the Ravaz index calculated.

Key data box

Theme

Climate change and adaptation, adaptive management of soil, cover crops, biodiversity, soil health

Context

Rainfed vineyards located in the Douro Demarcated Region (northeastern Portugal)

Year 2023: Total annual rainfall: 654 mm; rainfall from march to harvest: 200 mm; average annual temperature: 17.1°C; average temperature from March to harvest: 21°C; average temperature in July: 23.8°C; average temperature in August: 25.4°C; ma temperature registered: 45°C in August

Duration

One year (spring to autumn 2023)

Partners involved

CITAB (research centre); Sogevinus (wine company) and ADVID (wine farmer association)

Budget

The work was also funded by CITAB with the participation of private funds (Sogevinus S.A and ADVID).

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Main achieved or expected results

With this work we intended to evaluate how ground cover management impacts arthropod biodiversity and grapevine characteristics in the Douro Demarcated Region. Thus, an experimental design was conducted to assess the impact of three different inter-row soil management practices (tillage, rolling and mowing) on vine performance, grape quality and soil functional biodiversity. Results suggest that ground cover modalities (rolled and mowed) promoted more functional biodiversity and did not induce more water stress than the tilled modality, nor did they impact production and grape quality parameters.

- b) c)

Figure 1. a) TILL – tilled soil, b) MOW – mowed vegetation, c) ROLL – rolled vegetation

Existing materials

Videos

https://www.youtube.com/watch?v=kCghF6cUIvA&list=PLqU_4ysqg2QmO7plsRi5r5C_M4mMFuVwW&index=13&ab_channel=CLIMED-FRUIT

Further reading

Guia de boas práticas para a Biodiversidade - Enrelvamento

https://www.advid.pt/uploads/DOCUMENTOS/Subcategorias/apoio-fitossanitario/1%20-%20Enrelvamento.pdf

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Extended Practice Abstract Nº 18

MANUAL Diferentes estratégias para controlo de infestantes em viticultura de encosta

https://www.advid.pt/uploads/DOCUMENTOS/Subcategorias/Comunicacao/MANUAL_INFESTANTES_FINAL_WEB.pdf

- G. Maia; F. Gonçalves; I. Oliveira; M. Nóbrega; M. Rui; C. Carlos (2023). Efeito de diferentes formas de gestão da vegetação do solo da vinha na biodiversidade funcional do solo. Livro de resumos *12º Encontro Nacional de Proteção Integrada* (ENPI)**.** Escola Superior Agrária de Elvas/ Instituto Politécnico de Portalegre, Elvas, 30 e 31 de Outubro de 2023 (pp. 30-31) (oral communication).

- G. Maia, F. Gonçalves, C. Maia, I. Oliveira, M. Nóbrega, I. Gonçalves, R Menezes, A. Pereira, M. Rui, C. Carlos (2023). Efeito de diferentes formas de gestão da entrelinha da vinha na biodiversidade funcional do solo e no estado hídrico da videira. Livro de resumos das VII *Jornadas de Engenharia Agronómica*, Universidade de Trás os Montes e Alto Douro, 23 de novembro de 2023 (p. 11) (oral communication).

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- Carlos C., Maia G., Ferreira M., Magalhães D., Martins M., Gonçalves I., Soares R., Nóbrega M., Oliveira I., Falco V., Crespí A., Torres L., Pinto R., Gonçalves F. (2024). "How soil management impacts vineyard performance, grape quality and biodiversity. Case-studies of Douro Demarcated Region vineyards", Book of abstracts *13th International Symposium Oenoviti International Network* , Asti, Turim, 14 May 2024, source-work-id: cv-prod-id-4236545 (pp. 46-57) (oral communication C. Carlos).

- Gonçalves F., Maia G., Rui M., Maia C., Dinis L., Pinto R., Crespí A., Oliveira I., Gonçalves I., Nobrega M., Soares R., Torres L., Carlos C. (2024). Abordagens agroecológicas na gestão do solo em viticultura: casos de estudo em vinhas da Região Demarcada do Douro. Livro de resumos XIII Encontros Vínicos dos Vinhos Verdes, 10-11 maio 2024, 4-6 (oral Communication F. Gonçalves).

- G. Maia (2024). Efeito de diferentes formas de gestão da vegetação do solo da vinha na biodiversidade de artrópodes e características fisiológicas da videira. Dissertação de mestrado Engenharia Agronómica. UTAD, Vila Real. 90 pp.

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ADVID https://www.advid.pt/pt

Project website: https://climed-fruit.eu/

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Extended Practice Abstract Nº 19

Tillage and frost in the vineyard: how to anticipate practices to avoid increasing the risks

Challenge

Spring, particularly the month of April, is the period for resuming tillage. As temperatures increase, weeds resume actively growing, the soils dry out from winter precipitation and tractors can pass, so it is imperative to prepare the *cavaillon* (area located under the vines in the axis of the row) for future work by carrying out *décavaillonnage* to remove the mounds of earth that have formed at the foot of the vines at the start of winter and thus limit the growth of weeds. In a context of reducing the use of herbicides, these *cavaillon* working techniques are increasingly being adopted by winegrowers.

In 2020, it was observed that a 25% increase in air humidity can lead to a 50% increase in the number of frozen buds at the same temperature. This phenomenon is explained by relative humidity, which increases when the temperature decreases, increasing plants' sensitivity to spring frost. Previously moistened surfaces are more sensitive to frost phenomena.

Anticipating the risk of spring frost is a major issue. Anticipatory and prophylactic solutions are possible, in particular by adapting cultural practices. The objective is to know the factors that increase the effects of freezing and to reduce the impacts of these episodes by adapting practices better.

Solution

By anticipating tillage practices, it is possible to avoid increased damage from spring frost on broken buds. Whether it is tillage itself or grass cover management, the objective is to have the buds in the driest environment possible.

Benefits

Careful management of tillage practices during these risky periods makes it possible to avoid significant

Applicability box

Theme
Adaptive management
Climate change adaptation

Context
Loire Valley, central France.
Increasingly earlier vine bud burst due to global warming
3 consecutive years of spring frost damage (> 20%)

Application time
End of winter–early spring (bud burst)

Required implementation time
None – Organisation time needed for implementation

Period of impact
From bud burst to harvest

Equipment
No specific equipment is required

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damage to yield and improve the efficiency of vineyard areas.

Practical recommendation

In case of the risk of spring frosts is announced, one week before:

- The atmosphere around the buds needs to be as dry as possible.
- No tillage or mowing 5–6 days before the announced risk.
- Failure observed due to mowing of a dense cover of clover five days before frost.
- '*Le mieux est l'ennemi du bien*' = 'The best is the enemy of good'
- Sometimes it is better to do nothing!

All the observations carried out on the plots in the central Loire Valley region made it possible to establish a set of best practices: seven days before an announced frost (timeline corresponding to the anticipation possible thanks to forecast weather data), it is necessary to avoid releasing moisture, either by working the soil (from the sloping ground or between the rows) or by mowing or crushing inter-row plant cover. It is preferable not to do anything regarding the soil (covering or managing weeds by tillage) in the week before a frost episode.

Further information

Videos

Results presentation :
https://www.youtube.com/watch?v=752SF02YhqY

Web links

Project presentation :
https://www.sictag.fr/

Contact information

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Project website: https://www.sictag.fr/

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Simplified cost/benefit analysis

Tillage recommendations when there is a risk of spring frost

Introduction – presentation of ex-ante and ex-post situation

For 3 days after tillage, an increase of up to 30% in relative humidity is noted at the level of the vine buds above a tilled soil. Considering that 25% relative humidity can increase frost damage on buds by 50%, tillage 3 days before frost would considerably increase the damages (ex-ante situation). But this can be avoided by not tilling the soil or by mowing 5/6 days before the risk of frost is announced (ex-post situation). In both cases, the crop itinerary does not change as it is just a question of timing.

Economical costs and benefits

Legend

Estimated indicator

Measured indicator

The economic benefit of applying the ex-post situation compared with the ex-ante situation is based on the loss of yield that is avoided, as the ex-ante situation can increase frost damage on buds by 50%.

It is difficult to put an economic figure on the impact of implementing the ex-post situation compared with the ex-ante situation, as the loss of yield caused in the ex-ante situation depends on many conditions, and in particular the intensity of the frost event itself.

COMPARISON	Estimation: up to 50% reduction of the damages on vine buds: 

Environnemental costs and benefits

The analysis of environmental costs and benefits is not appropriate in this case. In fact, the crop itinerary does not change, only the period of application, which therefore implies no change in environmental terms.

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SICTAG project: frost protection methods for wine growing

Short description of the project

The SICTAG project is studying different ways of combating frost in vineyards. The project is organised into four parts.
The first part aims to define a method for modelling frost risk situations in different terroirs.
The second part focuses on the implementation of solutions to anticipate the risk of frost by drawing up recommendations on the management of grass cover during periods of frost.
The third part is devoted to characterising and modelling the operation of a fleet of frost protection towers.
Finally, the fourth part is working on the development of an innovative, connected system to remotely activate anti-freeze towers, with a monitoring tool accessible by mobile phone.

Benefits

Limitation of frost damage resulting from global warming

Stage of implementation

The SITCAG project has ended (2020–2022).

Key data box

Theme
Adaptive management
Climate change adaptation

Context
Loire Valley, central France.
Increasingly earlier vine bud burst due to global warming
3 consecutive years of spring frost damage (> 20%)

Duration
3 years (2019–2022)

Partners involved
FRCUMA, Vinopole, Végépolys Valley (growers association), Weather Measures (weather specialist), INRAE and IFV (research centre)

Budget
€115,000

Particularity
Development of a methodology to streamline empirical methods.

Extended Practice Abstract Nº 19

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Main achieved or expected results

The main achieved results for part 2 on the implementation of solutions to anticipate the risk of frost:

Three days after tillage, an increase of up to 30% in relative humidity (Chart 1) is noted at the level of the buds above a worked *cavaillon*, as seen in Picture 1. Considering that a 25% increase in relative humidity can increase frost damage on buds by 50%, tillage three days before the frost would have considerably increased the damage.

It takes up to eight days with daily temperatures > 12°C to find equivalent relative humidity at the level of the buds between the modalities. In some situations, it takes up to 20 days if precipitation greater than 20 mm has been recorded after tillage and when daily temperatures are low.

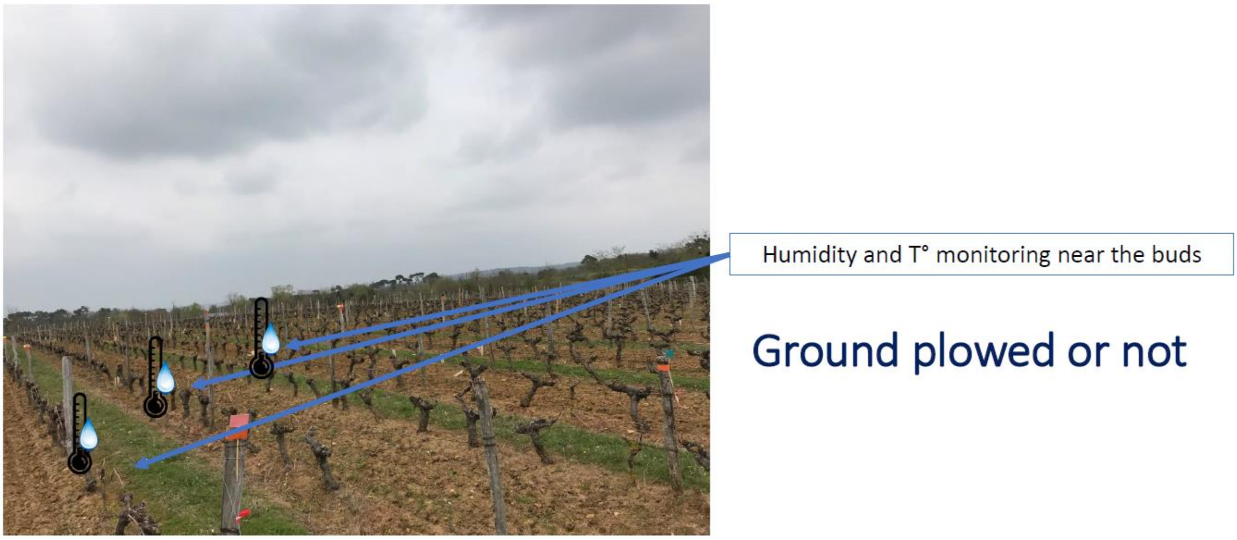

Figure 1: Measuring device near the buds

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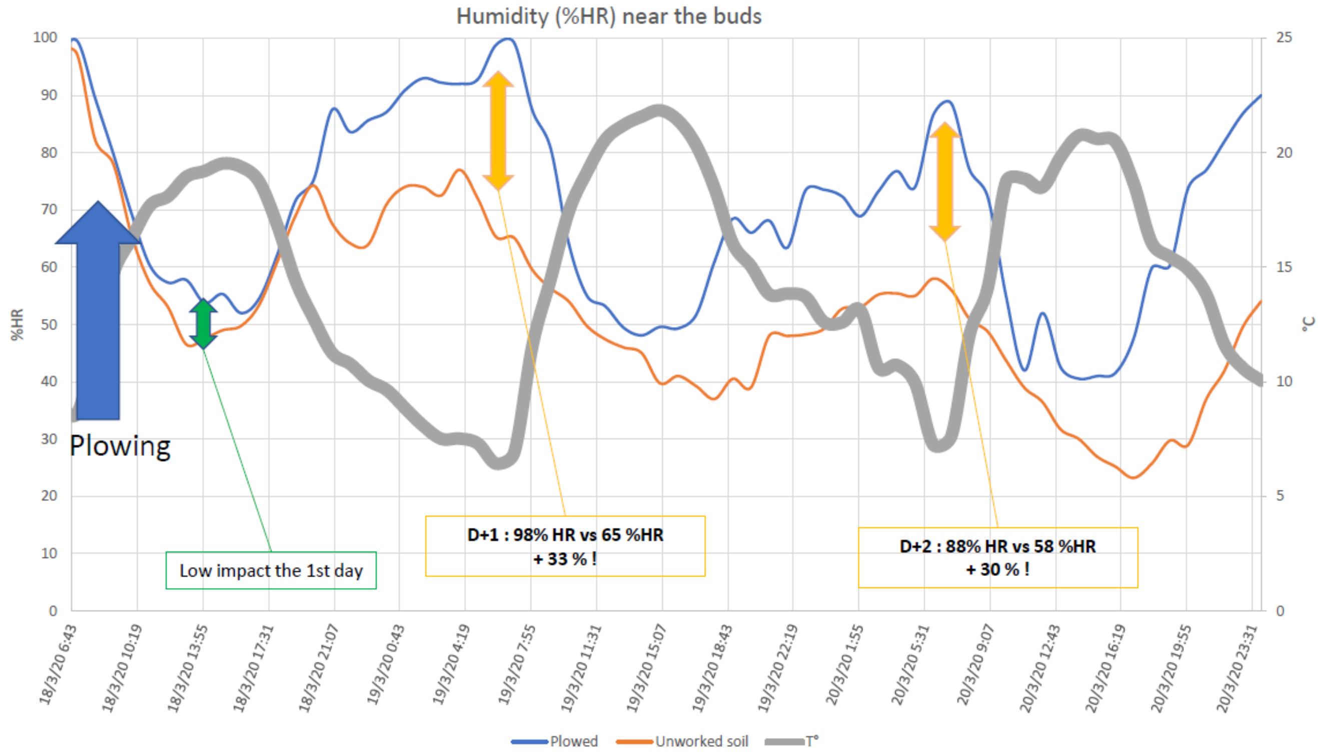

Figure 2: Humidity monitoring results three days after tillage

Existing materials

Videos

OG presentation :
https://www.youtube.com/watch?v=752SF02YhqY

Web links

Project presentation :
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