MACMHER: alternative methods to control weeds in organic vineyards

Summary

Using tillage for the management of weeds in the rows of vines at vineyards that employ organic production techniques is an efficient process. However, the removal of the plant life that grows under the rows of vines is a complicated task due to the risk of damage it poses to the vines. It is in this area where the main competition for water and nutrients takes place, which means that in some cases, depending on the type of weeds involved, tillage may be not only costly, but also inefficient.

The use of specific under-vine weeders has enabled progress to be made in weed control, particularly those with hydraulic springs, which enable the soil to be turned over under the vines and then removed. However, in some cases the hardness of the ground means that these weeding machines may have to work more intensely, running the risk of damaging the vines. At the same time, the ability to remove weeds under the vines cannot be fully guaranteed as it depends on the floristic composition, architecture and plant life structure of the species to be removed.

In recent years, certain species of hardy and quick-growing weeds, such as *Conyza bonariensis*, *Conyza sumatrensis* and *Aster squamatus*, have been identified at fruit orchards and vineyards in our country. These species are considered to pose the biggest threat to various strategic production sectors in Spain (Jiménez-Díaz et al., 2017).

One of the possible alternatives to the use of under-vine weeders, especially given the proliferation of infestations of the aforementioned species, is the use of mulch, particularly organic mulch made up of a variety of plant materials. In general, organic mulch inhibits the growth of weeds thanks to both its physical effects (light interception and temperature) and its chemical effects (the possible release of allelopathic substances) (Oliveira et al., 2014).

It has also been observed that the effect of mulch not only reduces the population of weeds in vines, but also improves a number of soil quality indicators, such as humidity and structure (Zribi et al., 2011; DeVetter et al., 2015). However, there are no studies that assess the possible collateral effects on the vines with a view to avoiding unsuitable options.

This study also considers weed control using bioherbicides of different types that act as contact burners or desiccants. Their efficacy, however, depends on the dose and on the type and development stage of the weeds (Chinery, 2002). The implementation of this alternative, however, is hindered by a lack of the necessary experimental knowledge and technological advances. Using alternatives to traditional mechanical methods at vineyards to control weeds may lead to a number of positive outcomes.

Objectives

The general objective of the study was to assess the efficacy of alternative methods to control weeds in organic vineyards.

The study focused on the control of weed species that grow under the vines (where it is most difficult to take action) and on the assessment of alternatives to the use of under-vine weeders.

The work focused mainly on the species *Conyza bonariensis*, one of the most problematic weeds in the vineyard, which is noticeably spreading and has a high capacity for dispersal and infestation. The objective of establishing alternative methods to control these species is based on the proven efficacy of using different mulches and new bioherbicides on other crops and at different locations.

Specific objectives:

- Assess the effect of different mulches on the emergence of the selected target species and any others that may grow under the vines. The selected mulches will be made of straw from different plants and pine needles.
- Determine the possible allelopathic effects of extracts of plant material used as mulch as a result of inhibiting the growth of the target species.
- Assess the effect of different bioherbicides, in different amounts and in different phenological states, on the weed species in the study, as indicated above.
- Compare the efficacy of control methods based on padding or bioherbicides with the efficacy of traditional under-vine weeders.
- Estimate the possible inhibiting effects on the robustness and yield of the vines arising from the use of mulches and bioherbicides.
- Conduct a financial and viability assessment of the implementation of the tested treatments.

Description of the actions carried out in the project

1. Effects of different mulches: Pine bark mulch for commercial plots:

In a vineyard with 200-m vine rows, a trial was conducted to compare different methods of soil management under the rows. Five different treatments were considered: a) traditional use of the under-vine weeder, at different times throughout the campaign ('under-vine'); b) control, with no intervention ('control'); c) pine-based mulch ('pine'); d) compost-based mulch ('compost) and mulch mixture of pine bark and compost ('pine and compost'). The different mulches were mechanically applied in January 2020 with the help of a dispensing machine that place the mulch under the rows of vines. Each month throughout the 2020 campaign, and in different rows for each treatment, inventories of flora composition and percentage grass cover were taken in a total of 16 plots, 6.5 m long and 60 cm wide.

2. Trial to assess the herbicidal effect of different natural substances (bioherbicides): At the beginning of the 2018 summer, some rows of Cabernet Sauvignon vines with a high infestation of well-developed *C. bonariensis* were selected. The trial began in the summer of 2018. The plants were at an advanced stage, reaching a mean height of 10-40 cm. Eight rows of vines were selected and, below them, 24 randomly distributed plots measuring 3 m x 80 cm were marked out, where different treatments were applied with the help of a manual dispenser. Each plot was equivalent to the length of three vines. Seven substances of natural origin were tested.

The first application was made in July 2018, at an advanced stage of weed development coinciding with a 60-65 BBCH phenological stage (inflorescences developed). However, the trial was repeated in the same plot during the 2019 season, on seedlings of this species at different stages of development, starting in February 2019 with rosette plants and 2-5 leaves (BBCH 12-15). The rest of the applications were carried out in April, May and June coinciding with different stages of weed development.

The trial was repeated in the 2020 campaign, but on another plot, to avoid a possible masking of results by applications made in the previous campaign. Different rows of vines were selected in which a high *C. bonariensis* infestation had been detected in the autumn of 2019.
The treatments were the same and the application dates were 13 March, 15 April, 5 and 19 May, 2020. In this trial, the same number and repetitions of plots were marked out as in plot 40 in 2018 and 2019.

In all applications, the *C. bonariensis* coverage percentage was estimated before and 4-5 days after each treatment. The effectiveness of the treatments was estimated in reference to the values of the control plots (controls) using the Hendersol-Tilton formula.

Final results and practical recommendations

The two tests yielded the following results and recommendations.

- From the tests with pine bark mulch:

The compost acted as a promoter for the growth of the grass, regardless of whether it was applied alone or mixed with pine. In the middle of the campaign (July), pine mulch showed similar or even slightly lower coverage values than with the under-vine weeder. Given these results, we think that a higher frequency of under-vine weeder use could further decrease grass cover, but would involve a higher cost in soil maintenance, compared to pine mulch. Spreading pine mulch in large commercial plots, such as in this trial, with the aim of making this under-vine soil maintenance technique viable, would require: a) optimising the volume and quantity of pine bark spread; b) adapting the machinery for sufficiently effective dispensing that guarantees adequate mulch thickness and high persistence; and c) adapting the width of the chipper to the width of the row or passing the chipper as close as possible to the mulch, with the goal of leaving no uncovered spaces, to prevent weeds from growing.

- Herbicidal effect of different substances of natural origin:

In one of the plots, in the July 2018 application, with the plants at an advanced stage of development and a high percentage of coverage, the most effective treatment was the mixture of humic and fulvic acids, reducing the initial weed coverage by an average of 77%.
The other treatments showed a lower level of efficacy. Although the plants did not die with any of these treatments applied in July, the inflorescences showed a general necrosis with humic and fulvic acids, thus preventing fruiting and achene dispersion. The other products (with the exception of camelina oil) showed a degree of necrosis both in inflorescences and the apical area, in later days observing a reduction in vigour with respect to the untreated control.

In the application carried out in February 2019 on plants in the rosette stage and with low weed coverage, humic and fulvic acids again showed better efficacy in reducing coverage, with 92% efficiency, followed by pelargonic acid, the mixture of pelargonic acid and $K_2S_2O_5$, with 77% efficiency. Unlike the most effective mixtures (fulvic and humic acid and N32 acetic acid), pelargonic acid was found to affect the cuticles of the leaves but not the meristems of the plant, leaving green shoots at the top of the plant, which could facilitate a degree of apical development.

The results of this trial confirm the importance of the phenological stage in the herbicidal efficacy of the substances used. In the rosette stage with two to five leaves (BBCH 12-15), weed sensitivity is much higher than in advanced stages.

Regarding the results obtained in the 2020 season in another plot, the unequal efficacy of different treatments carried out at four different times is clear, also depending on the different development stage of *C. bonariensis* throughout the season. On the four dates of application, humic and fulvic acids showed an efficiency between 70% and 80%, even as high as 90% in the April application. Application of the mixture of pelargonic acid and $K_2S_2O_5$ in the April and two May applications showed the greatest efficacy, with values ranging from 80% to 90%. The rest of the treatments were not notable.

In general, applications were made to a high density of weeds and, throughout the season, at increasingly advanced stages of development, especially in the plants that survived the previous treatment. It is also possible that when applied by manual dispenser, the plants may not have been completely dampened. In addition, these results show lower efficacy values than those observed under controlled conditions in the greenhouse (data not shown, corresponding to another project).

Conclusions

- An adequate thickness of pine bark and chips as mulch under the vines rows is a suitable technique for avoiding the presence of weeds, especially *C. bonariensis*.
- The possible spreading of straw on pine mulching, dispensed by the chipper in the vine rows, further guarantees stopping proliferation of under-vine weeds.
- A pine mulch about 10 cm thick and 80 cm wide guarantees a minimum persistence of two years while maintaining the physical effect on the soil and preventing the emergence of weeds, especially *C. bonariensis*.
- In a commercial plot, a suitable mechanised pine mulch system is required, providing the thickness and spread necessary to obtain the desired effect.
- During the summer season, pine mulch ensures lower weed cover levels (<10%) than under-vine weeder (15%). The mixture of pine and compost is not suitable as mulch, as it favours a greater presence of grass (coverage> 30%)
- The mixture of humic acid and fulvic acid was the most effective treatment in the control of *C. bonariensis*, reaching values even higher than 90% in early stages of weed development (between 2 and 5 leaves). In more advanced stages (developed inflorescences) these acids cause necrosis to the inflorescences and their heads.
- The mixture of pelargonic acid and potassium metabisulphite shows efficacy values between 70 and 90%, depending on the stage of development of *C. bonariensis*.
- The herbicidal efficacy of the substances used is determined by the weed development stage and density.

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Àmbit/s temàtic/s d'aplicació

☐	Agricultural production system
X	Agricultural practice
☐	Agricultural equipment and machinery
☐	Livestock farming and animal welfare
☐	Vegetable production and horticulture
☐	Landscape / Territorial management X Pest and disease control
☐	Fertilisation and nutrient management
☐	Soil management
☐	Genetic resources
☐	Forestry
☐	Water management
☐	Climate and Climate Change
☐	Energy management
☐	Waste and by-product management
☐	Biodiversity and environmental management
☐	Food quality/processing and nutrition
☐	Supply chain, marketing and consumption
☐	Competitiveness and agricultural and forestry diversification
☐	General

Geographical area(s) of application

PROVINCE(S)	REGION(S)
LLEIDA	SEGRIÀ

Difusió del projecte (publicacions, jornades, multimèdia...)

The first results were presented at the following congresses and

conferences: Congresses

- Valencia, N. Mas, A. Arbonés, C. Cabrera, J. Recasens (2018). Uso de Acolchados orgánicos y bioherbicidas en el control de malas hierbas en viña ecológica. III Jornadas del Grupo de Trabajo de Viticultura de la Sociedad Española de Ciencias Hortícolas. 28-29 noviembre 2018. Palma de Mallorca
- Valencia, N. Mas, A. Arbonés, C. Cabrera, J. Recasens (2018). Uso de Acolchados orgánicos y bioherbicidas en el control de malas hierbas en viña ecológica. 3rd Conference of the Viticulture Working Group of the Spanish Society of Horticultural Sciences. 28-29 November, 2018. Palma de

- Cabrera, F. Valencia-Gredilla, A. Royo-Esnal, J. Recasens (2019). Herbicide effect of different organic compounds to control *Conyza bonariensis* in vineyards. Working Group Meeting of EWRS: "Weed Management Systems in Vegetables" and 'Weed Management in arid and semi-arid climates'. Minutes pp. 50-52. 13-15 May 2019. Oeiras (Portugal)
- C. Cabrera, Valencia-Gredilla, A. Sala, JR Solans, J. Recasens (2019). Efecto herbicida de diferentes compuestos orgánicos alternativos al glifosato para el control de *Conyza bonariensis* en viña. 17th Congress of the Spanish Society of Weed Control. Minutes: pp. 102-106. 8-10 October 2019. Vigo. This presentation was awarded the prize for the best communication of the congress.

Technical seminars

- Participation in the National Rural Network Conference at the Directorate-General for Rural Development, Innovation and Forestry Policy of the Ministry of Agriculture, Fisheries and Food (MAPA), with the presentation of "operational groups in the field of the Ecological Agriculture". Madrid. 25 February 2020.

Dissemination on social media

- Following participation in the National Rural Network Technical Conference, the project was selected for dissemination by video, prepared by the MAPA. The Twitter link for the video is: https://mobile.twitter.com/home

Press releases

INTEREMPRESAS:
https://www.interempresas.net/Vitivinicola/Articulos/312961-Metodos-alternativos-para-el-control-de-malas-hierbas-en-vina-ecologica.html

WINE WEEK:
http://www.sevi.net/es/3575_enoturismo/94/15304/Proyecto-MACMHER-m%C3%A9todos-alternativos-para-el-control-de-malas-hierbas-en-vi%C3%B1a-ecol%C3%B3gica-viticultura-femac.htm

OTHER MENTIONS:
http://www.redruralnacional.es/-/red-rural-nacional-reune-a-los-grupos-operativos-proyectos-innovadores-y-proyectos-horizonte-2020-en-materia-de-agricultura-ecologica

https://www.femac.org/fianlitzacio-del-grup-operatiu-macmher/

Pàgina web del projecte

https://www.femac.org/project/projecte-macmher-2/

More information on the project

PROJECT DATES	TOTAL BUDGET
Start date (month-year): June 2018	Total budget: €157,200.00
Completion date (month-year): September 2020	DARP funding: €64,227.60
Current status: Executed	EU funding: €48,452.40
	Own funding: €44,520.00

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Order ARP/133/2017 of 21 June, approving the regulatory bases for grants for cooperation for innovation by promoting the creation of European Association for Innovation operational groups in the areas of agricultural productivity and sustainability and the execution of innovative pilot projects by those groups, and Resolution ARP/1868/2017, of 20 June, announcing the call for the grant.

Generalitat de Catalunya
Departament d'Agricultura, Ramaderia, Pesca i Alimentació

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Europa inverteix en les zones rurals