Extended Practice Abstract Nº 1

Subsurface irrigation

Challenge

Winegrowers are no longer able to perfectly control their production systems due to summer drought. Aerial drip irrigation under the vine row is the most widely used system, but is it the most efficient? The objective of this study was to examine the profiles of soil wet bulbs obtained from 2 irrigation systems: aerial drip located under the vine row and subsurface drip located in the middle of the vine inter-row.

Solution

In this experiment, using capacitive probes in the soil, it was demonstrated that **subsurface irrigation (40 cm depth) in the middle of the row generated larger volumes of wet bulb**, with vertical and lateral percolation of the water, than aerial drip irrigation system (Figure 1).

Subsurface irrigation in the inter-row did not change the vines' water status or the yields compared to aerial irrigation under the vine row.

During our trial, it was also possible to visualize, without measurement, that the water from the subsurface irrigation reached the ground surface by capillarity. This still-underdeveloped irrigation system could be a lever in dry areas to promote the establishment of plant cover in the inter-row, which is known for providing a set of sustainable services.

Benefits

Better water use efficiency, facilitating the establishment of vegetal cover in the Mediterranean area, and maintaining viticulture in dry areas.

Applicability box

Theme
Climate change adaptation, water-use efficiency, cover crop

Context
Mediterranean area; no stony soils

Application time
Period of use (irrigation + eventual fertigation): April to mid-August (a deadline may be imposed by local regulation)
Installation of the subsurface irrigation system: Before planting or during vine dormancy (after harvest, before budburst)

Required implementation time
Depends on plot configuration; similar to an aerial drip system

Period of impact
April–August

Equipment
Irrigation material: pipes, drippers, valves, backwash, etc.

Practical recommendation

3 main steps of subsurface drip irrigation system installation on the plot:

1. Opening of trenches and installation of irrigation combs
2. Assembly of the central station and connection to the combs
3. Installation of drip rails and connection to the combs

It is advisable to adapt the irrigation equipment to this subsurface technique. For installation, a subsoiler is all you need to lay the pipe network. A mini-excavator can be used to install the combs and fittings. This installation is quick to set up, and the working time is comparable to that of an aerial drip system.

Focal points:

- ➢ Importance of filtration and network maintenance
- ➢ Need to install appropriate drippers: flat (to prevent crushing of the drop-forming system under the weight of the soil), anti-siphon, anti-root and self-regulating

Advantages of subsurface drippers:

- ✓ Improved system durability: pipes are protected from pests and machinery
- ✓ Easier mechanical weeding/weed management
- ✓ Between rows, better expansion of the vine's root volume

Disadvantages of subsurface drippers:

- ✓ More expensive to install than an aerial drip system (+20% approx.)

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- ✓ Not suitable for stony soils

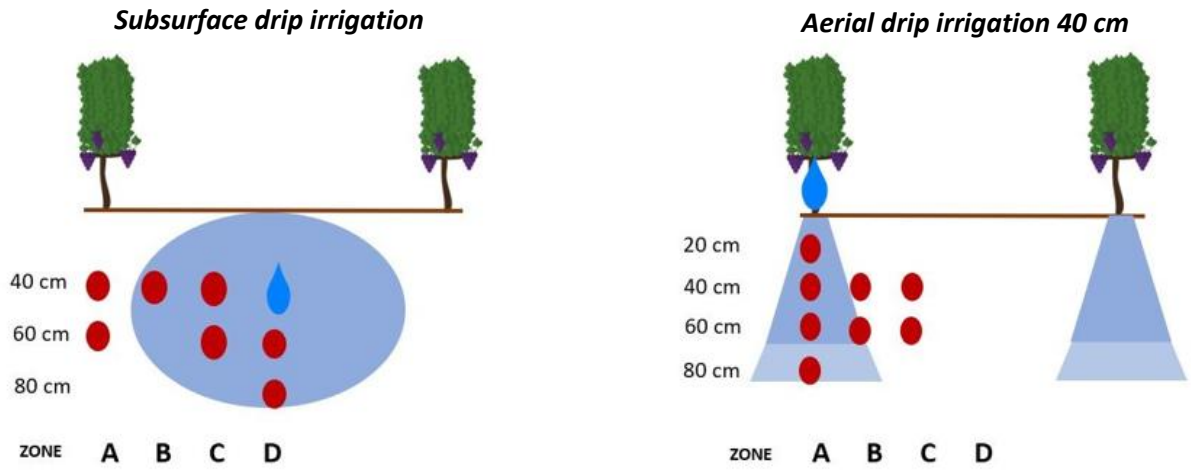

Figure 1: Capacitive probe positioning in subsurface irrigation and aerial irrigation treatments

Related materials

Videos

- Tutorial: Installation of a drip irrigation system (YouTube subtitles) 🇫🇷: https://www.youtube.com/watch?v=6e2vM_ko7xg&list=PL2VxgaK4MB_AefHRA13bf3Vu6uwpgZVDQ&index=3&t=1s&ab_channel=IFVSudOuest
- Irrigation management (YouTube subtitles) 🇫🇷: https://www.youtube.com/watch?v=8uvsWC1_0KU&t=148s&ab_channel=IFVSudOuest
- Vine irrigation: water regime and water quality (YouTube subtitles) 🇫🇷: https://www.youtube.com/watch?v=hPSVxGFRg9k&ab_channel=IFVSudOuest

Web links

- Subsurface irrigation 🇫🇷 https://www.vignevin-occitanie.com/fiches-pratiques/vignobles-innovants-et-ecoresponsables/irrigation-enterree/
- Vine irrigation: water regime and water quality 🇫🇷 https://www.vignevin-occitanie.com/fiches-pratiques/vignobles-innovants-et-ecoresponsables/qualite-de-leau-et-entretien-du-systeme-dirrigation/
- Estimation of the vine water status 🇫🇷 https://www.vignevin-occitanie.com/fiches-pratiques/estimation-de-letat-hydrique-de-la-vigne/

Further reading

Better understand the soil wet bulb formation with subsurface or aerial drip irrigation in viticulture 🇬🇧
https://ives-openscience.eu/12943/

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This extended practice abstract was elaborated in the CLIMED-FRUIT project.
Project website:
https://climed-fruit.eu/ (no OFIVO website)

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Simplified cost/benefit analysis

Subsurface irrigation

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

Aerial drip irrigation (DI) system (ex-ante situation) is compared with a subsurface drip irrigation (SDI) system (ex-post) in the case of a Mediterranean vineyard with a density of 4,500 vines/ha located in the South of France.

Aerial drip irrigation is the most widely used type of irrigation in winegrowing today. The main advantage of the buried version is that it uses water more efficiently, particularly by limiting losses through evaporation. However, it is a very demanding system in terms of maintenance and monitoring to ensure its durability over time. The question of the system's end-of-life remains, and recovering the equipment can prove costly. This aspect must be considered at the time of planting. A line in the middle of the row will be easier to remove/replace than a line close to the vine.

Economical impact

The main differences between aerial and subsurface drip irrigation lie in the way the system is installed: subsurface irrigation requires more stringent installation, specific more resistant equipment, and more monitoring to ensure the system lasts. On the other hand, a subsurface system is less exposed to surface damage (equipment, animals). The extra cost of installation can be offset by the savings made later: water, fertilisers and herbicides (if fertigation), labour, etc. Investment for both irrigation systems is made for around 15 years.

Legend

Estimated indicator

Measured indicator

	Ex-ante: Aerial Drip Irrigation	Ex-post: Subsurface Drip Irrigation
Variable costs		
Installation (earthworks, connections, burying…)	1000 €/ha	1400 €/ha
Equipment (drippers, valves, combs…)	2000 €/ha	2800 €/ha
Maintenance	78 €/ha/an[7]	78 €/ha/an
	The maintenance costs can be considered equivalent, because although there are fewer interventions in SDI (less damage caused by animals, equipment, etc.), they are nevertheless more expensive. For easier maintenance with SDI, it is advisable to add volumeters for more accurate monitoring of potential leaks in the system and faster repairs.	
TOTAL for lifetime of the system	4170€	5370€
COMPARISON	Global increase of 30% of the cost: 	

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Environmental impact

Energy	No significant change estimated: 
There is no appreciable difference in terms of energy consumption, as the pumping systems are similar between underground and overhead drip irrigation.	
Water	Indicator approximate improvement of over 20%: 
- Subsurface irrigation (40 cm depth) in the middle of the row generated larger volumes of wet bulb than aerial drip irrigation system. Subsurface irrigation in the inter-row did not modify the vines water status neither the yields comparing to aerial irrigation under the vine row [(1)] - Irrigation water productivity (yield produced per unit of irrigation water use) improved by around 25% in comparison with surface drip irrigation [(2)] - Greater water savings for SDI compared with DI (up to 20% can be achieved) [(3) (5)]	
Soil	Unmeasured impact: 
No measurement of soil characteristics was taken in the framework of OFIVO. However, certain references based on tomato crops, rockmelons and onions (higher water consumption) indicate an impact of long-term SDI on the chemistry and physical properties of the soil, such as changes in clay content, cation levels and on pore space around emitters [(4) (5)]	
Air	Unmeasured impact: 
No direct relationship between the practice and the indicator in question	
Biodiversity	Indicator approximate improvement between 1 to 24%: 
It has been identified recently that the proximity of SDI emitters modifies the abundance of specific bacterial and fungal genera involved in plant and soil health, providing new information for improving the management of SDI systems [(6)]. In the framework of OFIVO, it was observed that the water from the subsurface irrigation reached the ground surface by capillarity. Therefore, SDI could be a lever in dry areas to promote the establishment of plant cover in the inter-row, which is known for providing a set of sustainable services.	

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(2) Guo, J.; Zheng, L.; Ma, J.; Li, X.; Chen, R. Meta-Analysis of the Effect of Subsurface Irrigation on Crop Yield and Water Productivity. Sustainability 2023, 15, 15716. https://doi.org/10.3390/su152215716, Academic Editor: Jan Hopmans

(3) J. Martínez and J. Reca, Water Use Efficiency of Surface Drip Irrigation versus an Alternative Subsurface Drip Irrigation Method, *J. Irrig. Drain Eng*., 10.1061/(ASCE) IR.1943-4774.0000745

(4) S.A. Barber, A. Katupitiya and M. Hickey, Effects of long-term subsurface drip irrigation on soil structure, 2001, https://www.agronomyaustraliaproceedings.org/images/sampledata/2001/p/3/barber.pdf

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(6) Michelle Quach, Pauline M. Mele, Helen L. Hayden, Alexis J. Marshall, Liz Mann, Hang-Wei Hu, Ji-Zheng He, Proximity to subsurface drip irrigation emitters altered soil microbial communities in two commercial processing tomato fields, Applied Soil Ecology, Volume 171, 2022, 104315, ISSN 0929-1393, https://doi.org/10.1016/j.apsoil.2021.104315

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Extended Practice Abstract Nº 1

OFIVO – Optimization of irrigation & fertigation on Occitan vineyards

Short description of the OG

The gradual change in rainfall patterns experienced in the vineyards of southern France, especially around the Mediterranean Sea, means that the vines are increasingly subject to summer drought.

The objectives of the OFIVO operational group are to study **different irrigation systems** to see which is best suited to vines, as well as **the implementation of fertigation** and its use in viticulture.

OFIVO was implemented by 5 partners (winegrowers, technical institutes, negociants, cooperatives), and 40 winegrowers were involved throughout the project. The trials were mainly located on two plots, in Gascony and the Mediterranean area.

To compare irrigation systems, capacitive probes were used to explore the profiles of wet bulbs in the soil. More than 10,000 pieces of data were collected during the project. The impacts of fertigation were assessed through yield measurement and quality analysis of the harvest.

Benefits

The main added ecological value for the farmer addressed by the OG: water use efficiency in vineyards, precision of water and fertiliser inputs, better mobilisation of fertilising units by the vines.

Stage of implementation

OFIVO has ended (2018–2021).

Applicability box

Theme
Climate change adaptation, water-use efficiency, fertilization

Context
South of France, 2 main regions concerned (near Toulouse = Gascony and near Montpellier = Mediterranean context). Irrigation is already highly developed in the area near Montpellier, which is not yet the case in Gascony. Fertigation is not yet widely used in viticulture.

Duration
3 years (2019-2022)

Partners involved
Independent winegrowers, cooperatives, negociants, technical institute (IFV)

Budget
204 000,00€

Particularity
Organisation of a study trip at the request of winegrowers to get technical feedback from existing system

Main achieved or expected results

The results focus on the positioning of the irrigation system in the vine row (aerial or buried in the middle of the inter-row or under the row) and the impact of the use of fertigation on vines and especially on grape maturity. Expected results are:

- **To secure annual production** in terms of quantity and quality
- **To optimize water use** according to its availability
- **Reduced fertilisation inputs** thanks to defining differences in requirements between plots
- **Improved farm competitiveness** thanks to better control of yield factors and better grape quality management in line with market expectations
- **Improved vine longevity** thanks to better nutritional balance

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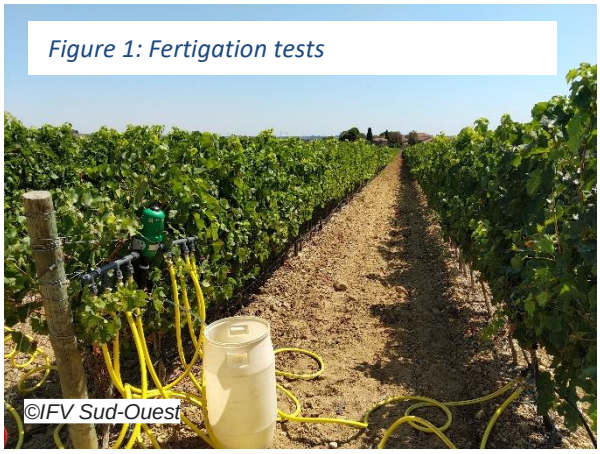

Figure 1: Fertigation tests

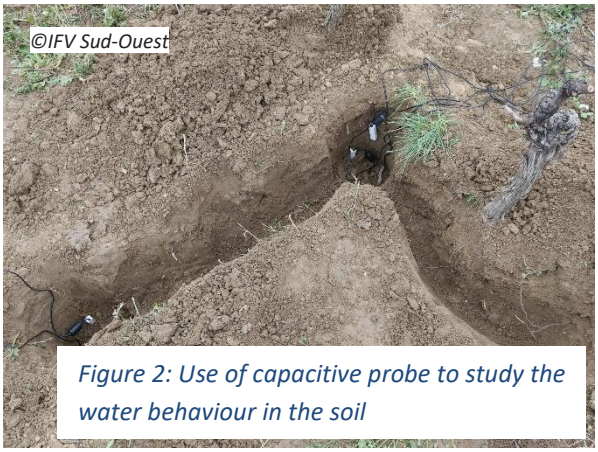

Figure 2: Use of capacitive probe to study the water behaviour in the soil

Related materials

Videos

OG presentation 🇬🇧:
https://www.youtube.com/watch?v=DqhjMEjyGmw&t=930s&ab_channel=CLIMED-FRUIT

Web links

Project presentation 🇫🇷: https://www.vignevin-occitanie.com/nos-recherches-2/viticulture-de-precision/ofivo/

Further reading

To better understand soil wet bulb formation with subsurface or aerial drip irrigation in viticulture 🇬🇧:
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