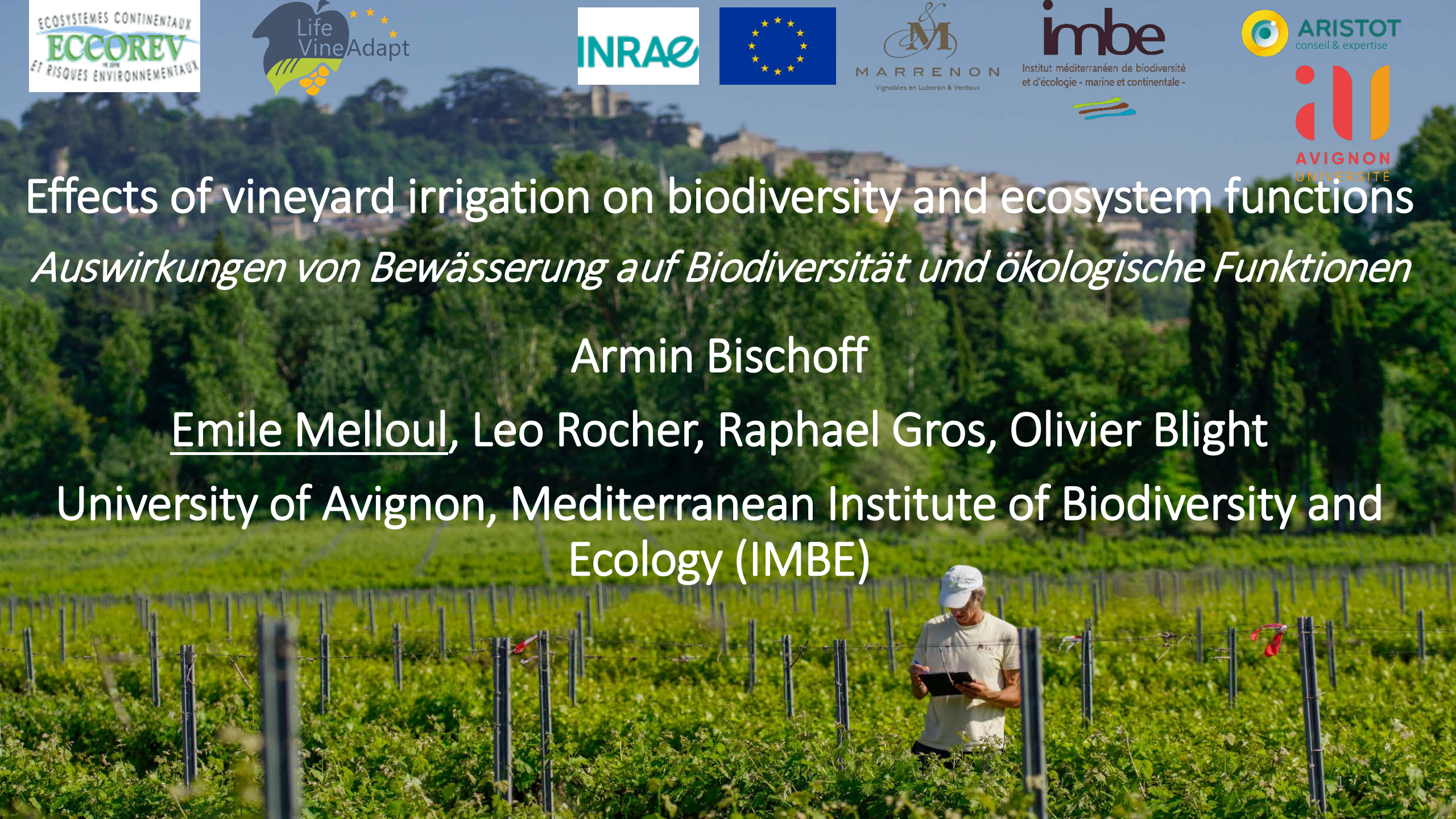
Effects of vineyard irrigation on biodiversity and ecosystem functions

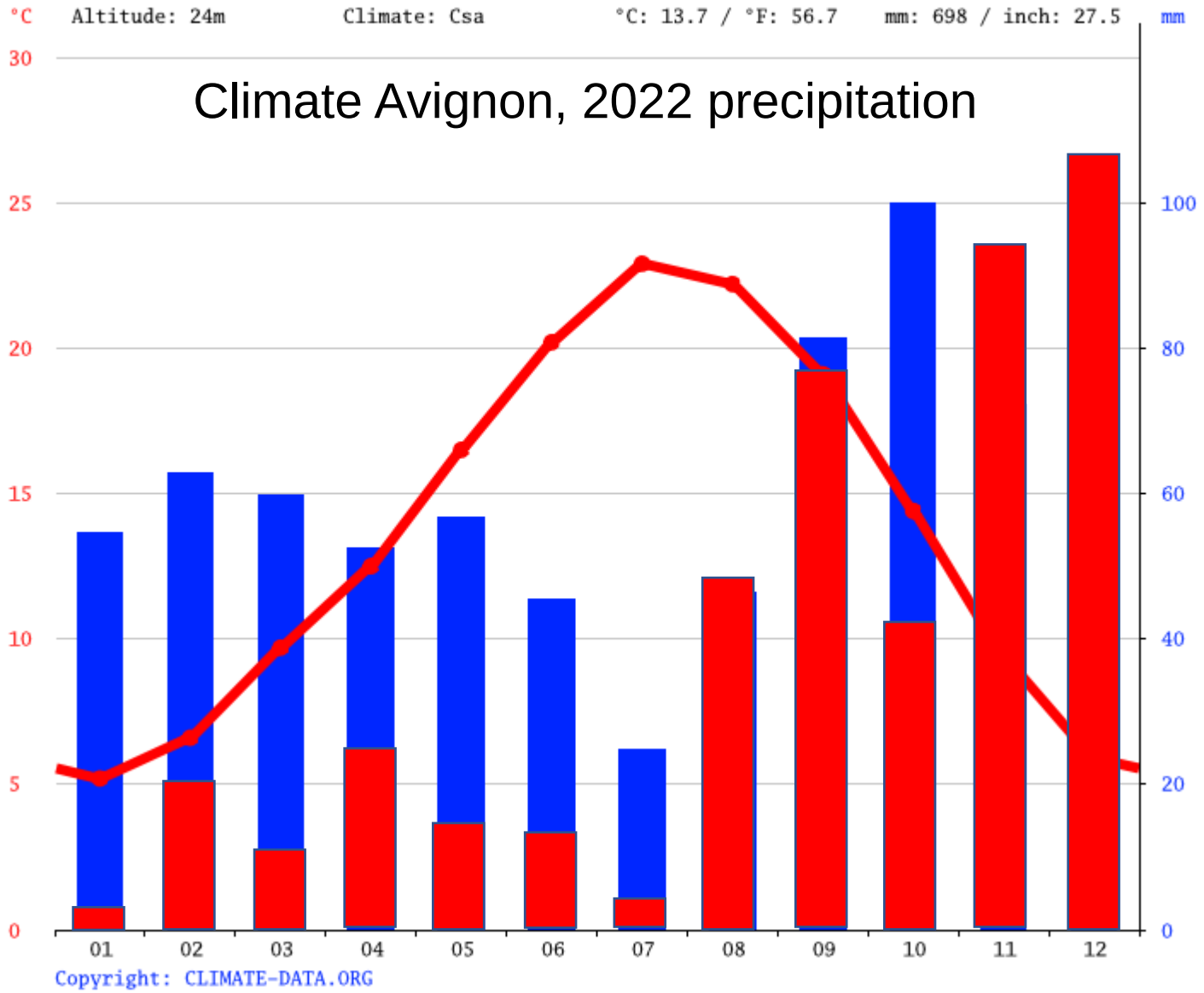
Auswirkungen von Bewässerung auf Biodiversität und ökologische Funktionen

Armin Bischoff

Emile Melloul, Leo Rocher, Raphael Gros, Olivier Blight

University of Avignon, Mediterranean Institute of Biodiversity and Ecology (IMBE)





Vineyard irrigation – Why?

Climate change is reality in Southern France:

Annual precipitation of new standard period (1991-2020: 600mm) **10% lower** than in previous period (1981-2010: 600mm)

The recent 9 years with considerably lower precipitation than average except for 2018 and 2024

Seasonality unfavourable: low precipitation during growing season

Irrigation – Consequences

In the Luberon region (SE France), grapevine is traditionally managed without irrigation

Increasing drought (in particular in spring and summer) has **increased** the number of irrigated vineyards from **0 to 35% in the last 20 years**

- Advantages: preservation of plant health and yield by reducing hydric stress due to more intense and longer drought periods

- Potential problems: loss of grape quality, loss of biodiversity (plants and related arthropods), irrigation costs

Life VineAdapt - Sustainable Viticulture for Climate Change Adaptation

C.1 Innovations in inter-row greening to increase biodiversity and resilience

C.2 Biodiversity friendly undervine management

C.3 Reduction of greenhouse gas emission by using resource-efficient fertilization techniques

C.4 Climate change induced drought, irrigation, constraints and solutions (Melloul et al.)

C.5 Sustainability analysis

VineAdapt – **Initially planned**

- Risk analysis: impact of drip irrigation on plant community, beneficial arthropods, soil biota and soil functions
- Effects of irrigation on grapevine performance, yield and grape quality
- Increase of irrigation efficiency, in particular below-ground irrigation

Site Köppelberg, Bad Kösen, Germany

Control: rain-fed
Drip irrigation below-ground
Drip irrigation above-ground

VineAdapt – **Realised**

- **Risk analysis: impact of drip irrigation on plant community, beneficial arthropods, soil biota and soil functions (France)**
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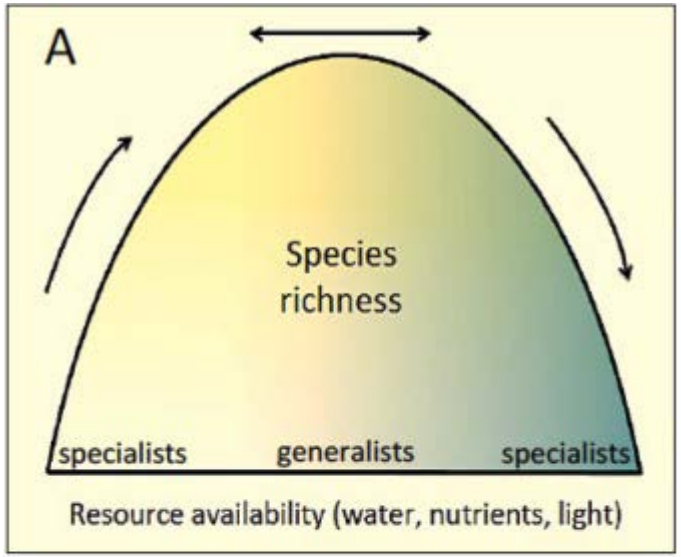
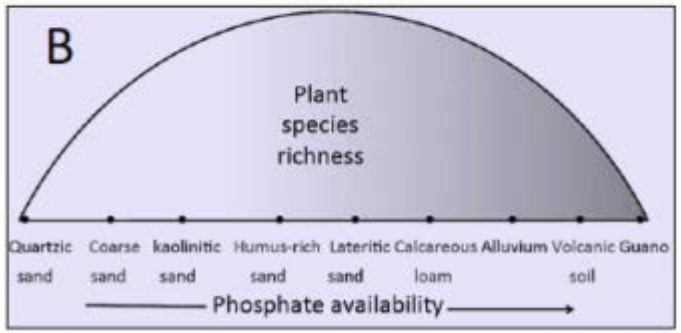
Irrigation and biodiversity





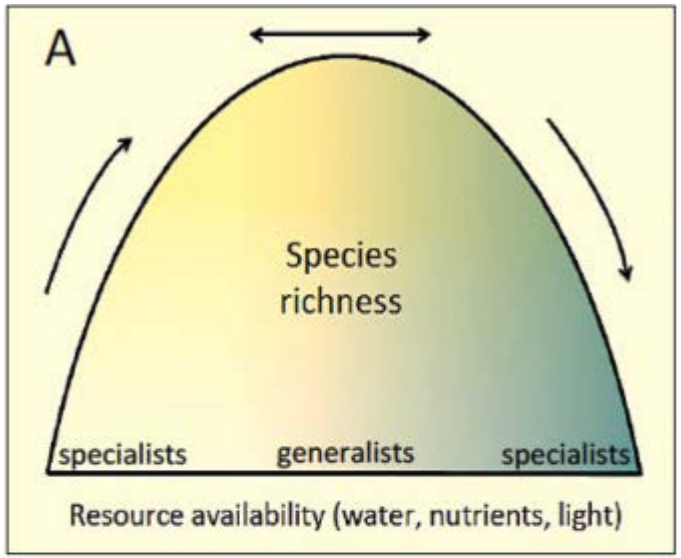
Lamont 2024

Hump-shaped relationship between resource availability and diversity

If resource availability is very high biodiversity is decreasing

This is well-known for nutrient availability: eutrophisation is a major threat for biodiversity

Irrigation and biodiversity



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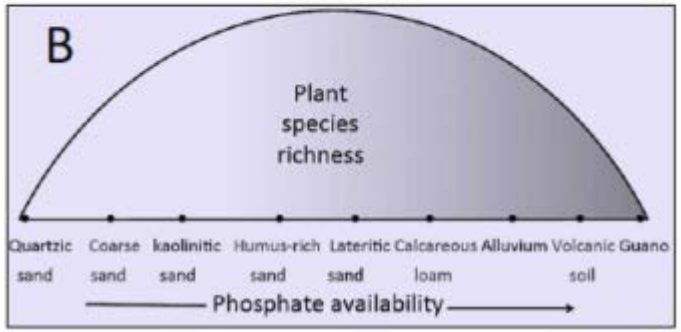

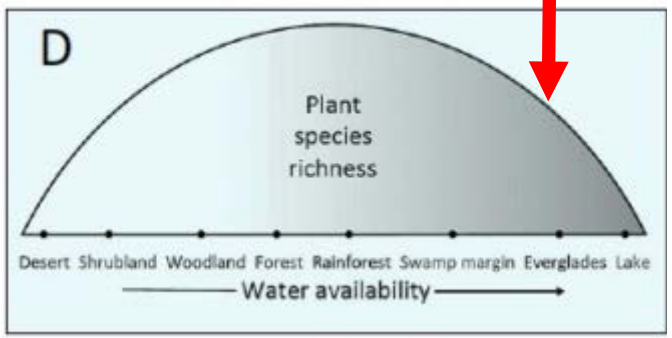

Water is also an important resource, in particular for plants:

Risk of biodiversity loss if high increase in water availability

Lamont 2024

Irrigation and biodiversity

Irrigation may have a strong impact in Mediterranean ecosystems adapted to summer drought

Typical Mediterranean plant species may disappear and be replaced by widespread competitive weed species

Consequence: overall loss in plant diversity and organisms depending on plants such as insects or soil biota

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However,

Vineyard irrigation is very local: drippers close to grapevine plants

Amount of irrigation low: 50-60 mm/year but concentrated on mid-June to mid-August

Winegrowers are aware that high irrigation reduce vine quality

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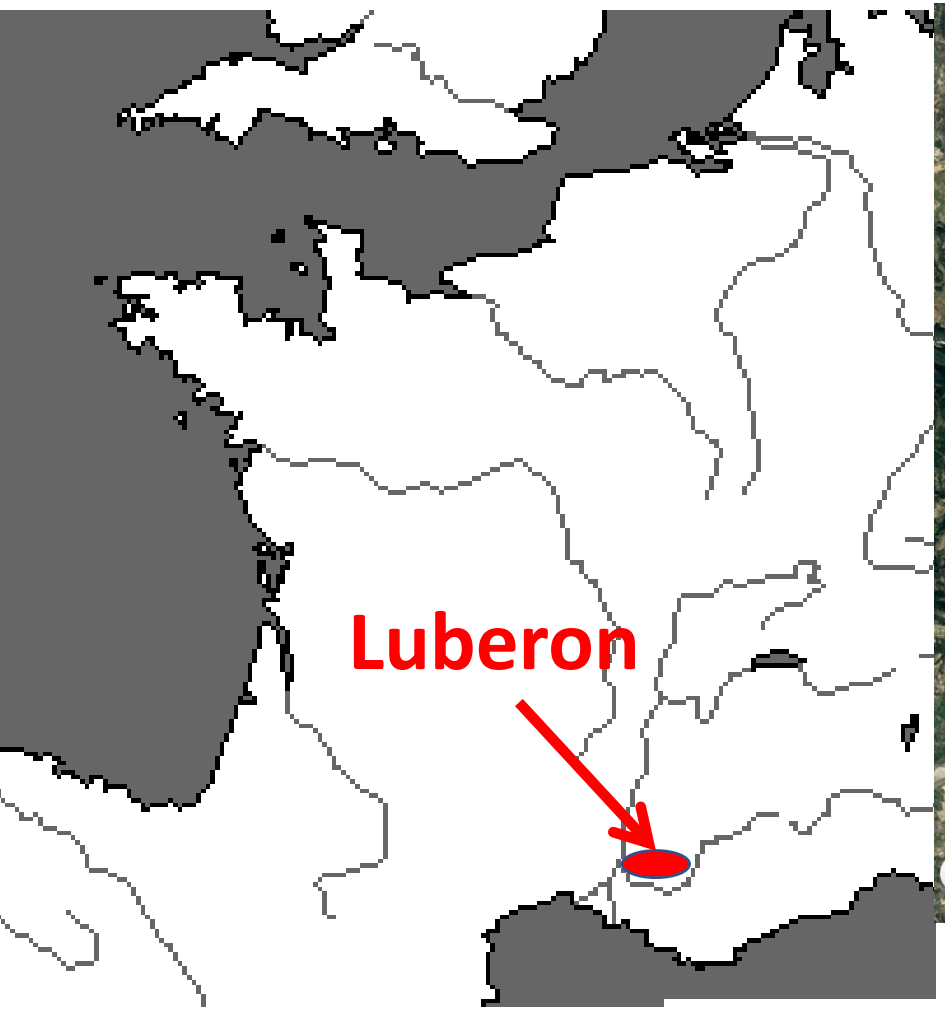
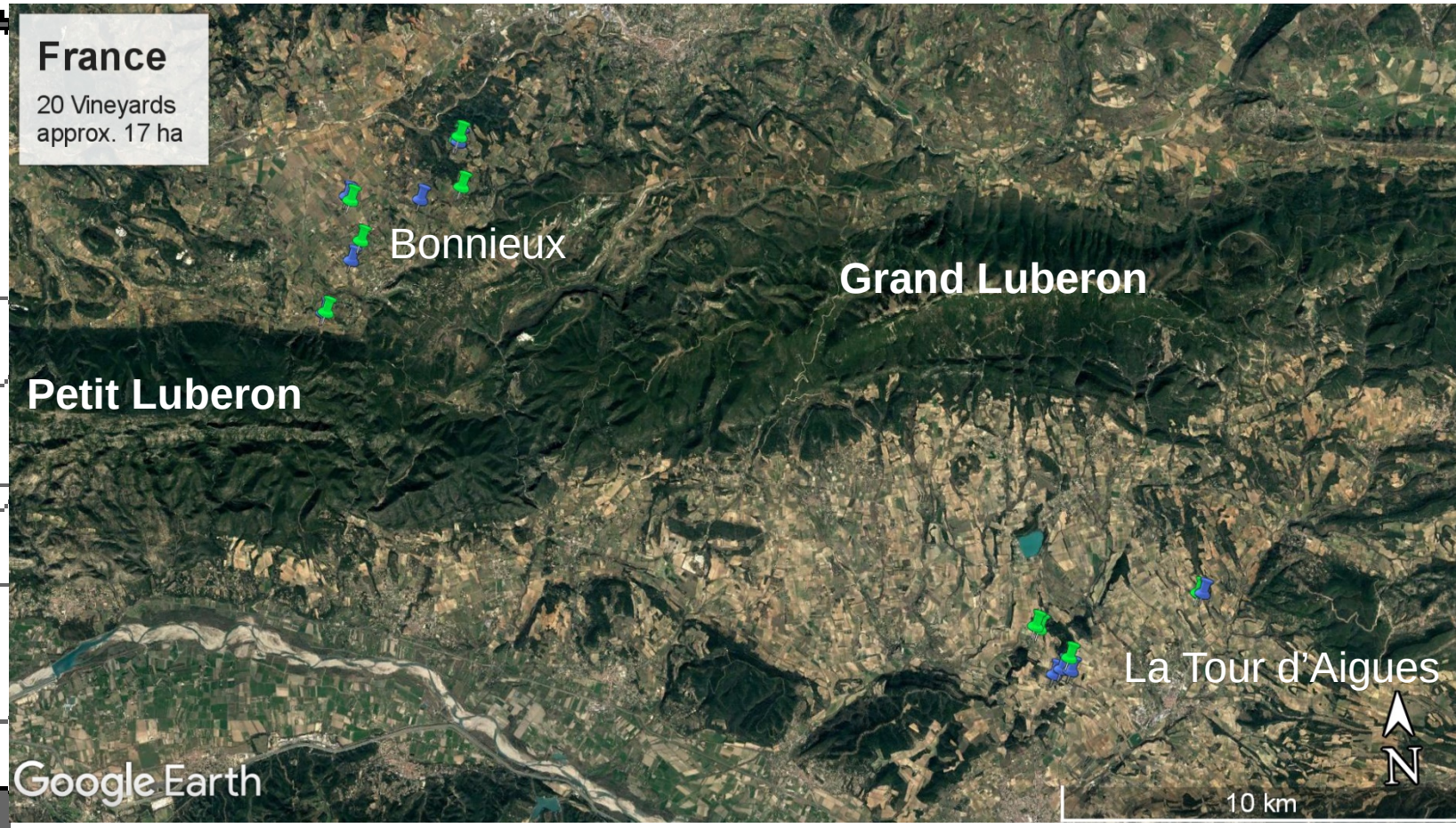
Is there really an effect on biodiversity and ecosystem function?

Pairs of 10 irrigated and 10 non-irrigated vineyards

Same soil type, age and grape variety

Irrigation: study sites





Non irrigated

Drip irrigation

Irrigation: measurements

Vegetation analysis

Direct observation (2.5 min)

Mesofauna

Respiration

Lucilia larvae predation

Net hunting

Decomposition

Yield

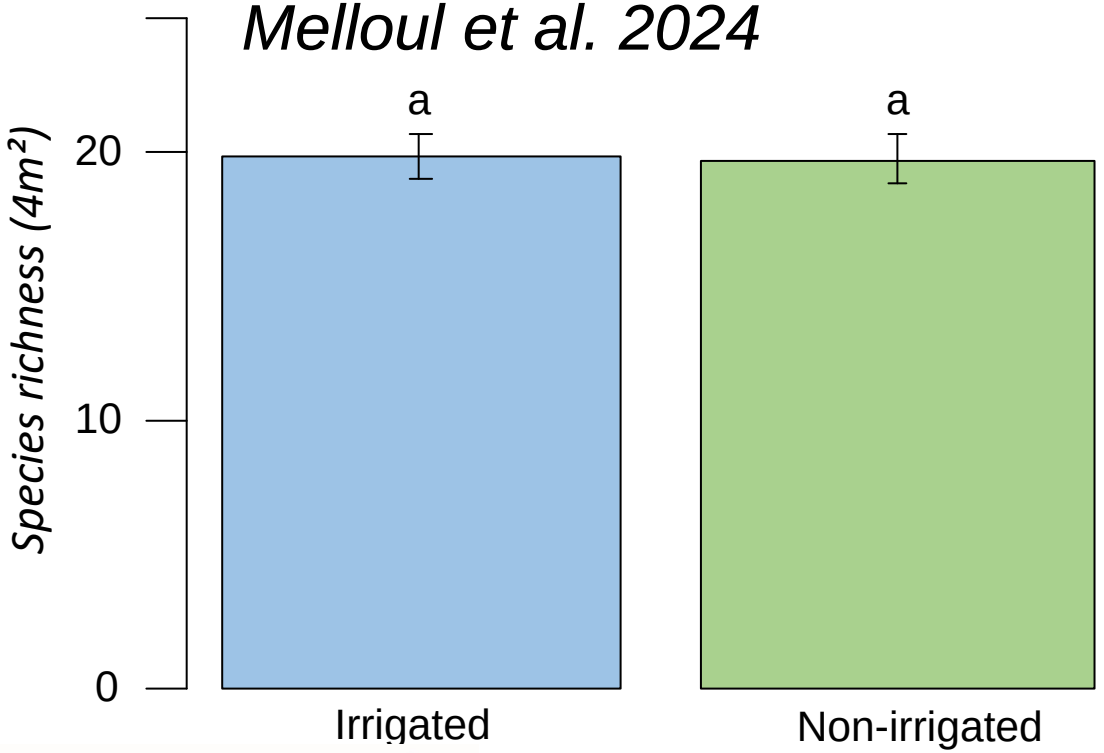
Irrigation and inter-row vegetation

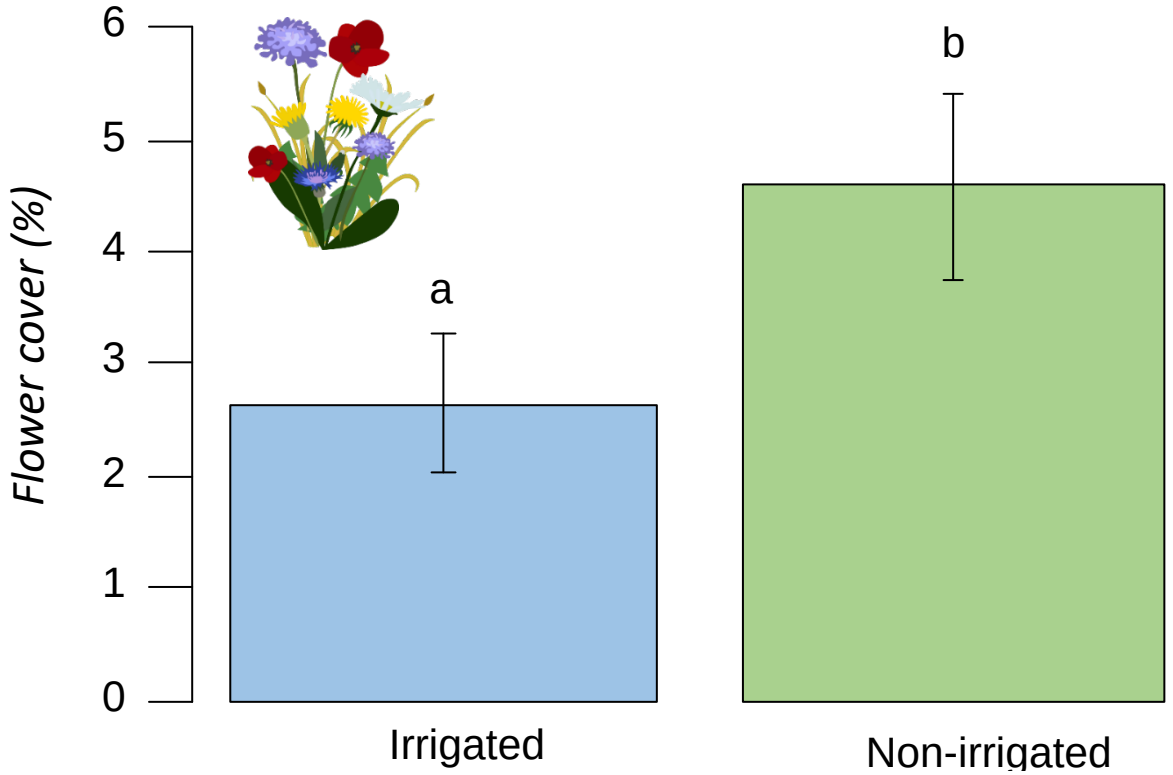
Surveys late May to early June: before irrigation period!

No difference in species richness or plant community composition

However, flower cover much lower in irrigated vineyards

Melloul et al. 2024

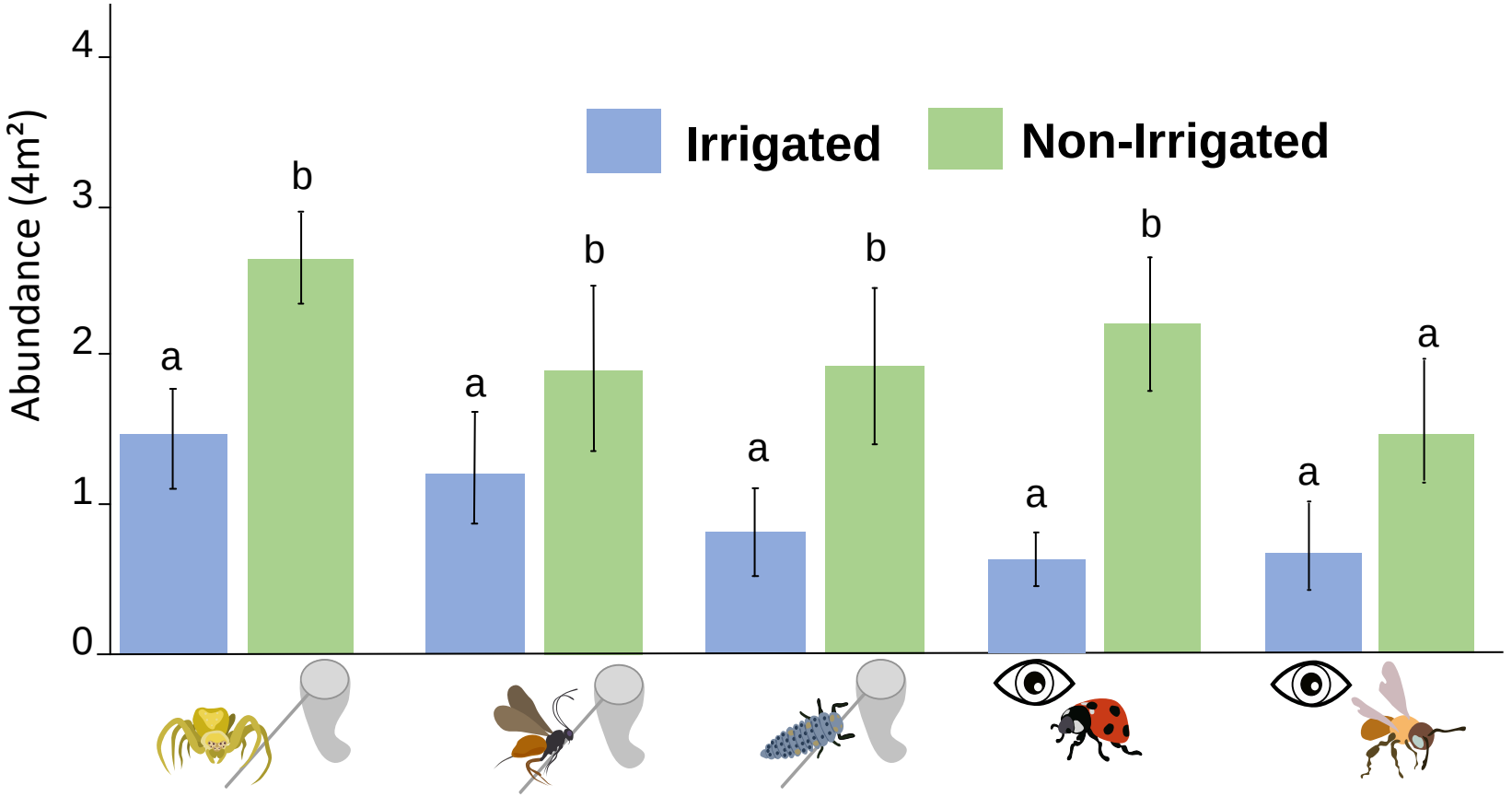




Irrigation and inter-row vegetation

Irrigation decreases the abundance of several beneficial arthropod groups

In particular, of crab spiders, parasitoids and ladybirds

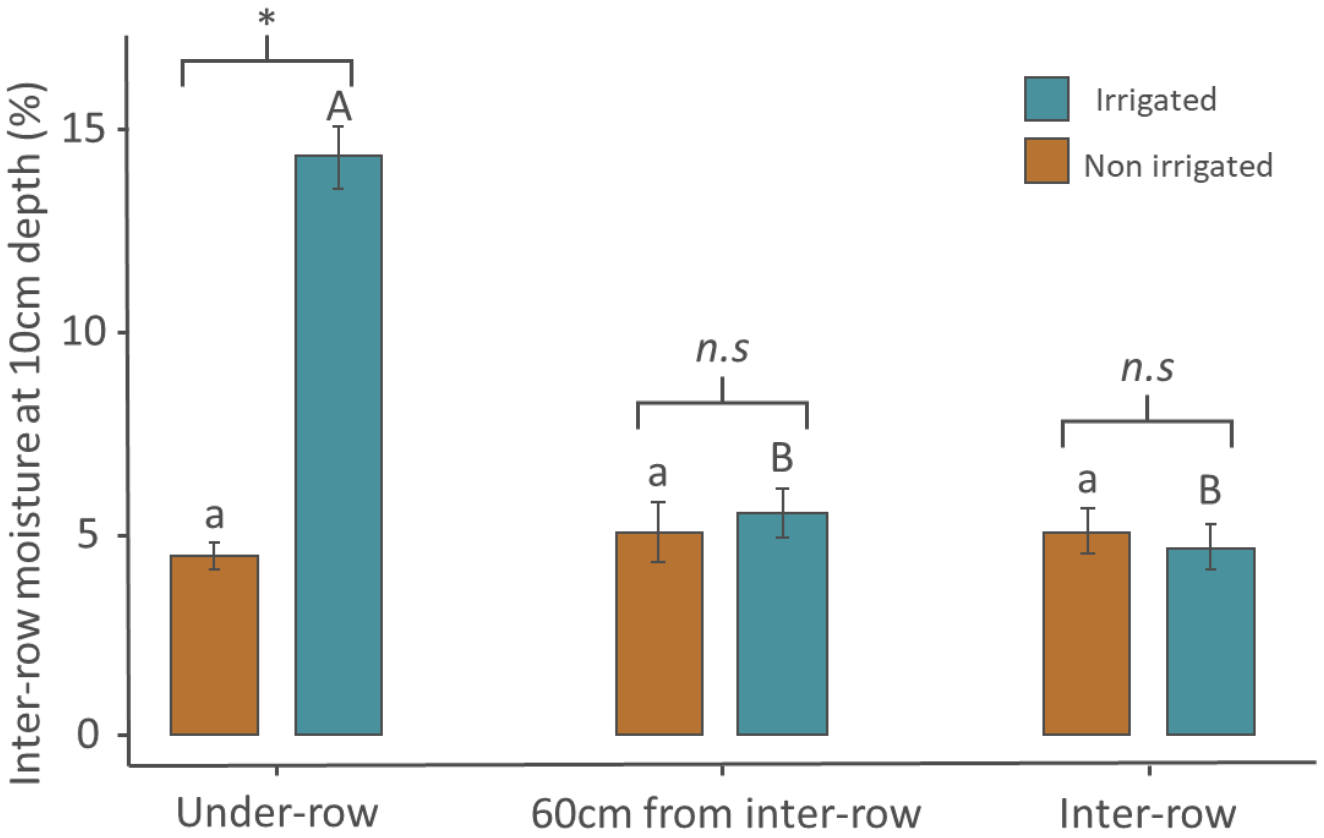


Melloul et al. 2024

Irrigation and soil moisture

However, effect on soil moisture only detectable under drippers

At soil surface (0-10 cm), no effect on soil moisture in the inter-rows



Roots of inter-row plants can still capture irrigation water

Lateral water flow at higher soil depths?

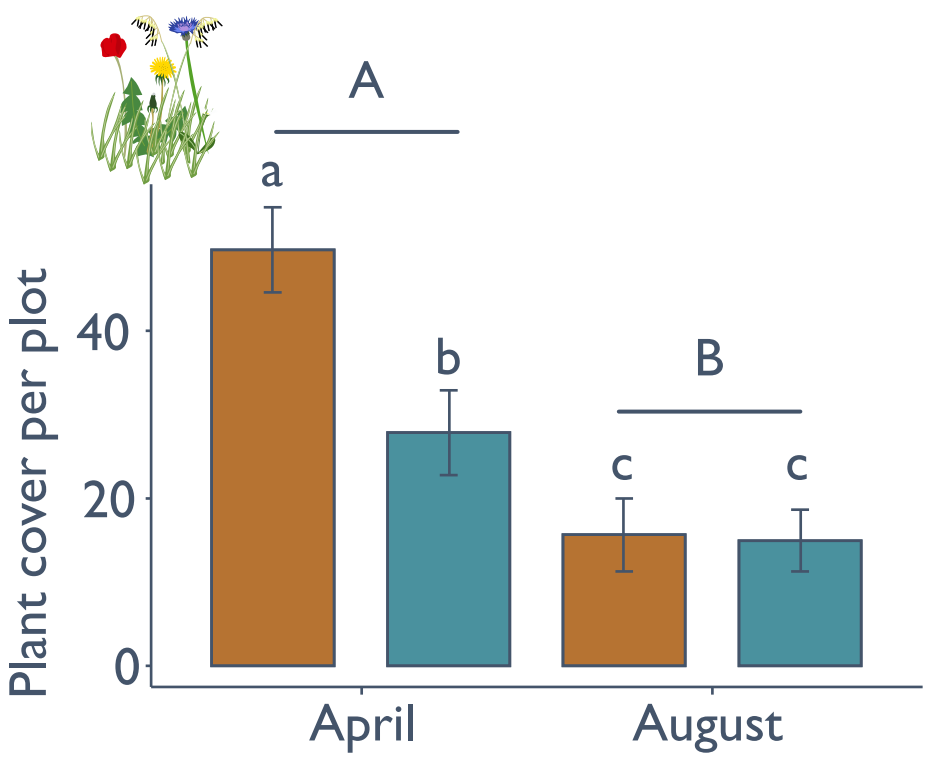
Response of arthropod probably linked to lower flower cover: changes in phenology?

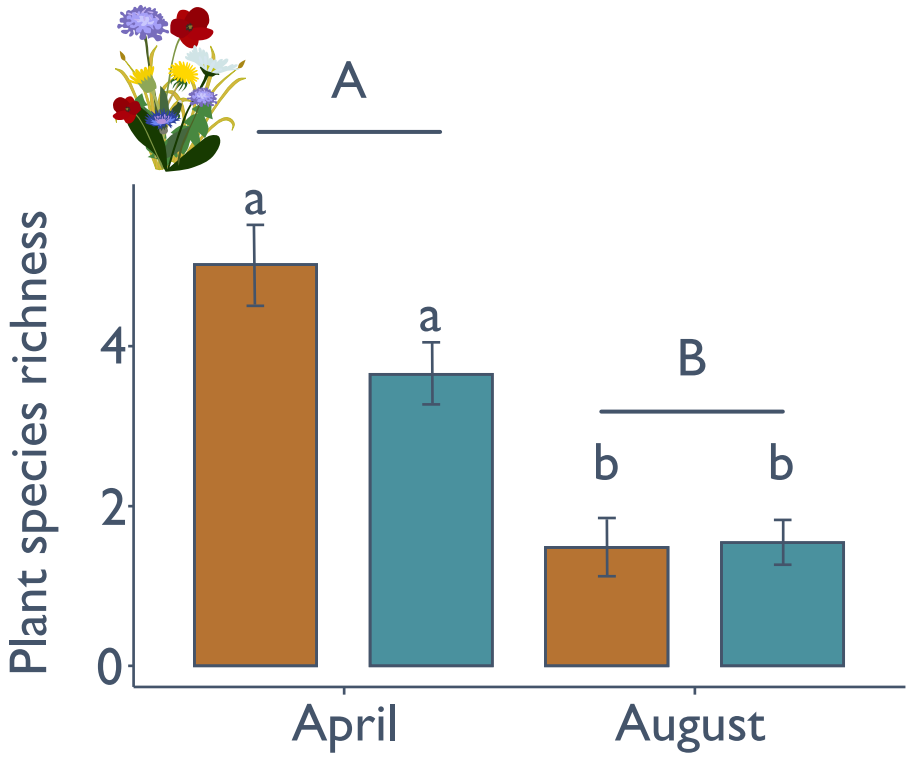
Melloul et al. 2025

Irrigation and intra-row vegetation

Surprisingly no influence of irrigation on intra-row plant communities

Even lower plant cover in April survey (before irrigation period)



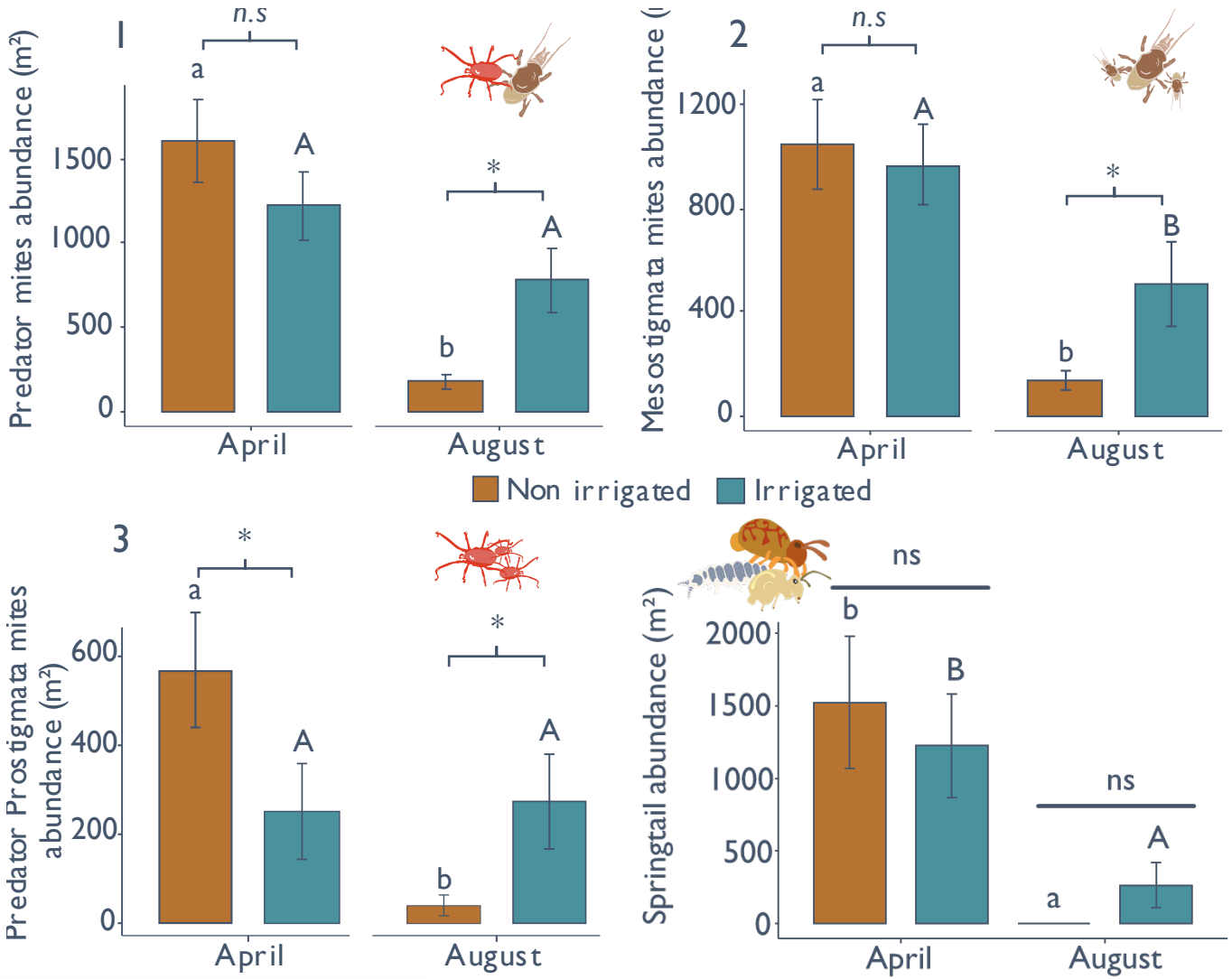


Highly disturbed habitat (glyphosate, mechanical weed control)

Overcompensation of weed control in irrigated mostly using round up?

Melloul et al. 2025

Irrigation and intra-row soil organisms



Irrigation buffers the negative effect of summer drought on soil organisms (significantly more mites, springtails too rare for statistical analysis)

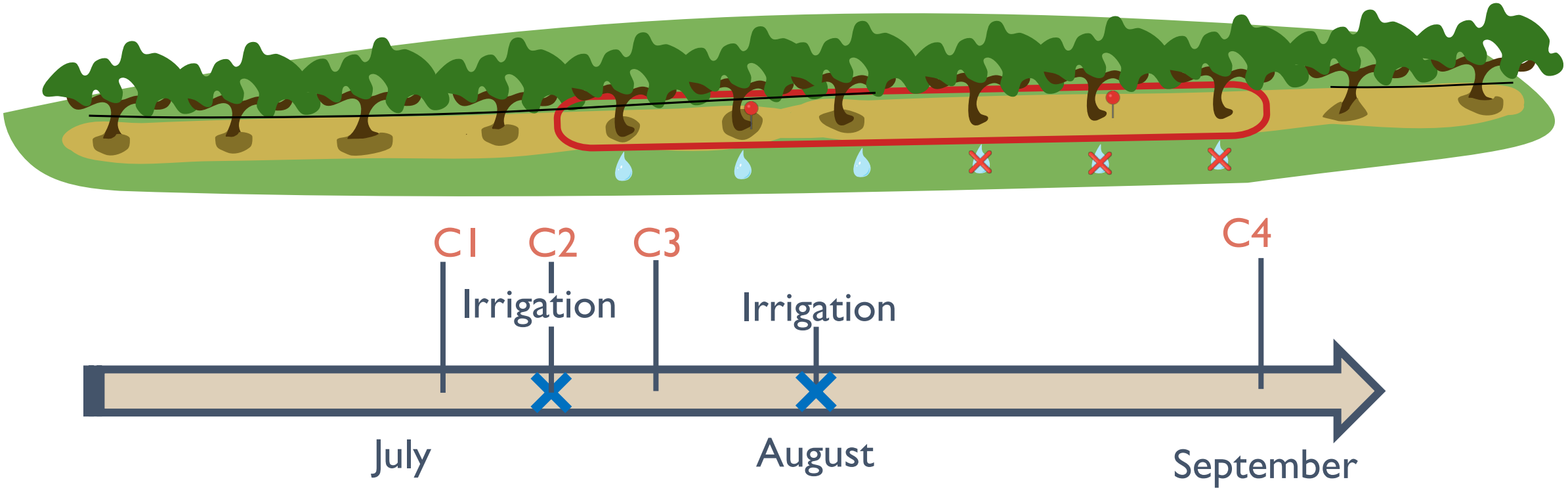
Nearly all effects disappear a few months after irrigation in the following spring (April)

Melloul et al. 2025

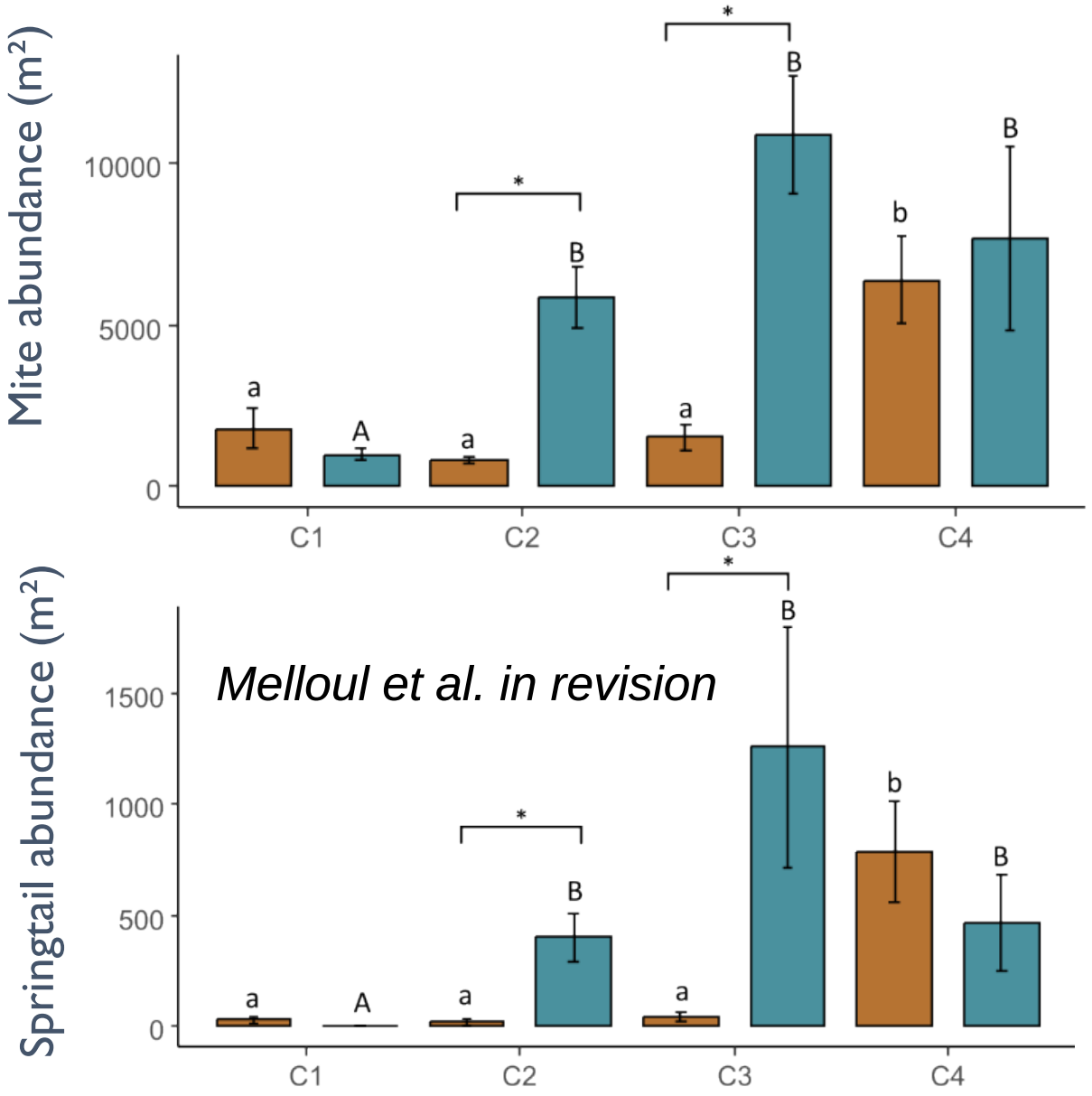
Irrigation and intra-row soil organisms

Analysis of temporal dynamics in an **irrigation exclusion** experiment

12 blocks, 2 vineyards



Irrigation and intra-row soil organisms



Strongly negative effects of irrigation exclusion on soil mesofauna (springtails, mites)

Effects only detectable for a couple of days, disappear after less than 6 weeks

Similar for organic matter decomposition, soil respiration and soil microorganisms (PLFA: bacteria, total microorganisms)

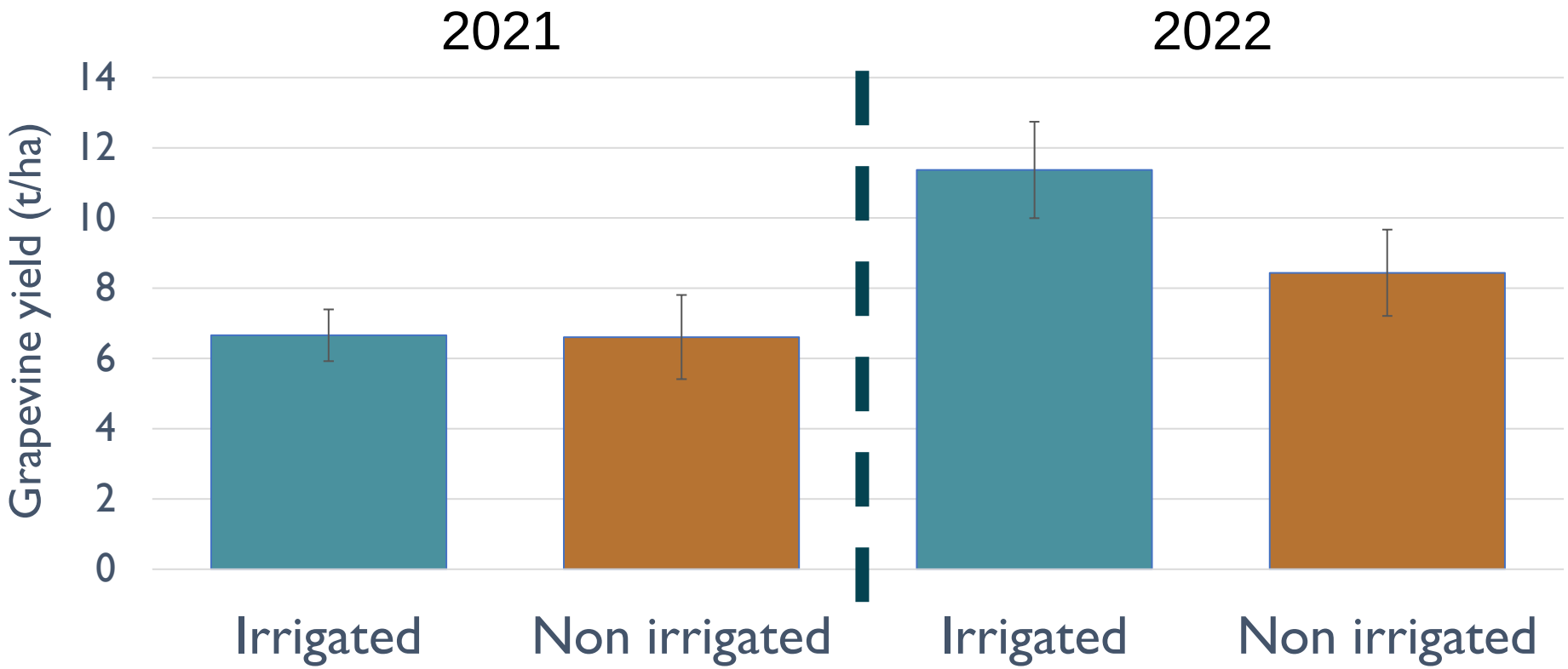
Effect more long-lasting for ground-dwelling arthropods

Irrigation and grapevine yield/quality

Irrigation has not always an effect on grapevine yield!

In 2021 sufficient summer rainfall, thus no effect of water addition

Similar results for sugar content (lower in irrigated vineyards, but only in 2022)



Conclusions

Die Bewässerung ist auf 50-60mm pro Jahr begrenzt und nicht auf Ertragsmaximierung ausgerichtet: Vermeidung von Verlusten bei extemer Trockenheit.

Selbst diese geringe Bewässerung wirkt sich negative auf Flora (Blütenangebot) und Nützlingsfauna aus. Aber die Grössenordnung der Effekte ist relative klein und bislang gibt es keine Veränderungen in der Pflanzengemeinschaft.

Die Auswirkungen auf Bodenorganismen und Bodenfunktionen sind grösstenteils positive, verschwinden aber nach wenige Wochen.

Die aktuell geringe Bewässerungsintensität scheint also im Einklang mit der Erhaltung von Artenvielfalt und Bodenfunktionen zu stehen. Ein langfristiges Monitoring ist allerdings notwendig, um die Folgen abschliessend zu bewerten.

Conclusions

Irrigation is limited to 50-60 mm per year in the study area; not used to maximize yield but to avoid losses under extreme drought

Even this limited irrigation has significantly negative effects on the flora (flower cover) and associated beneficial arthropods. The effect size is, however, relatively small, and so far no changes in plant community composition or plant diversity could be detected.

Effects on soil organisms and functions are rather positive but not long-lasting (few weeks)

Consequently, the current moderate irrigation seems to be appropriate for biodiversity conservation and soil functioning. However, monitoring over longer periods is required to finally evaluate the ecological impact

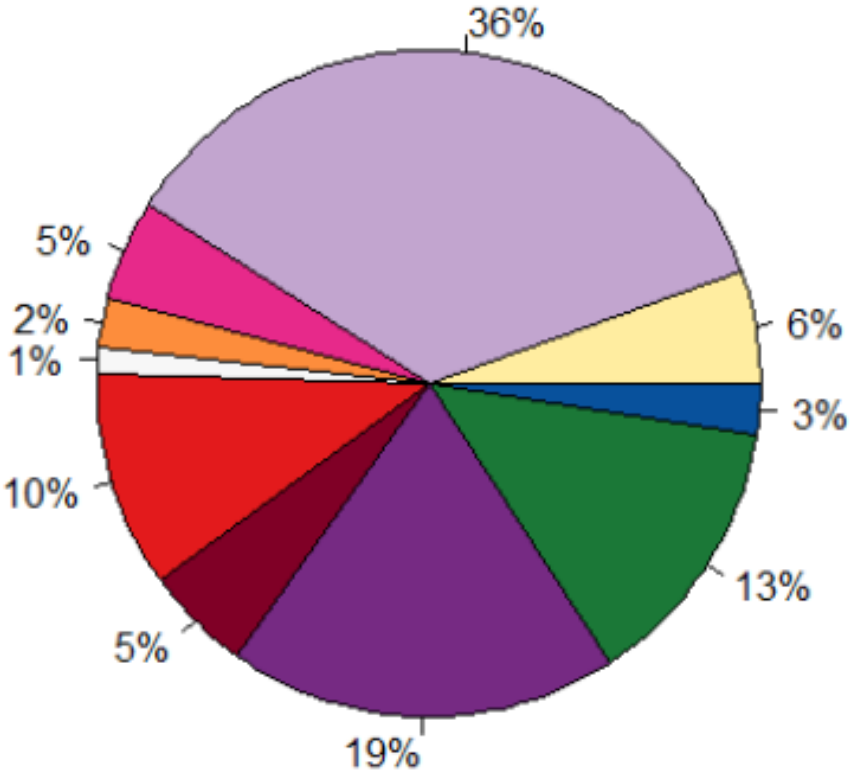
Thanks for your attention!

Vineyard inter-row vegetation

Vineyard vegetation in our study area: the Luberon mountains

55% of agricultural land is covered by vineyards (dominant crop)

1/3 of vineyards with inter-row vegetation (usually half of the inter-rows tilled)



Enherbement dans les vignes: le projet Life VineAdapt

Projet Life VineAdapt

Une viticulture durable pour une adaptation au changement climatique

« Sustainable Viticulture for Climate Change Adaptation »

Informations disponibles:

- https://www.life-vineadapt.eu/fr/aktuelles
- https://www.imbe.fr/life-vineadapt.html
- https://www.youtube.com/watch?v=4IQ5Ib3kVF0

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