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Influence of weed cover on leaf-level CO_2 and H_2O fluxes in an olive grove

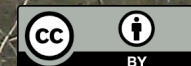
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EGU General Assembly 2020



Introduction

Olive Groves:

-Representative crop in the Mediterranean region.

-**Maintenance of weed cover:** increasingly common practice.

CO₂ & H₂O flows

-At ecosystem level, covered olive groves sink more carbon than weed-free olive groves (Chamizo et al. 2017), but can also increase evapotranspiration. Nevertheless this behavior can vary from year to year.

-However, **the role of this practice at leaf level** has not been studied yet.

Chamizo et al. (2017). Net ecosystem CO₂ exchange in an irrigated olive orchard of SE Spain: Influence of weed cover. *Agriculture, Ecosystems and Environment*. <https://doi.org/10.1016/j.agee.2017.01.016>

Experimental Site: Jaén, Spain

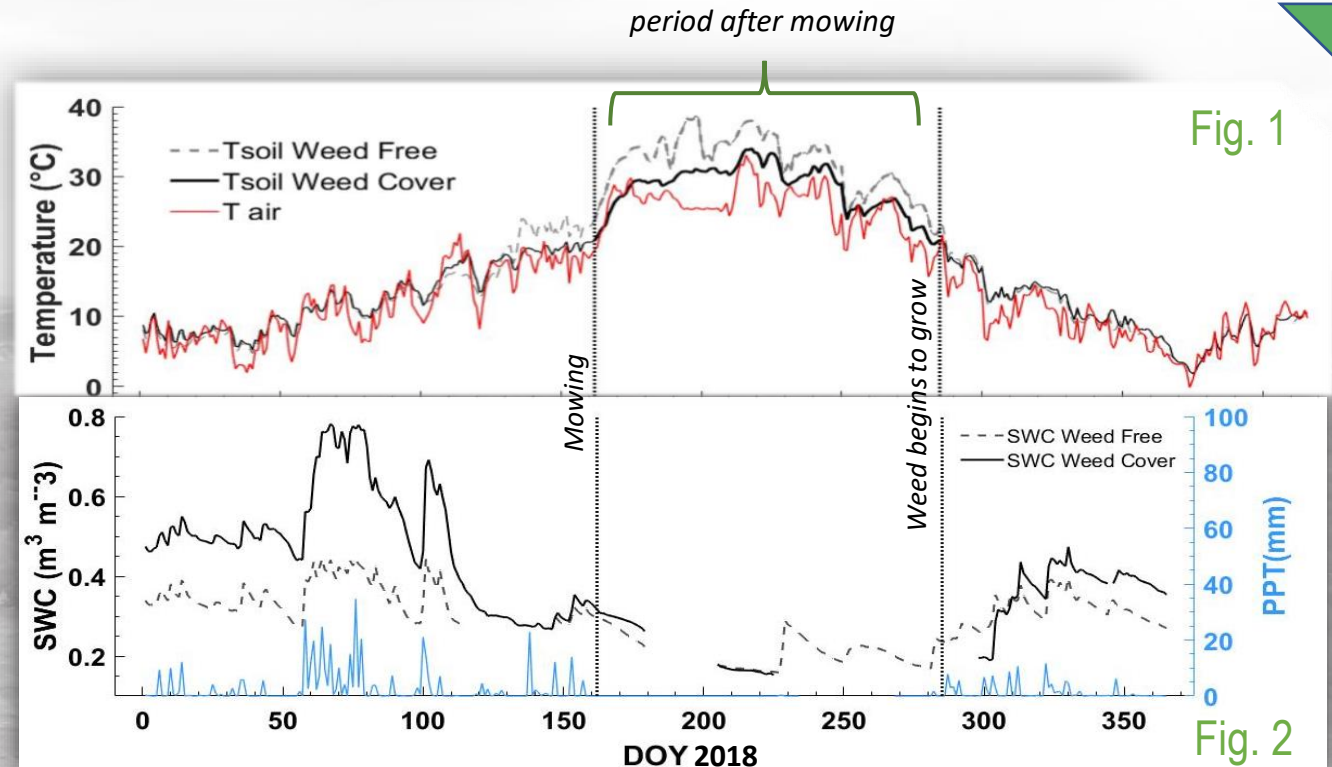
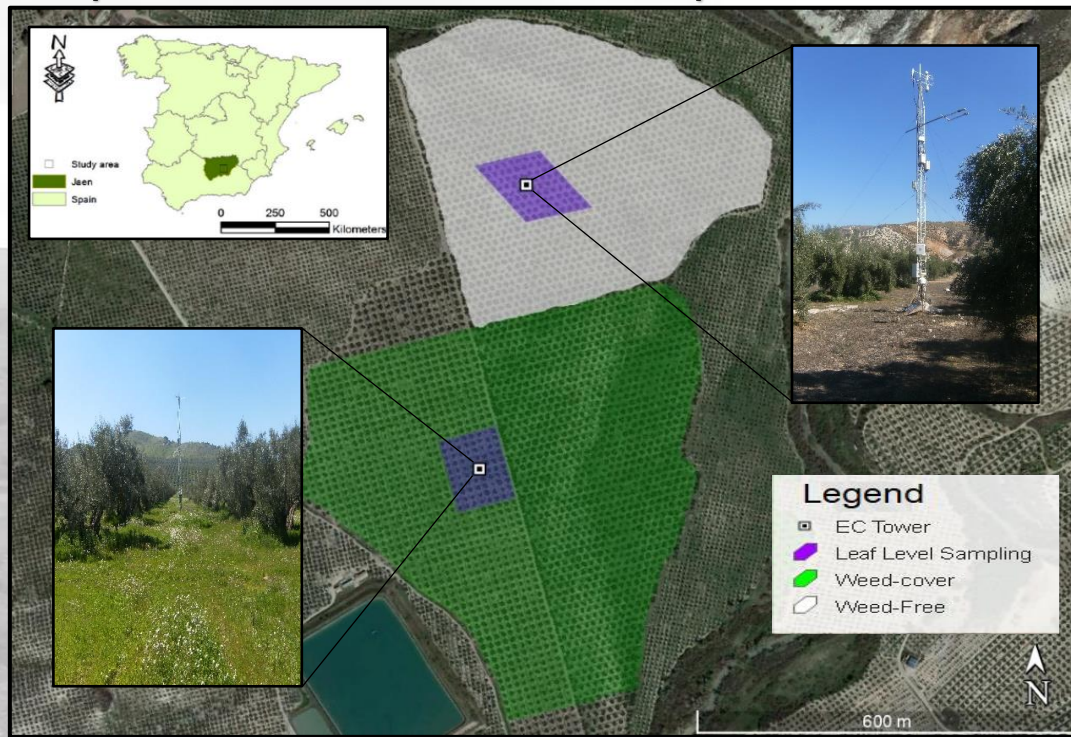


Fig. 1

Fig. 2

- Mediterranean climate
- ~ 200 Olive trees/ha
- **Drip irrigation** from February to October (32 L/h per tree for 8 h, 3 times a week)

Two treatments:

- 1) Herbicide is applied to the **weed-free** plot (**wf**):
- 2) In the **weed-cover** plot (**wc**) the weeds are mechanically mowed in late spring:



➤ Different micro-climate between treatments:

Weeds increase soil water content and reduce soil temperature, especially in the period after mowing.

*The period **after mowing** coincides with the **absence of rainfall** and the **highest temperatures** typical of the Mediterranean summer*

Methods – Flows



Leaf Scale

Portable gas analyzer

- LI-6800, Li-Cor
- **Controlled variables:**
 - Atmospheric CO₂ = 400 ppm;
 - Relative humidity = 60%;
 - T_{air} = the same for both treatments;
 - PAR = 1000 $\mu\text{mol m}^{-2} \text{s}^{-1}$
- **10 random trees per month**
- Apical leaf
- Southern exposure

- ❖ *One Campaign per month*
- ❖ *The data were taken between 11 and 13 hours GMT*
- ❖ *January-2018 to January-2019*
- ❖ *Ecosystem-level data that matches the leaf-scale sampling period is selected*

Ecosystem Scale

Eddy Covariance Technique

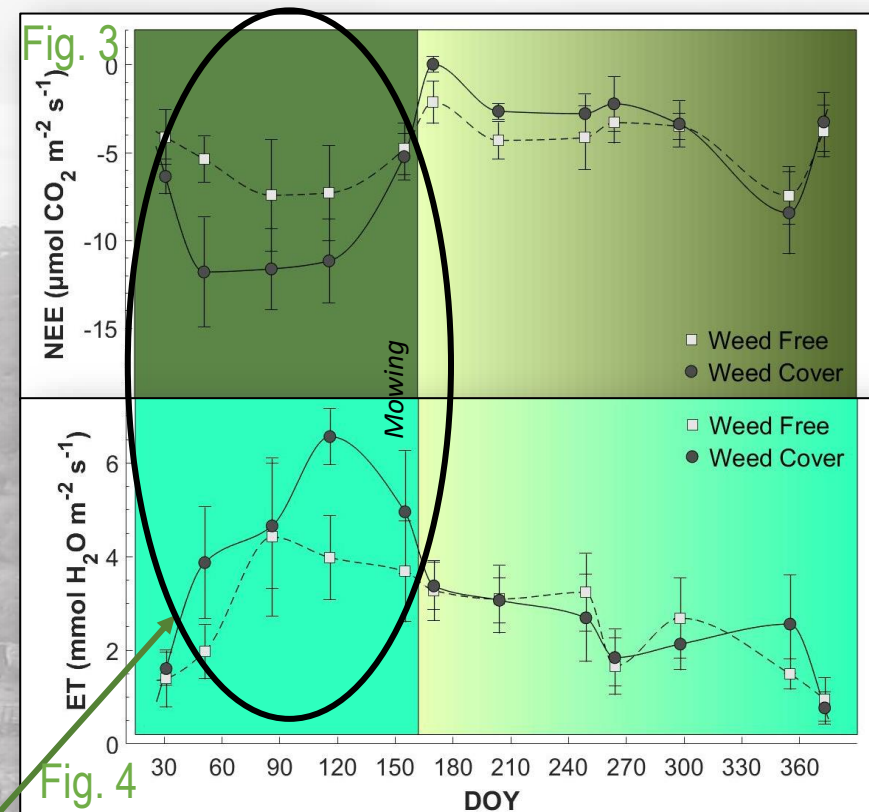


- Closed path gas analyzer (LI-7200, Li-Cor)
- Sonic anemometer (CSAT-3, Campbell)
- **Fluxes every 30 minutes.**
- Gap-filled data using marginal distribution sampling technique.

Results – Influence of weed cover in Ecosystem Flows

All the Year	Alleys Condition		NEE ($\mu\text{mol CO}_2 \text{ m}^{-2} \text{ s}^{-1}$)	-GPP ($\mu\text{mol CO}_2 \text{ m}^{-2} \text{ s}^{-1}$)	R _{eco} ($\mu\text{mol CO}_2 \text{ m}^{-2} \text{ s}^{-1}$)	ET ($\text{mmol H}_2\text{O m}^{-2} \text{ s}^{-1}$)	WUE _{eco} (-GPP/ET)
	Weed Free	Bare Soil	-4.8 ± 2.6	-7.8 ± 2.9	3.1 ± 1.6	2.4 ± 1.2	3.7 ± 1.6
	↕ t-student test ↕		<i>p < 0.05</i>	<i>p < 0.05</i>	<i>p < 0.05</i>	<i>p < 0.05</i>	
	Weed Cover	--	-6.0 ± 4.2	-10.0 ± 4.4	4.0 ± 1.9	2.8 ± 1.8	4.2 ± 2.1

- During the study period **the weed-covered plot sinks 25% more carbon** than the weed-free plot
- The improvement in the weed-covered to sink carbon is due to a large increase in gross primary production during the **weed growth season**
- **Weed-covered plot evapotranspires 14% more** than weed-free plot, especially during the growing season

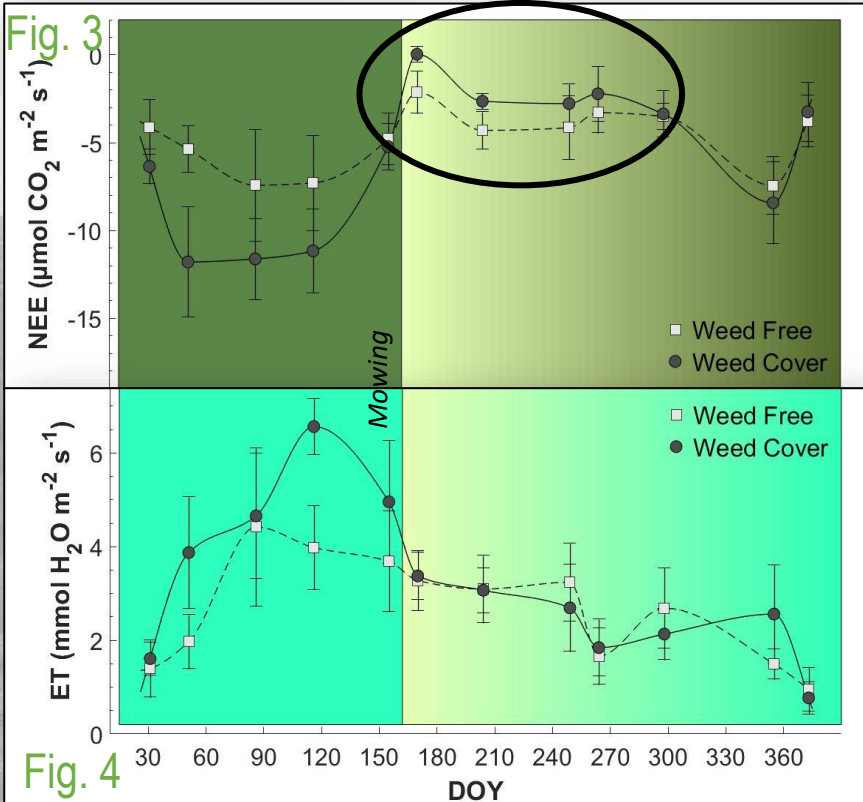


Results – Influence of weed cover in Ecosystem Flows

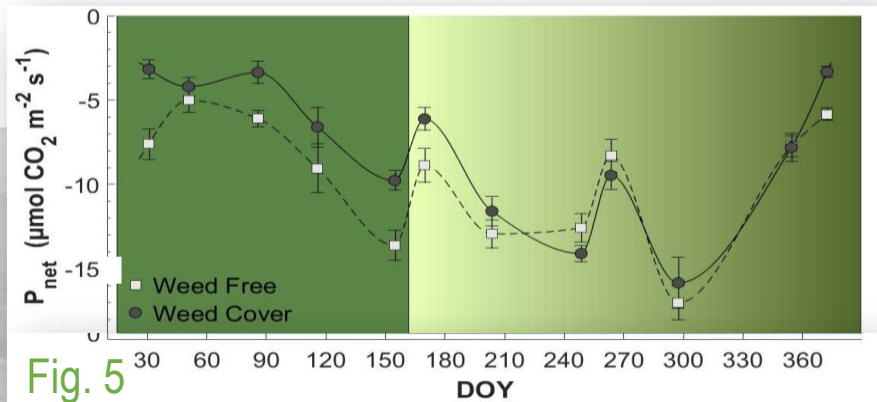
All the Year	Alleys Condition		NEE ($\mu\text{mol CO}_2 \text{ m}^{-2}\text{s}^{-1}$)	-GPP ($\mu\text{mol CO}_2 \text{ m}^{-2}\text{s}^{-1}$)	R _{eco} ($\mu\text{mol CO}_2 \text{ m}^{-2}\text{s}^{-1}$)	ET ($\text{mmol H}_2\text{O m}^{-2} \text{ s}^{-1}$)	WUE _{eco} (-GPP/ET)
	Weed Free	Bare Soil	-4.8 ± 2.6	-7.8 ± 2.9	3.1 ± 1.6	2.4 ± 1.2	3.7 ± 1.6
	↕ t-student test ↕		p < 0.05	p < 0.05	p < 0.05	p < 0.05	
	Weed Cover	--	-6.0 ± 4.2	-10.0 ± 4.4	4.0 ± 1.9	2.8 ± 1.8	4.2 ± 2.1
After Mowing	Weed Free	Bare Soil	-3.6 ± 2.0	-7.6 ± 2.6	4.0 ± 1.1	2.8 ± 1.1	2.9 ± 0.8
	↕ t-student test ↕		p < 0.05		p < 0.05		
	Weed Cover	Mowed weed	-2.2 ± 1.4	-7.3 ± 2.7	5.1 ± 2.1	2.5 ± 0.7	3.2 ± 1.7



- After mowing trends in flows change :
 - The weed covered plot increases its carbon emission due to increased respiration
 - Evapotranspiration is 11% less is the plot covered with weeds



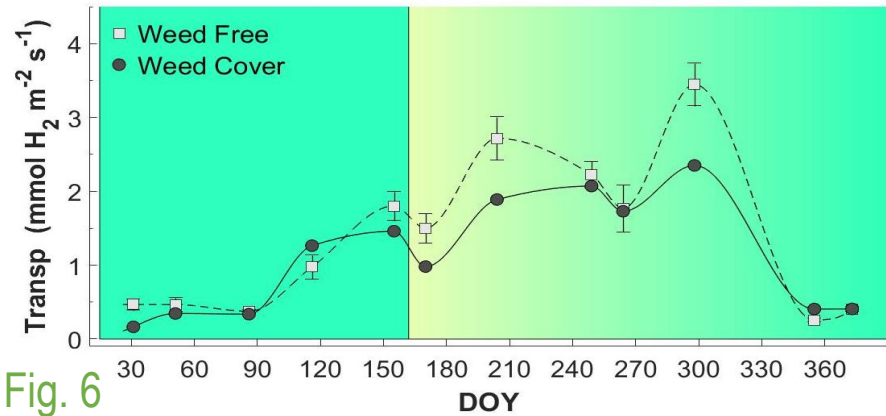
Results – Influence of weed cover in Leaf Flows



- During the year of study, the olive leaves of the weed-cover plot sinks less carbon. This difference is only observed at the time of weed growth where carbon assimilation (P_{net}) is 30% lower.
- After mowing, P_{net} is matched in both treatments

		Alleys Condition	P_{net} ($\mu\text{mol CO}_2 \text{ m}^{-2} \text{ s}^{-1}$)	Transp ($\text{mmol H}_2\text{O m}^{-2} \text{ s}^{-1}$)	WUE_{leaf} ($P_{\text{net}} / \text{Transp}$)
All the Year	Weed Free	Bare Soil	-9.6 ± 4.4	1.4 ± 1.2	11.5 ± 8.8
	↕ t-student test ↕		<i>p</i> < 0.05	<i>p</i> < 0.05	
	Weed Cover	--	-7.9 ± 4.8	1.1 ± 0.9	10.8 ± 8.1
After Mowing	Weed Free	Bare Soil	-12.7 ± 4.2	2.5 ± 1.0	5.3 ± 1.1
	↕ t-student test ↕			<i>p</i> < 0.05	<i>p</i> < 0.05
	Weed Cover	Mowed weed	-12.7 ± 3.9	2.0 ± 0.7	6.5 ± 1.2
Rest of the year	Weed Free	Bare Soil	-8.0 ± 3.6	0.8 ± 0.7	14.7 ± 9.2
	↕ t-student test ↕		<i>p</i> < 0.05		
	Weed Cover	Weed Growing	-5.5 ± 3.1	0.7 ± 0.6	12.9 ± 9.1

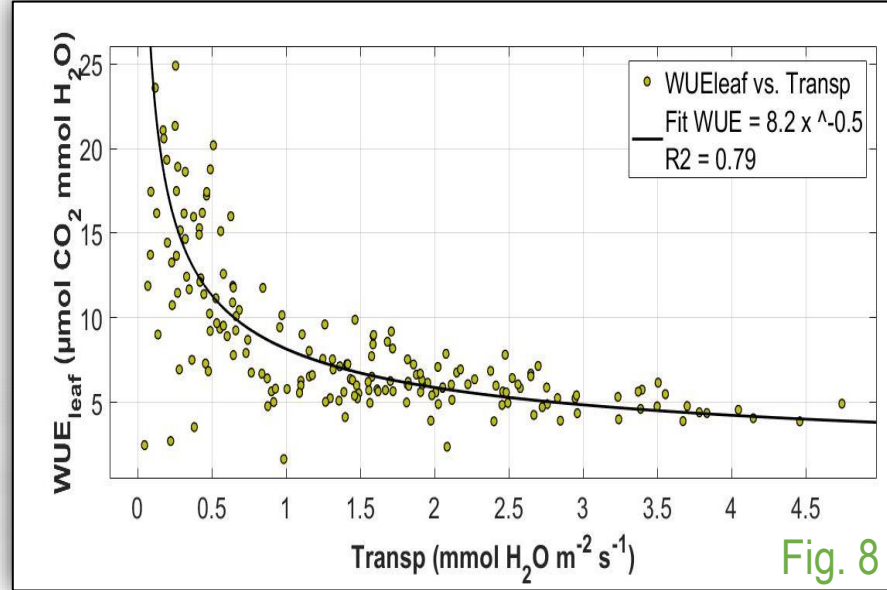
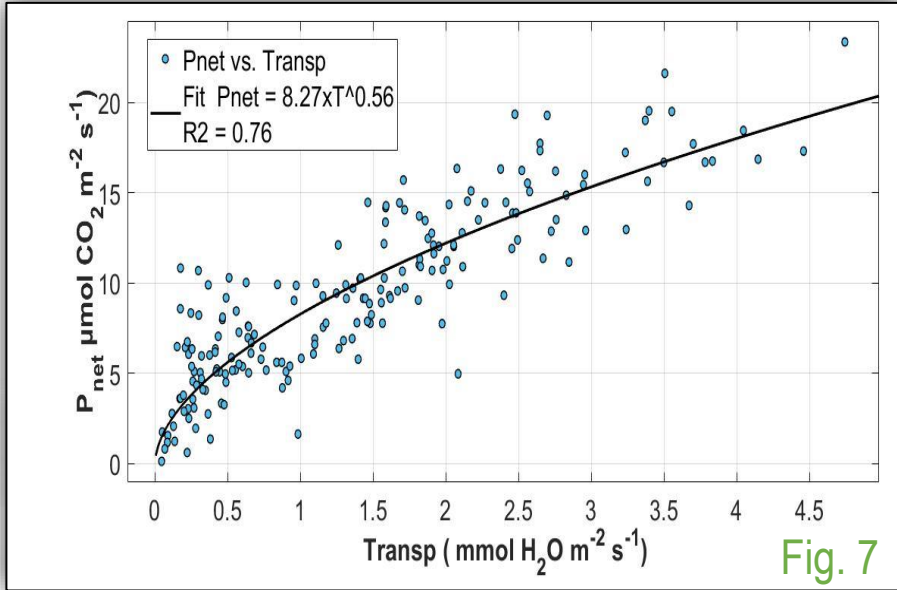
Results – Influence of weed cover in Leaf Flows



- During the year of study transpiration on the olives leaf of the **weed-cover plot is 21% less**. This difference corresponds only to the period after mowing.
- No differences appear in transpiration when cover is present

	Alleys Condition	P_{net} ($\mu\text{mol CO}_2 \text{ m}^{-2} \text{ s}^{-1}$)	Transp ($\text{mmol H}_2\text{O m}^{-2} \text{ s}^{-1}$)	WUE_{leaf} (P_{net} / Transp)
All the Year	Weed Free	-9.6 ± 4.4	1.4 ± 1.2	11.5 ± 8.8
	↕ t-student test ↕	$p < 0.05$	$p < 0.05$	
	Weed Cover	-7.9 ± 4.8	1.1 ± 0.9	10.8 ± 8.1
After Mowing	Weed Free	-12.7 ± 4.2	2.5 ± 1.0	5.3 ± 1.1
	↕ t-student test ↕		$p < 0.05$	$p < 0.05$
	Weed Cover	-12.7 ± 3.9	2.0 ± 0.7	6.5 ± 1.2
Rest of the year	Weed Free	-8.0 ± 3.6	0.8 ± 0.7	14.7 ± 9.2
	↕ t-student test ↕	$p < 0.05$		
	Weed Cover	-5.5 ± 3.1	0.7 ± 0.6	12.9 ± 9.1

Results – Water Use Efficiency



Higher transpiration values imply more assimilation of CO_2 but it also means less WUE

Results - Influence of environmental variables on leaf flows

- Although the net **photosynthesis** does not appear to be limited by Soil Temperature, it is **higher** in the range **between 15-25 °C**
- Above 15 °C in soil temperature, transpiration is three times higher compared to the 0 -15 ° range.
- **As VPD and T_{soil} increases, it decreases WUE** at leaf scale WUE stabilizes relatively when $VPD > 20\text{hPa}$.

Preliminary Conclusions

- ✓ **Differences in soil water content and soil temperature** are observed when the cover is established. The difference is accentuated in the summer that coincides when the weed is mowed.
- ✓ At leaf level, **30% less CO₂ is assimilated in olives with weed cover during the growing season**. The assimilation is **matched** in both treatments **when the weeds are cut**. However, at the ecosystem level, the weed-covered plot respire more carbon.
- ✓ After mowing **21% less H₂O is transpired in olives with weed-cover**
- ✓ **Alleys with mowed weed has more ET** than bare soil during the summer. Although more study is needed it may be a consequence of the more humid alley conditions.
- ✓ **Leaf CO₂ and H₂O fluxes correlate** relatively well with **SWC and Soil temperature**, precisely two of the variables that make the difference between treatments.. As VPD and Tsoil increases, it decreases WUE.

THANKS!

Your ideas are more than welcome!

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