

# Deficit irrigation and the reuse of reclaimed water as strategies to cope with water scarcity in perennial crops. A summary of long-term trials within the H2020 SHUI project

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# Acknowledgments

## The team

**CEBAS-CSIC:** J.M. Bayona, C. Romero. E. Pérez, F. Sanz, A. Yeves, D. Guerra, D. Hortelano, A. Martínez, J.M. Ramírez, J.L. Ruiz,

**IVIA:** J.G. Pérez, L. Bonet J.M. de Paz, F. Visconti

**Albacete (ITAP+UCLM):** R. López, M.A. Moreno



## Current grants related with the research

- **H2020:** Shui
- **Agencia Estatal de Investigación:**  
RTC-2016-4972-2 and RTC-2017-6365-2
- **Life:** Climatree
- **Interreg:** RiskAquaSoil and Triple-C, ClimAlert



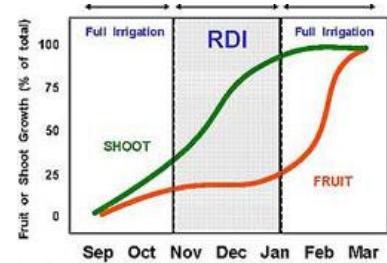
# Background

In woody perennial crops, long-term responses to the watering regime (quantity and quality) are required

There is much of information on short-term responses to the irrigation (deficit and saline water application)

There is a need to conduct long-term studies to determine the effects on soil sustainability and plant performance

The H2020 project SHUI (Managing water scarcity in European and Chinese cropping systems) is an opportunity to continue with the research on regulated deficit irrigation and non-conventional water use



To determine the long-term effects of different irrigation strategies in:

- Citrus trees with different water quality and quantity regimes, including the use of non-conventional water resources
- Grapevines for wine production with either deficit irrigation or the use of saline water

This study is **on-going** to determine the agronomic water use efficiency and economic sustainability of the different practices

# Grapevine research (Irrigation Regime)

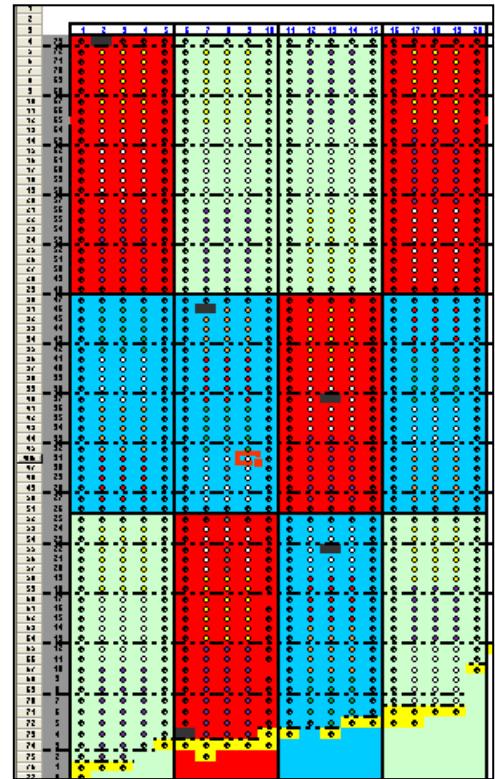
## Irrigation treatments

 Full irrigation 100% ETc = 276 mm

 Regulated déficit irrigation 35% ETc = 92 mm

 Rainfed

Vineyard located in Requena  
(Valencia, eastern Spain)



# Results

	2012	2013	2014	2015	2016	2017	2018	2019
<b>Irrigation regimes</b>	<b>Irrigation applied (mm/year)</b>							
Full irrigation	271	201	362	Data were not taken	309	123	69	56
Regulated deficit irrigation	90	63	127		110	62	68	96
Rainfed	0	0	0		0	0	0	0
	<b>Yield (t/ha)</b>							
Full irrigation	8,6	12,2	13,1	Data were not taken	18,4	16,3	12,1	9,1
Regulated deficit irrigation	4,6	5,3	7,5		11,1	8,9	6,9	9,9
Rainfed	4,2	4,9	2,4		5,3	7,4	7,8	5,8
	<b>Total anthocyanin (mg/g)</b>							
Full irrigation	0,52	0,45	0,39	Data were not taken	1,38	0,65	0,81	0,94
Regulated deficit irrigation	0,86	0,89	0,60		1,60	0,97	1,02	0,85
Rainfed	1,03	0,66	1,04		1,92	0,98	1,21	1,49

# Grapevine research (Irrigation Quality)

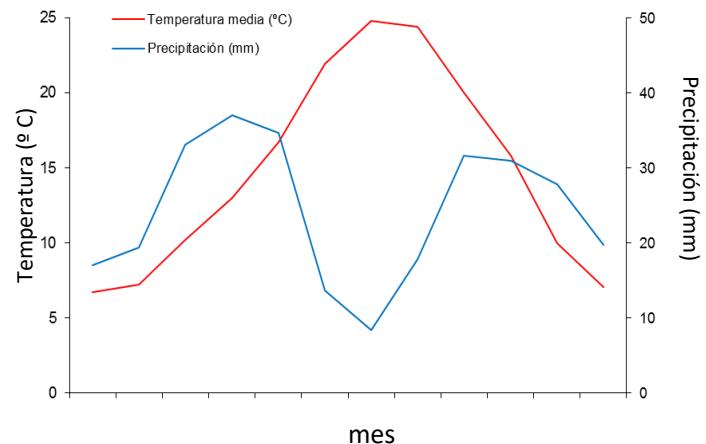
The experiment was carried out in a commercial vineyard, located in Fuente-Álamo (Albacete, Spain).

## Climate is semiarid Mediterranean.

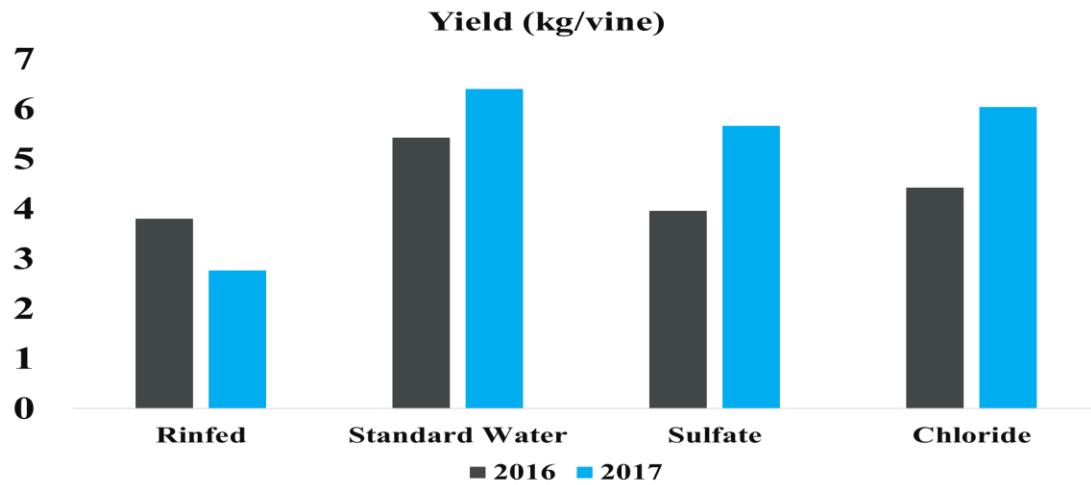
Annual rainfall average 291 mm

Annual average (ET<sub>0</sub>) is 1280 mm

Treatments	Salts used	CE(dS/m)	Irrigation (mm)
Rainfed	-	-	0
Standard water	-	1,5-2	104
Sulfate water	Na <sub>2</sub> SO <sub>4</sub> + MgSO <sub>4</sub>	4,5-5	106
Chloride water	NaCl	4,5-5	102



# Results

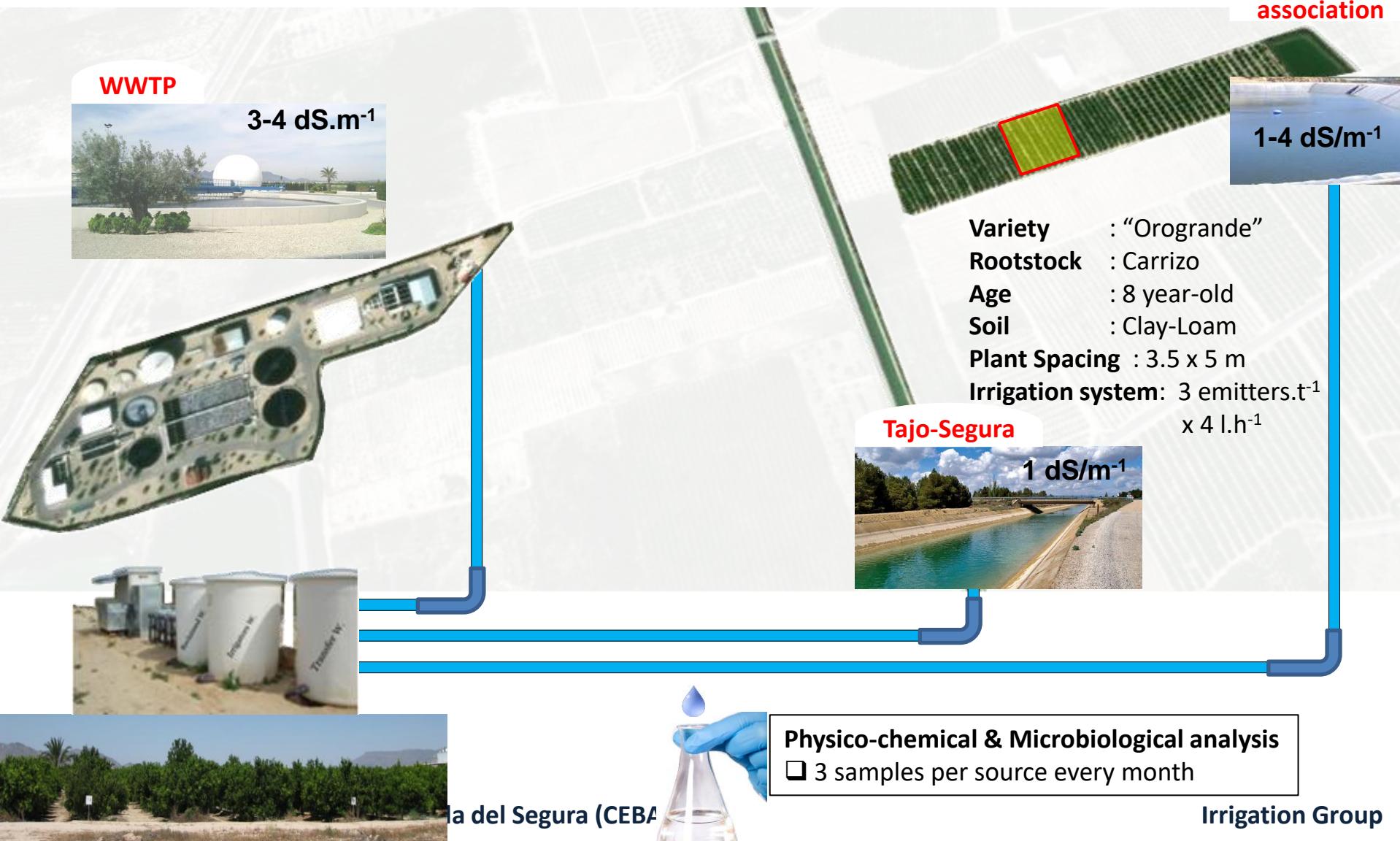


	STT(°Brix)		Total acidity (mg/L)		Tartaric acid (mg/L)		Malic acid (mg/L)	
	2016	2017	2016	2017	2016	2017	2016	2017
Rinfed	25.6 a	23.6a	4.3 a	5.1a	4.4	5.0 b	1.5 a	2.7 a
Standard Water	27.1 ab	23.3ab	6.6 b	5.7b	4.3	4.9 ab	2.1 b	3.8 c
Sulfate	28.2 bc	23.1ab	5.6 ab	5.6b	4.3	4.7 a	2.0 b	3.5 bc
Chloride	28.9 c	22.4b	6.7 b	5.0b	4.2	5.0 b	2.3 b	3.4 b

# Citrus Research (Wastewater reuse)

Orchard : Lo Montero  
Province : Campotejar-Murcia

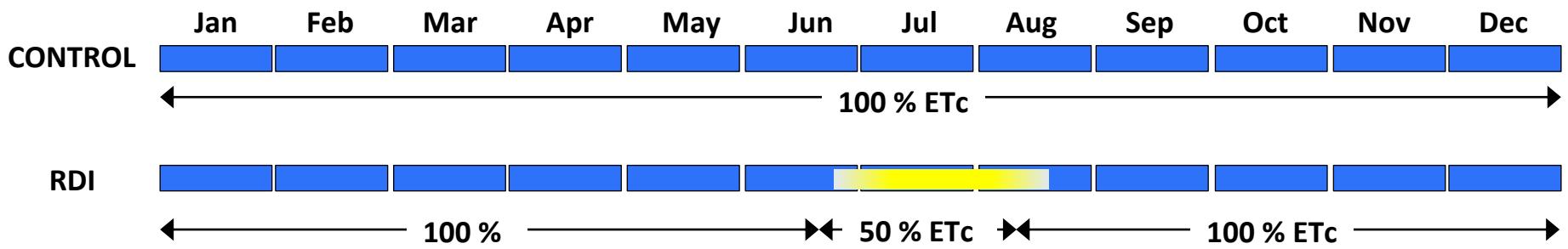
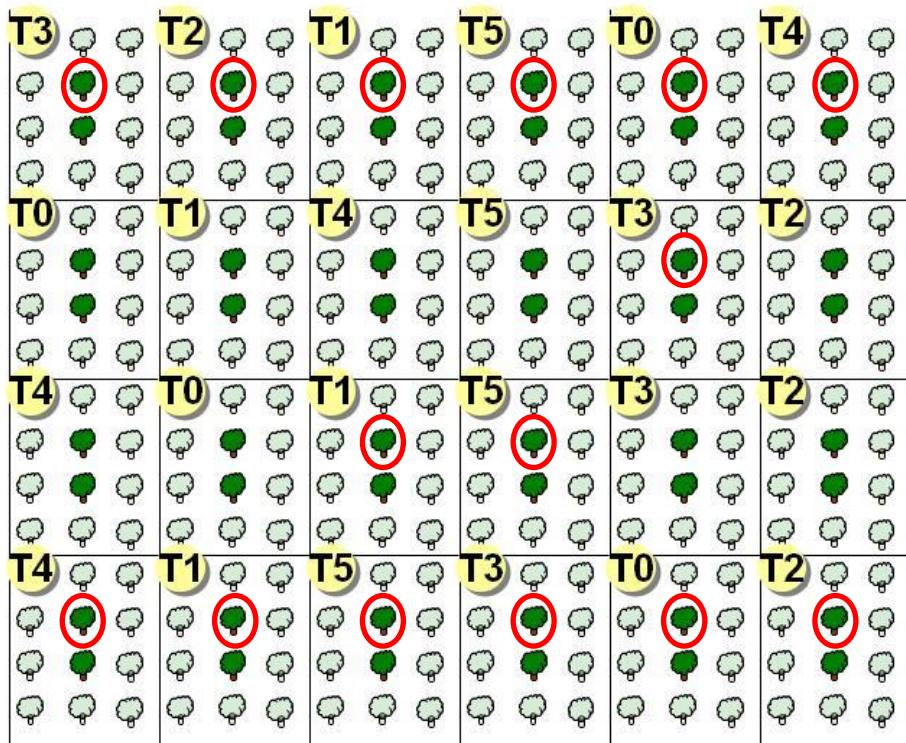
Irrigators association



# Material and Methods

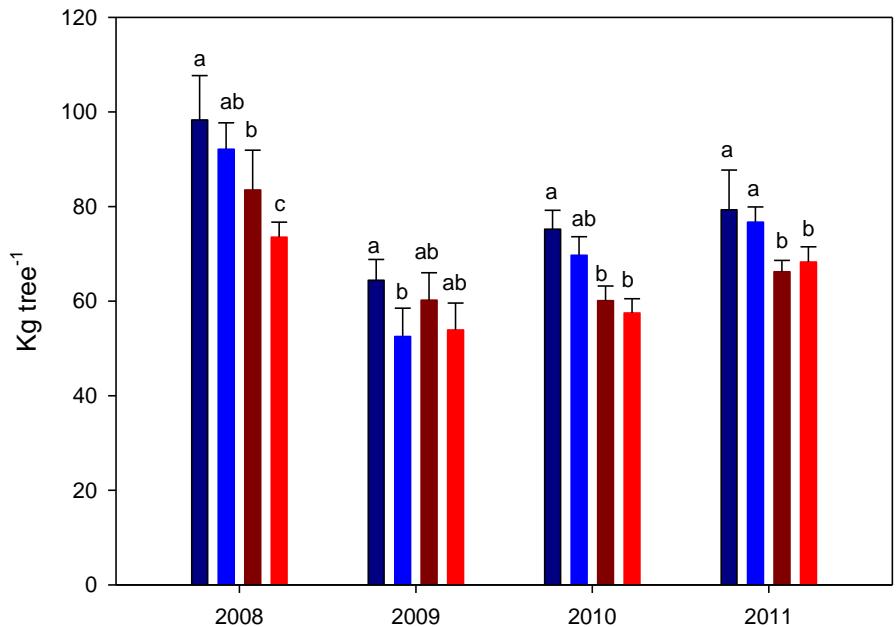
## Irrigation Treatments

- Transfer water
  - TW-C
  - TW-RDI
- Reclaimed water
  - RW-C
  - RW-RDI

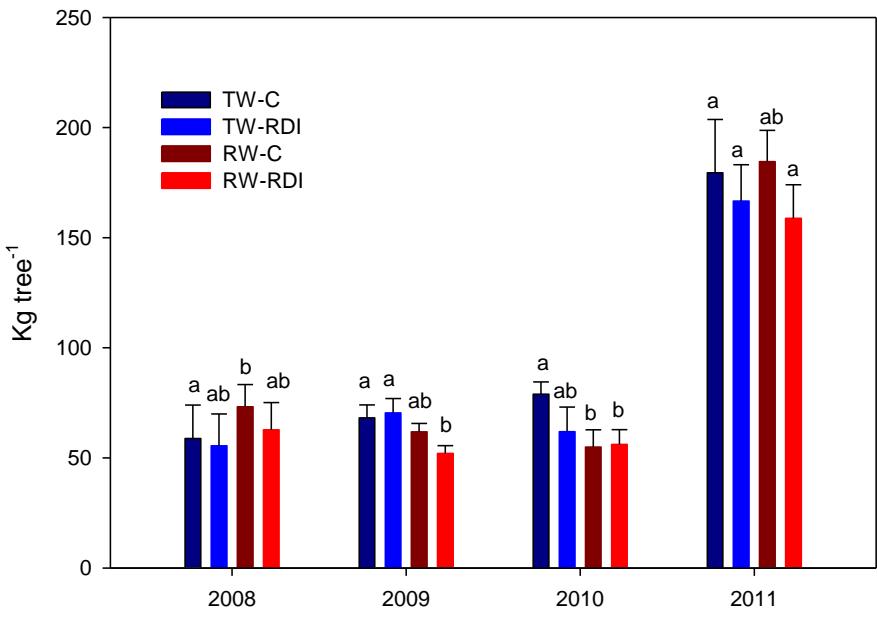


# Results. Citrus deficit irrigation with reclaimed water

## Mandarine



## Grapefruit



# Results. Citrus deficit irrigation with reclaimed water

Treatment	Peel thickness (mm)	Juice volume (ml)	° Brix	pH	Total Acidity	Maturity Index	Vitamin C
TW-CTR	2,52 ± 0,75a	53,00 ± 13,05a	11,6 ± 0,7a	3,6 ± 0,1a	0,9 ± 0,1a	12,8 ± 1,5a	8,5 ± 0,6a
TW-RDI	2,20 ± 0,44a	53,80 ± 14,81a	12,0 ± 0,4a	3,7 ± 0,0a	0,9 ± 0,0a	13,8 ± 0,6a	11,0 ± 0,4b
RW-CTR	2,43 ± 0,43a	61,33 ± 14,32a	12,2 ± 0,9a	3,7 ± 0,1a	1,0 ± 0,1a	11,9 ± 0,8a	13,8 ± 1,1ab
RW-RDI	2,57 ± 0,48a	57,53 ± 12,71a	12,7 ± 1,0a	3,6 ± 0,1a	1,1 ± 0,1a	11,8 ± 0,6a	17,7 ± 0,6c

# Take home messages

➤ **GRAPEVINE:** Irrigation quantity experiment. No clear long-term detrimental responses to rainfed nor to deficit irrigation was reported. Regulated deficit irrigation is the best strategy to optimize the balance between yield and fruit composition

➤ **GRAPEVINE:** Irrigation quality experiment. In the mid-term (two seasons) salinity was not harmful for grapevine performance. The experiment is on-going within the SHUI project to determine the mid-term effects.

➤ **CITRUS:** A tendency to reduce the number of fruits was detected under RW treatments. This reduction was more pronounced under regulated deficit irrigation (RW-RDI treatment).

➤ **CITRUS:** Irrigation with reclaimed water tends to accumulate salts within the plant root zone. Therefore, careful monitoring is needed to avoid possible reduction in the soil agronomic properties.

➤ **CITRUS:** Combined effects of RDI strategies and reclaimed water increased some fruit quality parameters on mandarin trees. [Vit.C] RDI-RW > RDI > Control treatments.



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