

# Irrigation Management for Improved Oil Yield and Quality

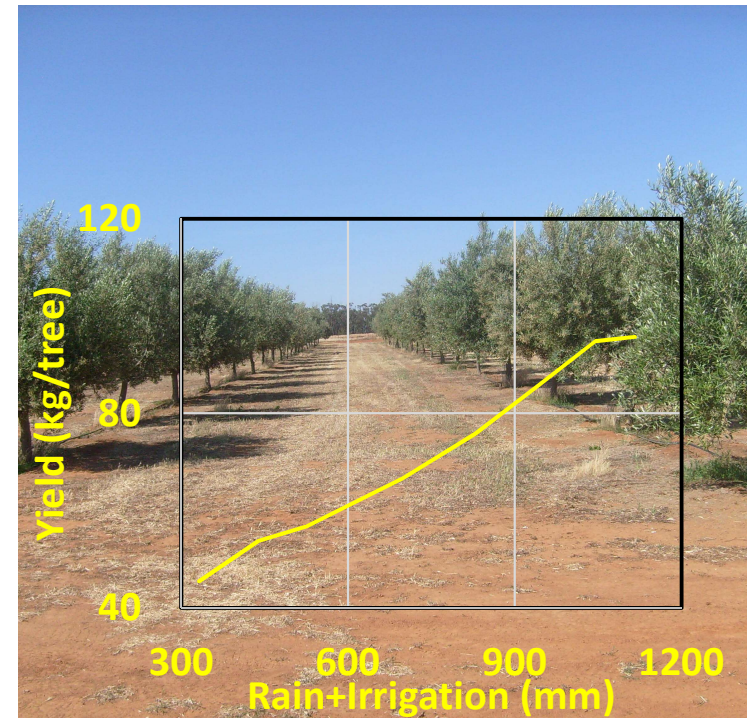
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# Introduction

- Traditionally, olive is grown under rainfed conditions
- Intensive commercial production requires significant water input (irrigation)
- In arid & semiarid regions, optimal use of limited water
- Irrigation influences fruit and oil yield and quality
- Moreover, for good quality oil, fruits need to be harvested at optimal ripeness



- The degree of maturation of olive fruits varies with growing area, variety, and cultural practices
- This presentation deals with results from field experiments on the effect of **regulated deficit irrigation** and **harvest time** on olive oil yield and quality





## Site description and method

- The study was conducted at CSU Wagga Wagga campus in 2010-2012.
- On 12 yr old, nine olive varieties
- More detailed study, cv. Corregiola
- The layout of the grove, shown in Figure 1



# CSU Olive Grove Plantings (Horticultural Precinct)

## East

Tree number																								
	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Row																								
1																23	23	23	23	23	23	23	23	23
2 I															10	16	20	12	14	4	19	8	5	18
3 R														2	1	13	3	17	15	6	9	11	7	3
4 I														9	3	20	16	13	15	18	4	19	17	2
5 D													11	10	14	5	7	6	12	2	1	8	4	21
6 D												14	5	17	3	9	8	10	2	18	12	22	2	3
7 I											7	20	11	13	16	15	6	1	4	19	2	3	4	21
8 R										6	2	19	18	14	15	4	10	1	13	2	3	4	21	22
9 I									9	20	8	3	11	17	5	16	12	7	3	4	1	2	3	4
10 D									12	11	20	15	8	4	3	7	18	5	1	2	3	4	1	2
11 R								14	2	1	9	16	13	6	17	19	10	8	9	10	1	2	3	4
12 I							2	14	16	11	20	5	1	13	7	17	10	1	2	3	4	5	6	7
13 R						3	10	19	6	4	9	8	12	15	18	1	2	3	4	5	6	7	8	9
14 D					12	6	7	3	9	16	2	14	20	5	14	17	13	4	18	20	15	11	12	2
15 I					19	1	17	11	15	8	4	13	18	10	5	1	3	8	16	6	7	10	9	19
16 R				5	12	4	15	6	11	14	9	2	18	17	3	16	4	2	11	6	14	19	5	24
17 D			13	3	16	8	7	17	10	19	1	20	10	7	12	9	8	1	20	13	18	15	24	24
18 R		15	17	7	12	16	5	1	14	4	18	11	5	20	4	6	2	3	7	17	12	12	12	12
19 I	3	10	13	6	11	2	8	20	19	9	9	14	19	1	15	10	8	13	16	18	11	11	11	12
20 R				17	7	10	8	6	2	5	9	14	13	4	3	18	15	9	2	10	19	8	13	11
21 D			15	3	1	4	18	16	12	11	19	20	17	6	1	12	5	11	20	14	16	7	11	11

Variety	
1	Mission (19)
2	Corregiola (23)
3	Nevadillo Blanco (24)
4	Manzanillo (23)
5	Hoji Blanca (16)
6	Arbequina (15)
7	Picual (16)
8	Leccino (16)
9	Pendolino (16)
10	Frantoio (16)
11	Verdale (14)
12	Barnea (16)
13	FS 17 (13)
14	I77 (13)
15	Coratina (14)
16	Picholine (14)
17	Koroneki (13)
18	Kalamata (14)
19	Hardies mammoth (14)
20	UC13A6 (13)
21	CSU Corregiola (3)
22	CSU Nevadillo Blanco (2)
23	CSU Manzanillo (9)
24	OA Hardies Mammoth (3)

## West

# Method and site description

- The weather parameters during the experimental years is given in Table
- There were three treatments and three replications.
- Irrigation: two drip laterals 50cm on either side of the trees, 2.3lph drippers at 60cm spacing
- Irrigation monitored using solenoid at the upstream end of each tree rows

Month	2010/11				2011/12			
	Rainfall (mm)	Irrigation (mm)			Rainfall (mm)	Irrigation (mm)		
		R	D	I		R	D	I
September	74	0	0	0	25	11	11	11
October	135	0	0	0	20	44	44	44
November	84	0	0	0	148	64	64	64
December	148	0	0	0	65	4	19	37
January	44	0	39	78	72	0	37	73
February	160	0	48	96	51	0	20	40
March	50	0	24	48	193	0	4	6
April	27	0	23	46	8	0	12	24
May	27	0	0	0	42	0	0	0
June	26	0	0	0	17	0	0	0
July	32	0	0	0	42	0	0	0
August	41	0	0	0	27	0	0	0
Total	848	0	134	266	710	123	211	299

R = rainfed, D = deficit, I = irrigated.

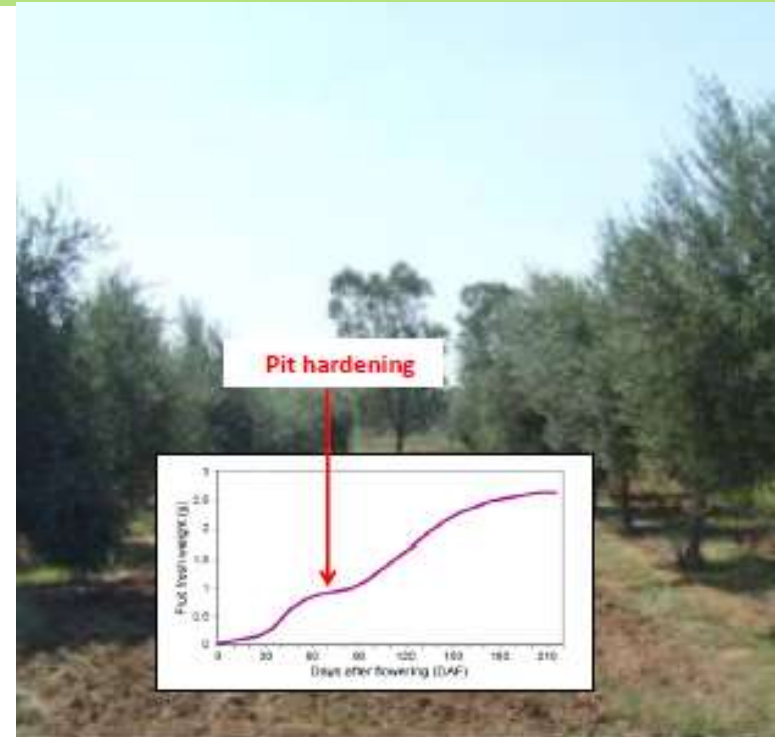


## Method and site description

- Three watering regime treatments during the **pit-hardening** period:
  - fully irrigated (I) ,
  - not irrigated (R) (**35% water saving**),
  - irrigated at 50%ETc (D); (**17.5% water saving**)

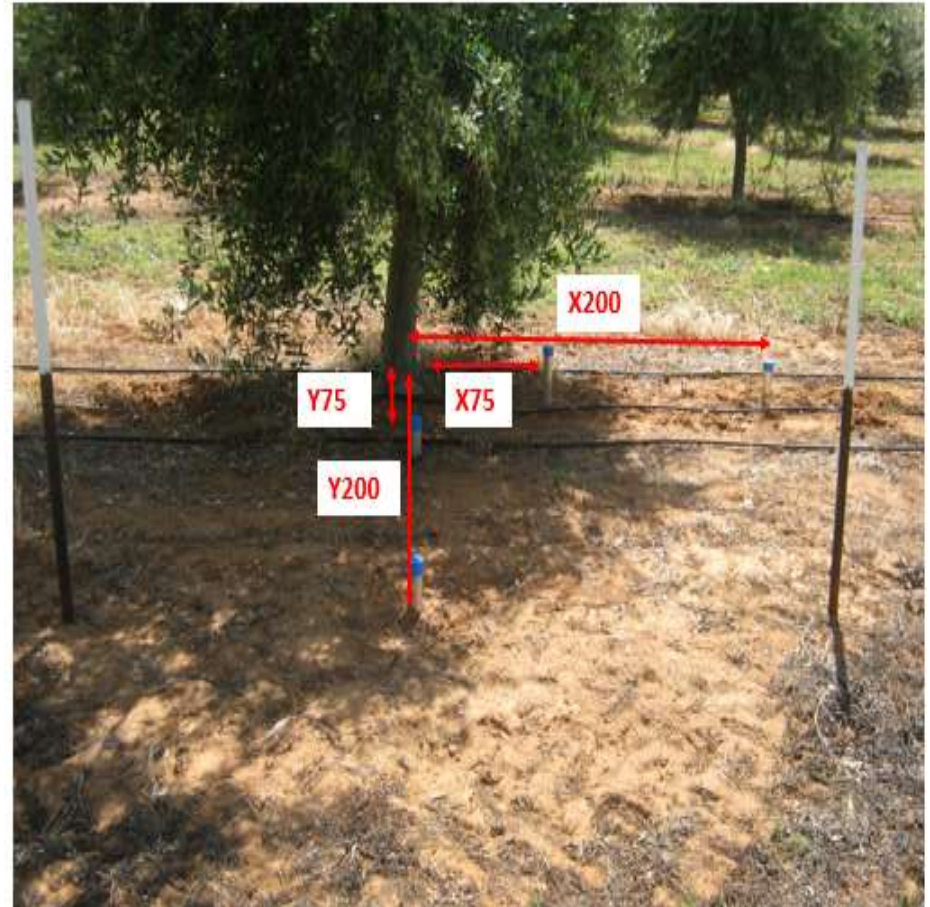
ETc is evapotranspiration

- Irrigation treatments during the pit-hardening period (Figure 2).



## Method and site description

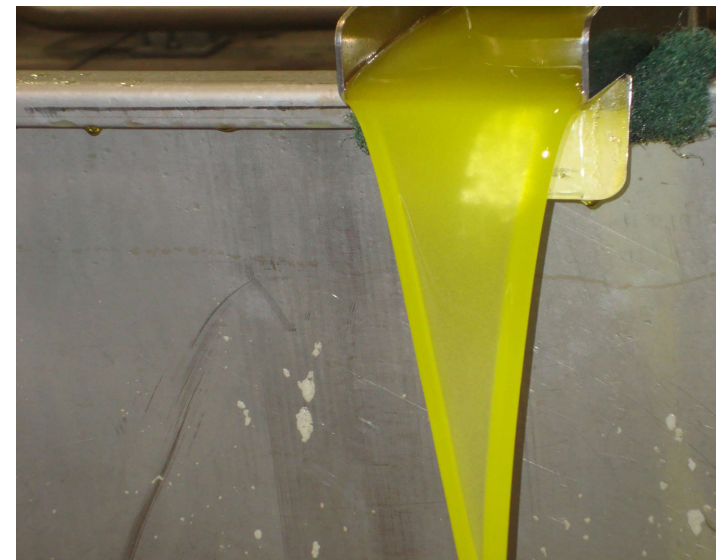
- Pit-hardening is the stage of slow fruit development.
- Oil accumulation starts only towards the end of the pit-hardening period.
- The amount of irrigation applied to the three treatments is given in Table 2.
- Soil water monitored using neutron probe.
- Four access tubes in Figure 3.





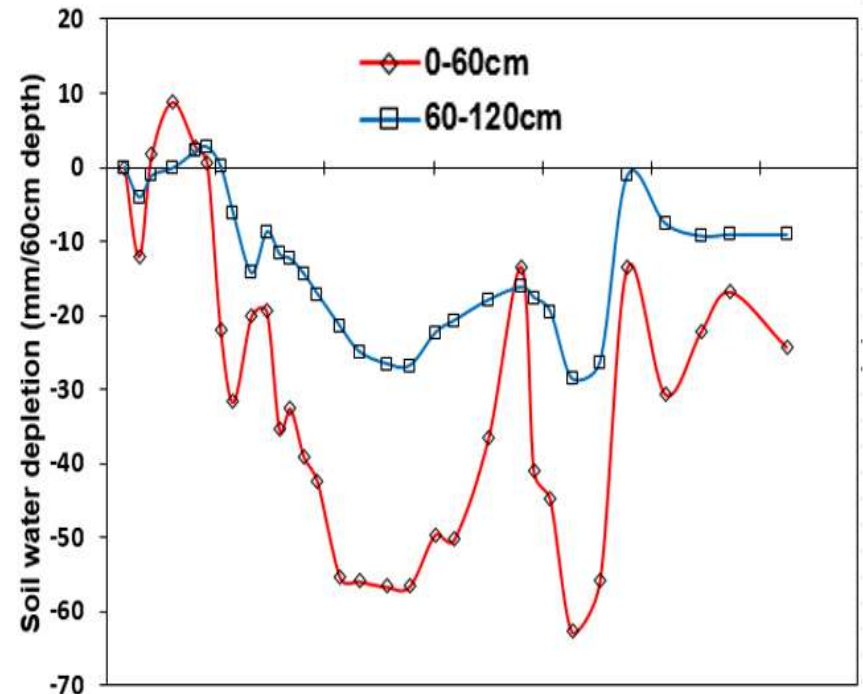
## Method and site description

- **Measured yield parameters (4 harvest times):**
  - **Fruit water content**
  - **Maturity index**
  - **Cold press or mechanical extraction of oil**
  - **Total oil extraction**
  - **Oil quality analysis**



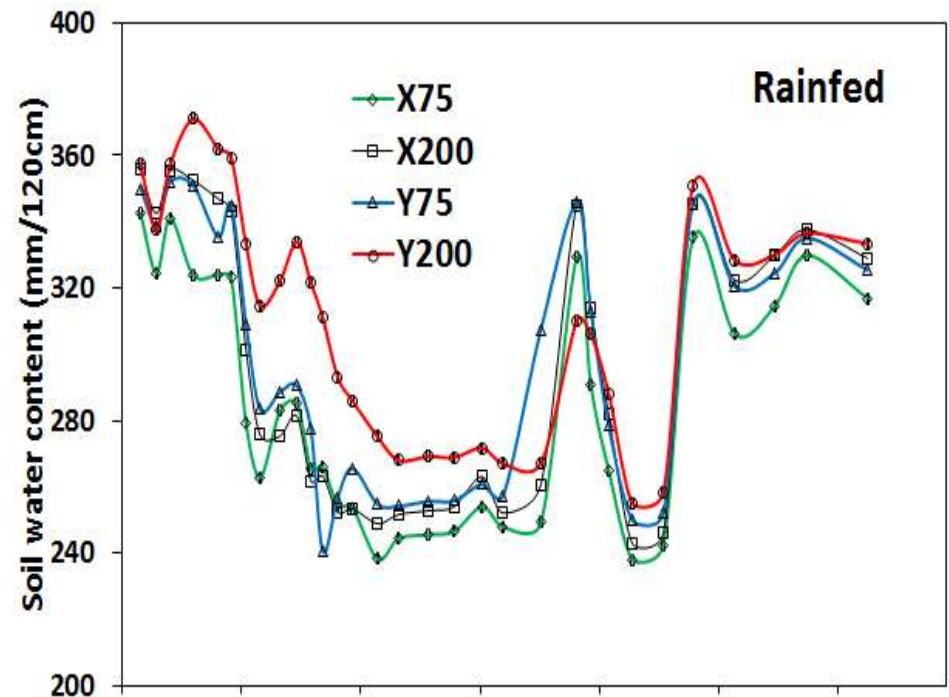
# Olive water requirement and irrigation

- Reduced wetted soil volume under drip-irrigation system influences root distribution and water extraction.
- Olive root growth responds positively to irrigation with irrigated olives having 34% more soil volume explored by roots and 22% more root length than non-irrigated trees.
- Olive evapotranspiration (mm) for R, D, I:
  - 'On' year: 620, 685, 723
  - 'Off' year: 555, 610, 673



# Olive water requirement and irrigation

- Searles et al. (2009): 70% of the roots within 0.5 m of the drip line and more than 90% was within 1 m; more than 70% of the roots in the top 0.5 m.
- Michelakis and Vougiouscalou (1988) showed that cv. Kalamon olive trees have 3 to 7 times more roots at the 0-120 cm horizontal distance from the drippers compared to a distance of 120-300 cm.
- This is important, for example, to select representative sites for the location of soil water sensors and fertilizer application.





## Effect of varieties

- Varieties differ in terms of the time they reach maximum oil content; implying the need for variety-based harvest time.
- Fruit oil content during the normal olive harvest period (April to June) increases rapidly until fruit maturity occurs (in May), then plateaus.
- Olive fruit and oil yield, and quality are affected by olive variety, region of cultivation, degree of maturation, and irrigation.

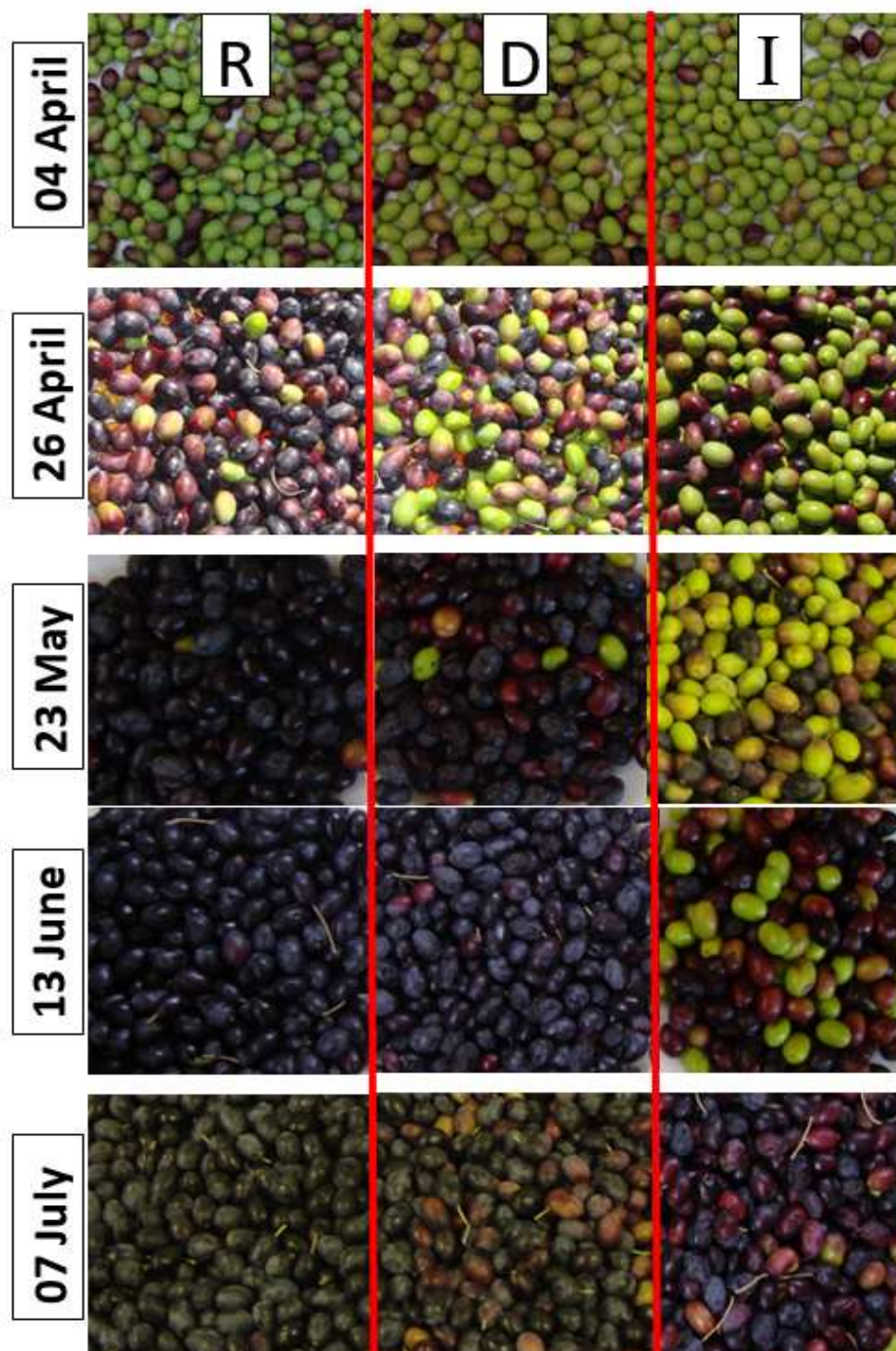


- Olives harvested relatively early, yield less oil, which is lower in free fatty acids, than olives harvested late.
- The best time to harvest olive is when ripe, oil accumulation is complete and the oil is at its best quality.
- However, the degree of maturation of olive fruits varies, according to the growing area, olive variety, and cultural practices.



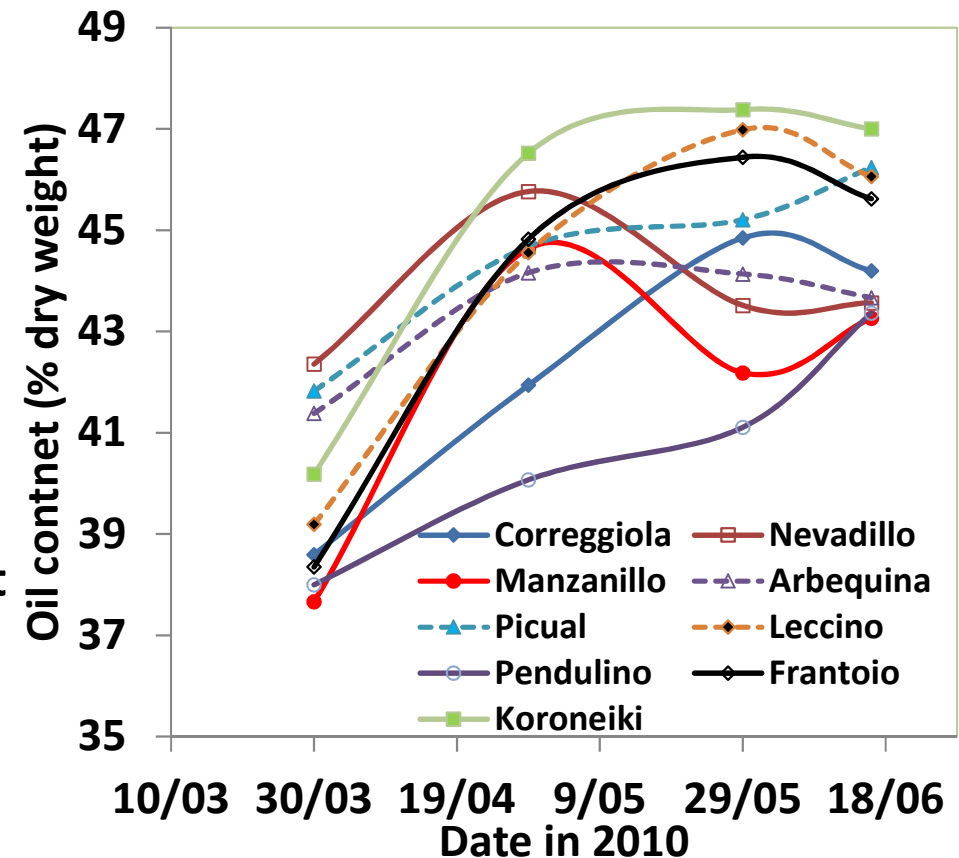
## Irrigation and ripeness

- Irrigation affected the ripeness of the olive fruits, esp. Arbequina, Koroneiki and Picual.
- Irrespective of the irrigation treatment some varieties (Manzanilo and Nevadillo) matured earlier whereas Koroneiki, Corregiolla and Picual matured late.



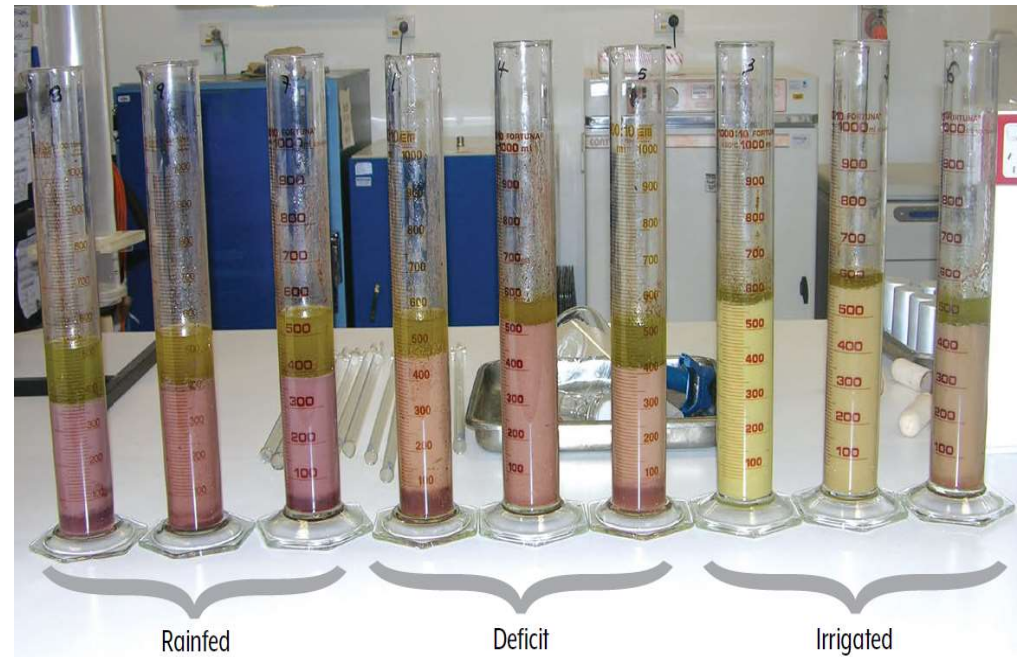


- There was no significant effect of irrigation on the oil content.
- Oil accumulation increased over the harvest season and plateaued towards the end
- Previous studies have found no effect or some effect.



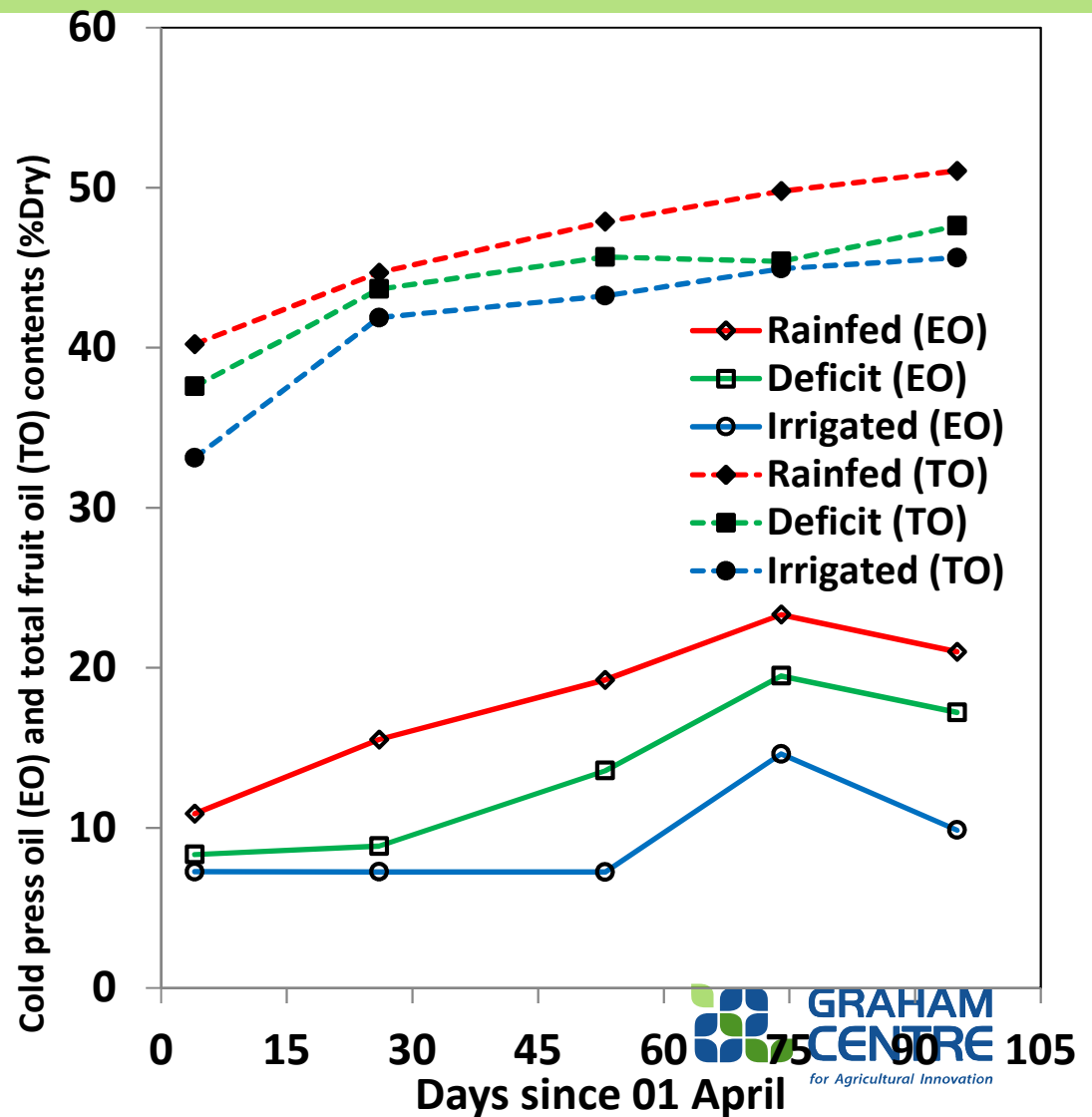
# Irrigation and oil extraction efficiency

- Irrigation may increase oil accumulation but may also limit oil extraction efficiency and reduce oil shelf life.
- Mechanically extracted oil was highest in the non-irrigated treatment, lowest in the fully irrigated treatment, and intermediate in the partially irrigated treatment.
- The higher the fruit water content, the lower the effectiveness of mechanical extraction.



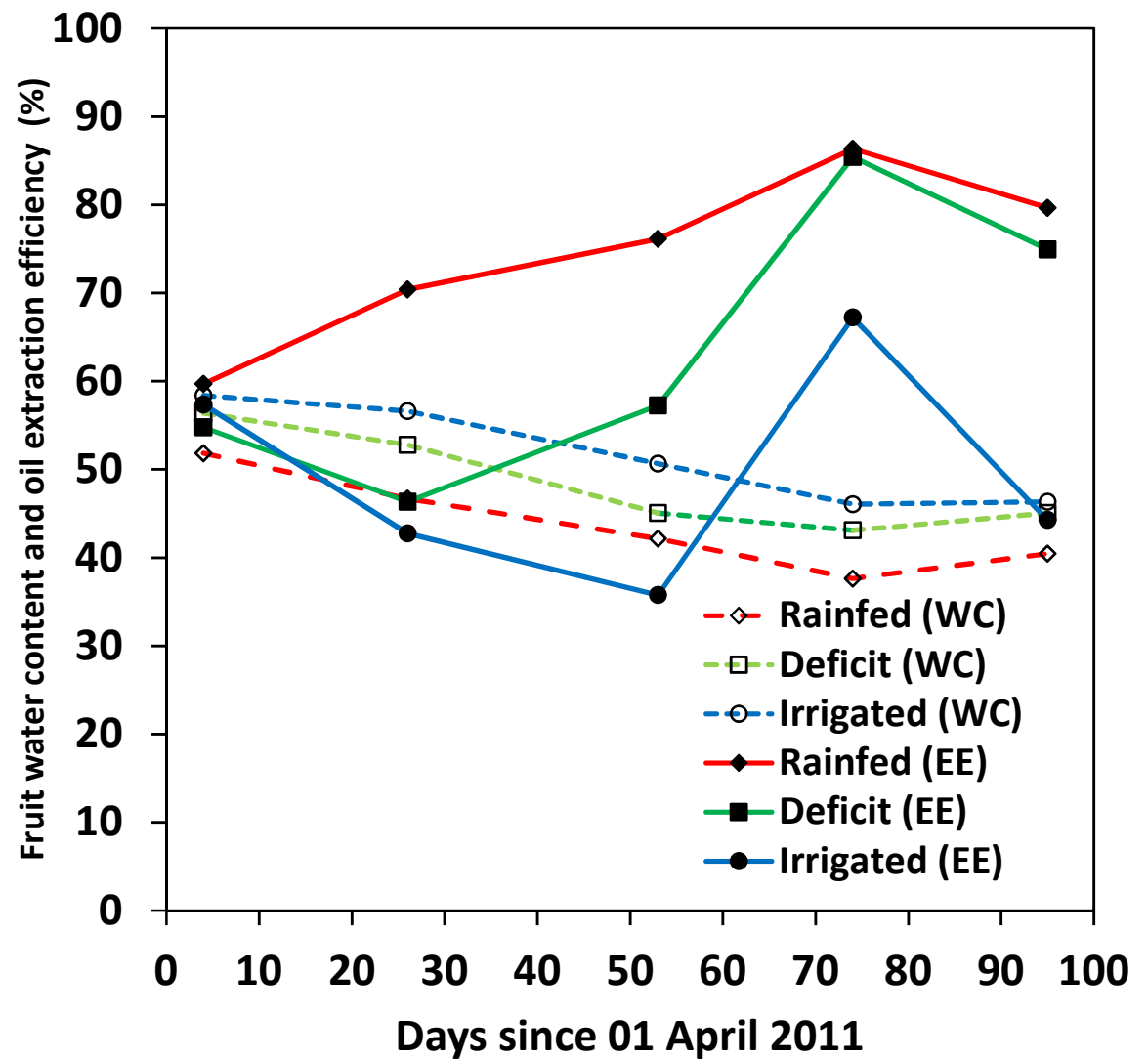
# Irrigation and oil extraction efficiency

- Comparison of mechanically extracted oil and chemically extracted oil (Fig. 2) shows that the olive fruits potentially contained high amount of oil.
- The total oil content was not significantly affected by the irrigation treatment; the irrigation treatment might not be contrasting enough to influence the oil accumulation.
- However, the irrigation treatments significantly affected the mechanical oil extraction.



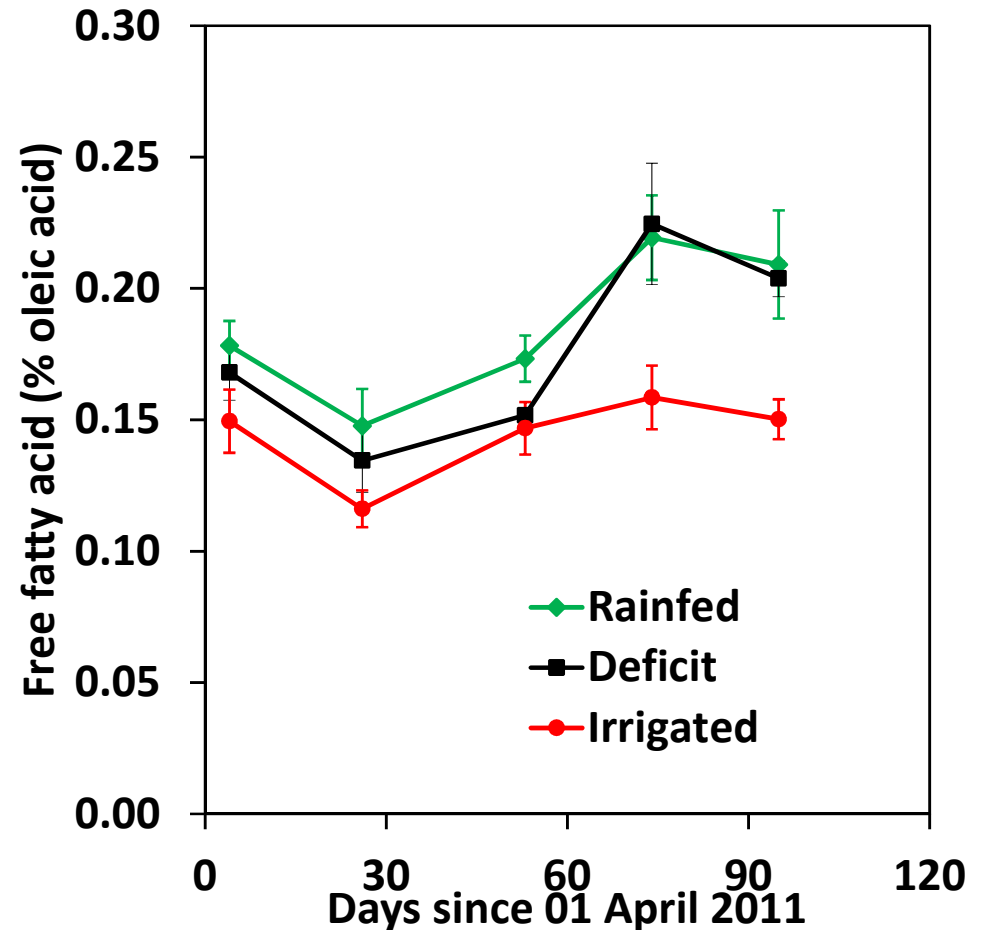


- High water content in the fruit led to low oil extraction from the irrigated treatments.



# Oil quality

- Irrigated treatments resulted in slightly but consistently lower **free fatty acid** (FFA) content. Generally, acidity increased during fruit ripening.
- **Peroxide value** is used as an indicator to reveal enzymatic and oxidative deterioration in oil. Peroxide value showed only little variation over the five harvest events and between the watering regimes.
- There was no significant difference between the total **polyphenol content** of the three watering regimes. Other studies have found that trees receiving more water have lower total polyphenol content (lower intensity of bitterness). The total polyphenol content decreased between the first and last harvests.



## Concluding Remarks

- **Regulated deficit irrigation during the pit-hardening period saves water, increases extraction efficiency without compromising quality**
- **Olive root distribution follows drip line and is shallow**
- **Different olive varieties have different ripening rate and oil content. For most of the varieties, maximum oil accumulation is reached by the beginning of May in Wagga**

### **Points to note:**

- **This study was conducted during relatively high rainfall years**
- **Due to the limited number of olive trees, fruit yield was not determined**

## References

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