Water use of avocado orchards

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AVOCADO PRODUCTION STATS & REGIONS

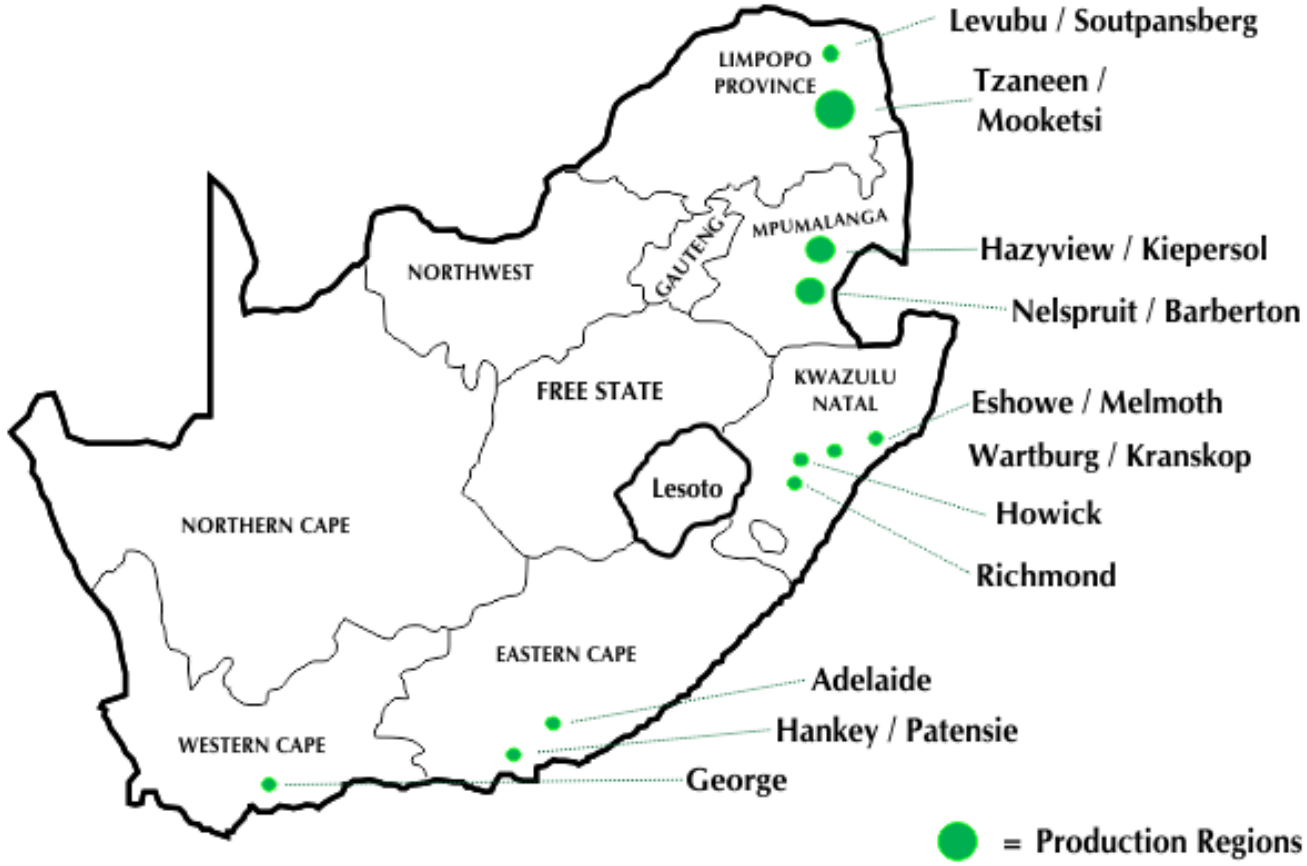
% Production by province

Limpopo
~ 58%

Mpumulanga
~24%

Kwazulu-Natal
~14%

Cape provinces
~4%



INDUSTRY FACTS

- 14 700 ha planted in South Africa (2020 SAAGA Census)
- ~800 ha new plantings annually
- 5 year average annual production 125 600 t
- Employment: 1 permanent worker / 2.6 ha
- Time to full production: 6-8 years

https://www.avocado.co.za/

How avocados and kale became so popular

(Image credit: Getty Images)

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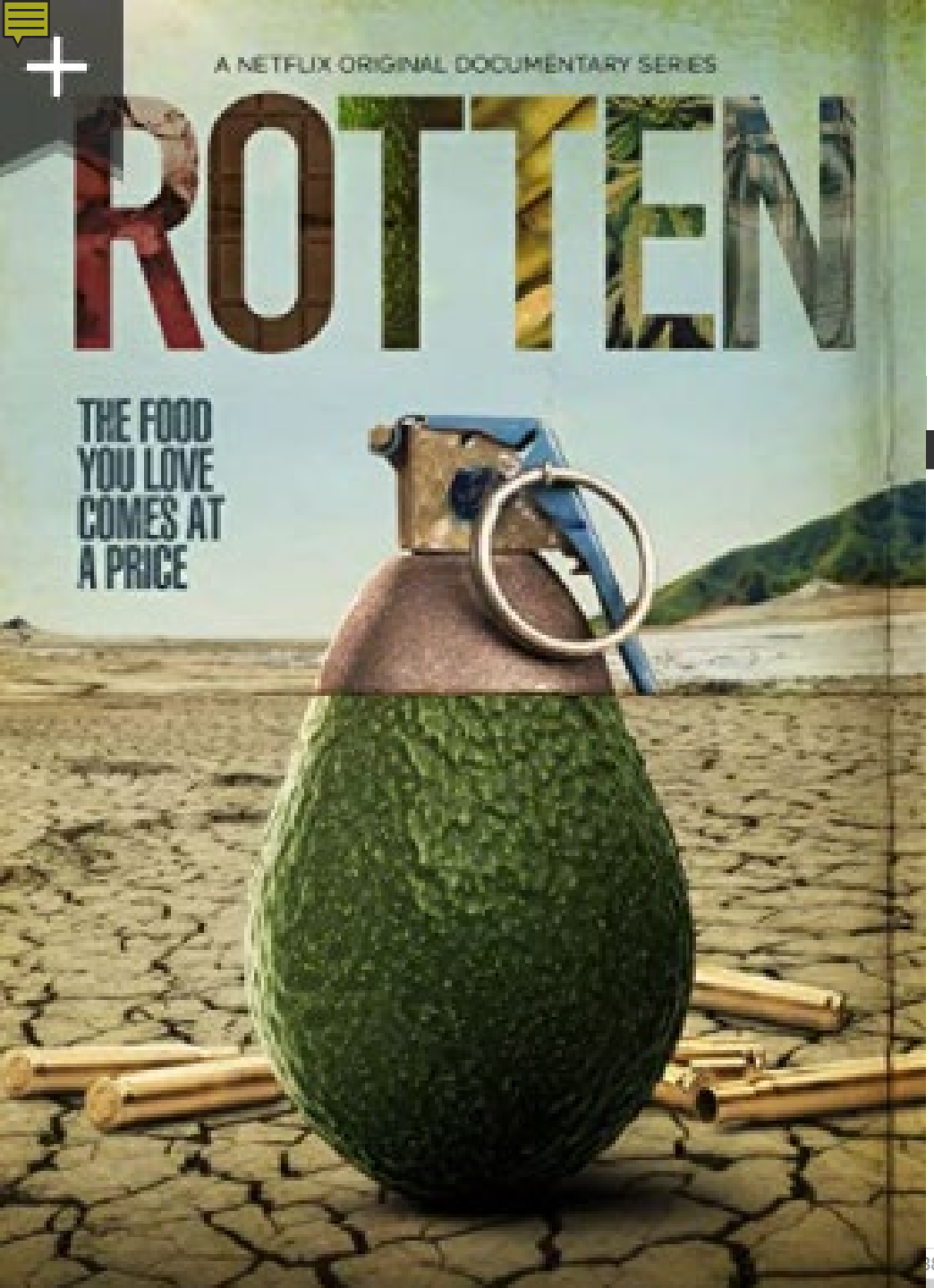
Plant Water & Nutrition



It Takes HOW Much Water to Grow an Avocado?!

TOM PHILPOTT
Reporter
Bio | Follow

The water footprint of avocados in Spain reduced to 600 liters per kilo

The World Avocado Organization (WAO) has reported that the constant improvements and advances achieved in avocado cultivation have allowed the amount of water needed to produce a kilo of this fruit to be reduced to between 600 and 700 liters. According to the WAO, which brings together Malaga-based companies such as Trops, Grupo Reyes Gutiérrez and Compañía Aguacatera del Sur, this reduction is an important step in the saving of water, since there are more and more growers who, starting from a global average of 800 to 1,000 liters of water per kilo produced, are achieving a reduction that ranges between the 200 and 300 liters.

For the WAO, this amount (600-700 liters per kilo of fruit), which may sound high at first, stands well below the 15,000 and 17,000 liters of water needed on average for a kilo of beef and a kilo of chocolate, respectively, or the 9,000 liters of water needed to produce a kilo of nuts, the 790 liters needed for a kilo of bananas or the 822 liters needed for a kilo of apples, according to the data collected by the study conducted by the IME (Institution of Mechanical Engineers)

Avocados have adapted to different climatic zones around the world. In a good part of the areas where it is cultivated, as in Colombia or Mexico, there is a lot of rainfall, so irrigation is often not necessary for

Do avocados use too much water?

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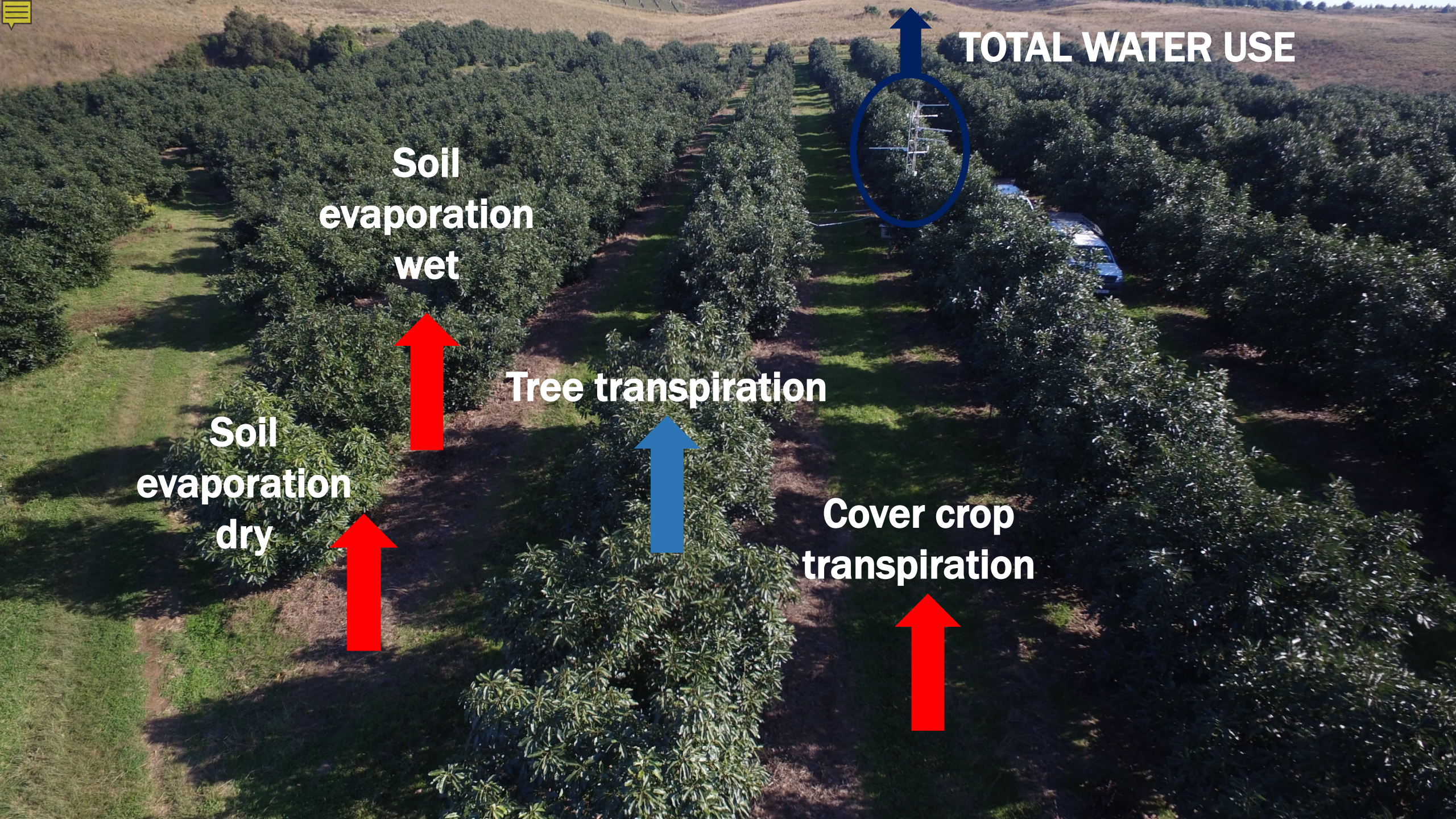
Plant Water & Nutrition

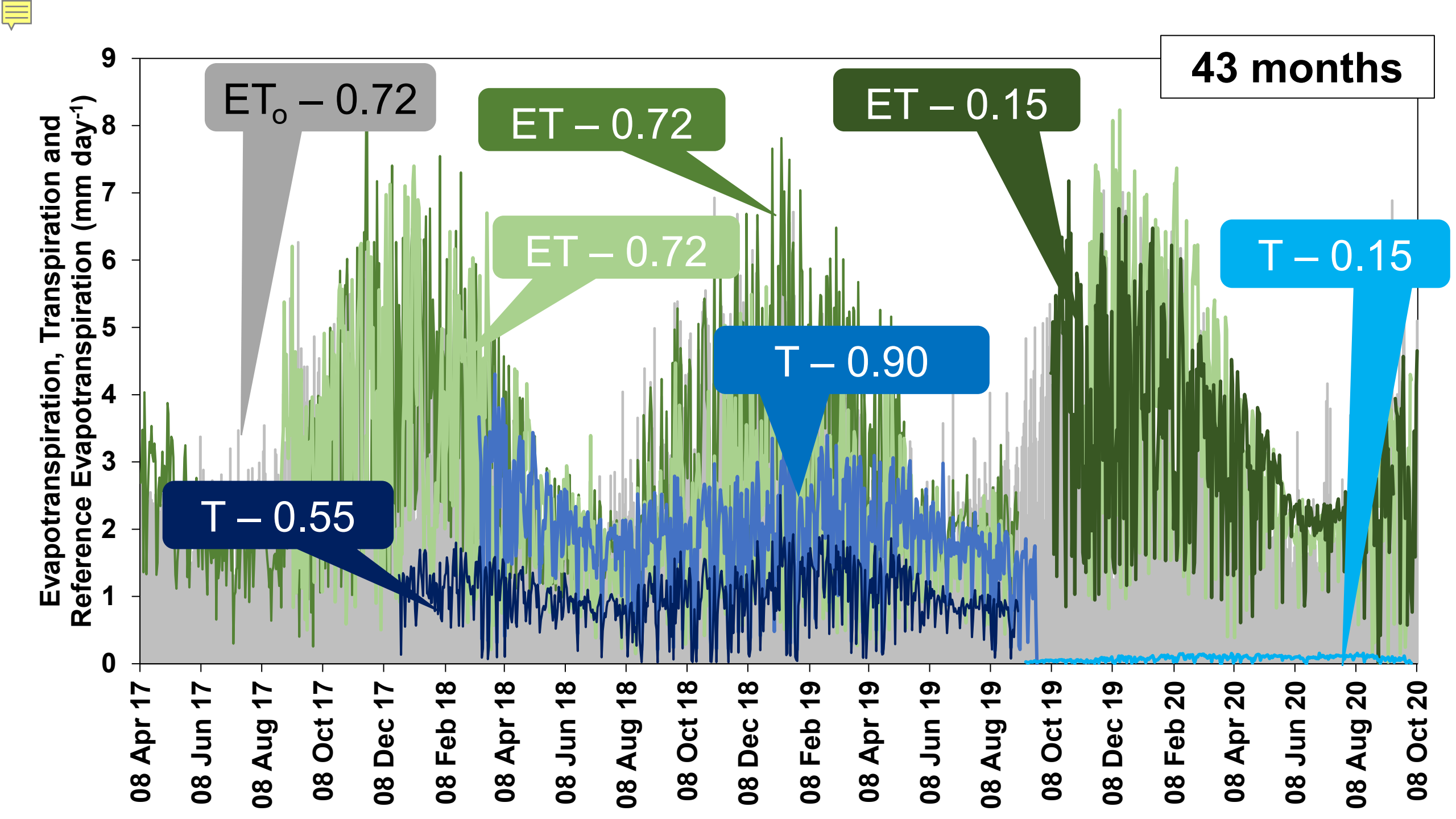

TOTAL WATER USE
Soil evaporation wet
Tree transpiration
Soil evaporation dry
Cover crop transpiration

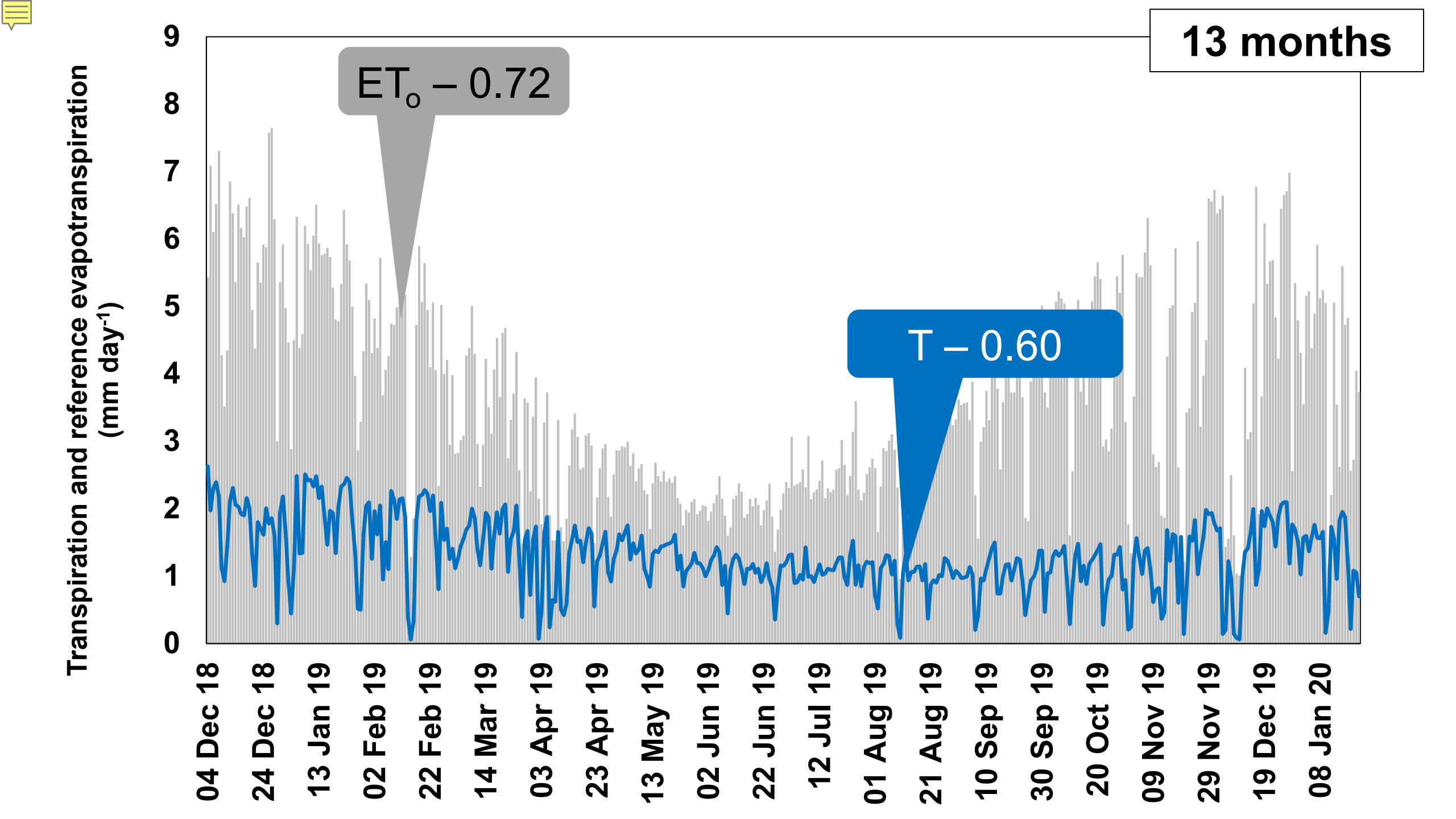

Mature orchard Howick
canopy cover = 0.90


Intermediate orchard Howick
canopy cover = 0.55


Immature orchard Howick
Canopy cover = 0.15


Mature orchard Tzaneen
canopy cover = 0.60


43 months
ET$_o$ – 0.72
ET – 0.72
ET – 0.72
ET – 0.15
T – 0.90
T – 0.15
T – 0.55
Evapotranspiration, Transpiration and Reference Evapotranspiration (mm day^{-1})
0
1
2
3
4
5
6
7
8
9
08 Apr 17
08 Jun 17
08 Aug 17
08 Oct 17
08 Dec 17
08 Feb 18
08 Apr 18
08 Jun 18
08 Aug 18
08 Oct 18
08 Dec 18
08 Feb 19
08 Apr 19
08 Jun 19
08 Aug 19
08 Oct 19
08 Dec 19
08 Feb 20
08 Apr 20
08 Jun 20
08 Aug 20
08 Oct 20

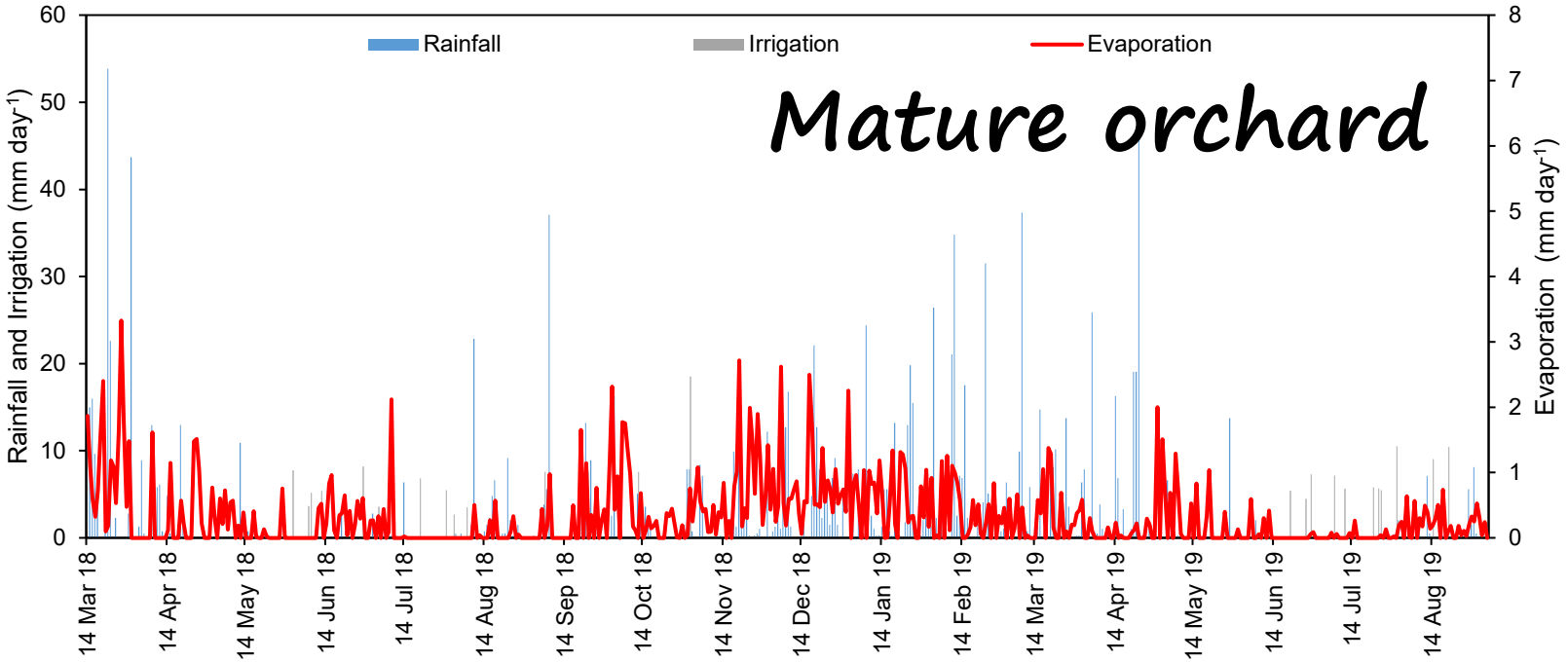

13 months
ET_o – 0.72
T – 0.60
Transpiration and reference evapotranspiration (mm day^{-1})
0
1
2
3
4
5
6
7
8
9
04 Dec 18
24 Dec 18
13 Jan 19
02 Feb 19
22 Feb 19
14 Mar 19
03 Apr 19
23 Apr 19
13 May 19
02 Jun 19
22 Jun 19
12 Jul 19
01 Aug 19
21 Aug 19
10 Sep 19
30 Sep 19
20 Oct 19
09 Nov 19
29 Nov 19
19 Dec 19
08 Jan 20

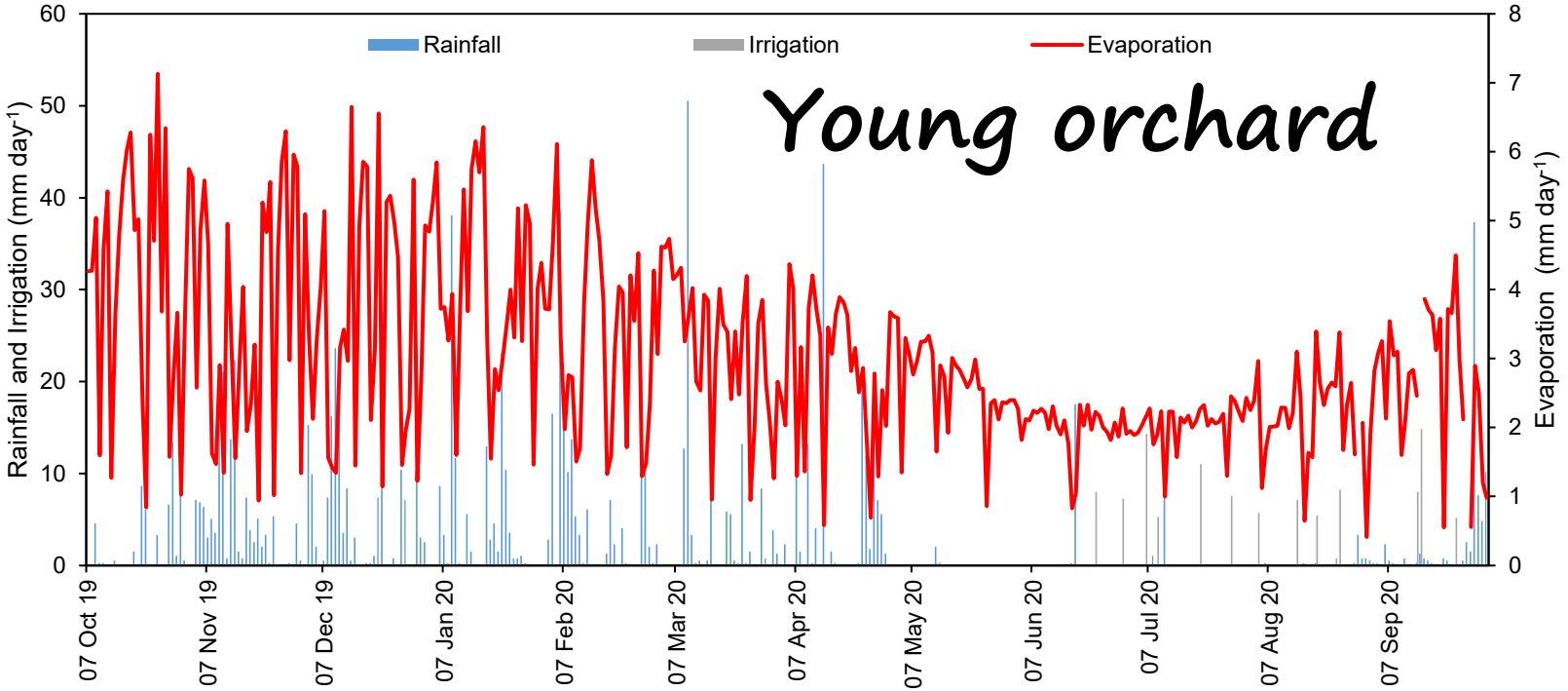
Seasonal water use

	Non-bearing	Intermediate	Tzaneen	Mature
Transpiration	30 mm	360 mm	480 mm	680 mm
Evapotranspiration	1120 mm	1150 mm	ND	750 mm
Evaporation (% of ET)	97%	66%	ND	15%

Daily water use

Season	Non-bearing	Intermediate	Tzaneen	Mature
Avg. daily T (L tree $^{-1}$ day^{-1})	2.3	27	42	53
Avg. daily T (mm day^{-1})	0.08	0.98	1.31	1.90
Max. daily T (L tree day^{-1})	4.4	70	84	121
Max. daily ET (mm day^{-1})	7.17	8.02	ND	7.40
Avg. daily ET (mm day^{-1})	3.11	2.89	ND	2.41

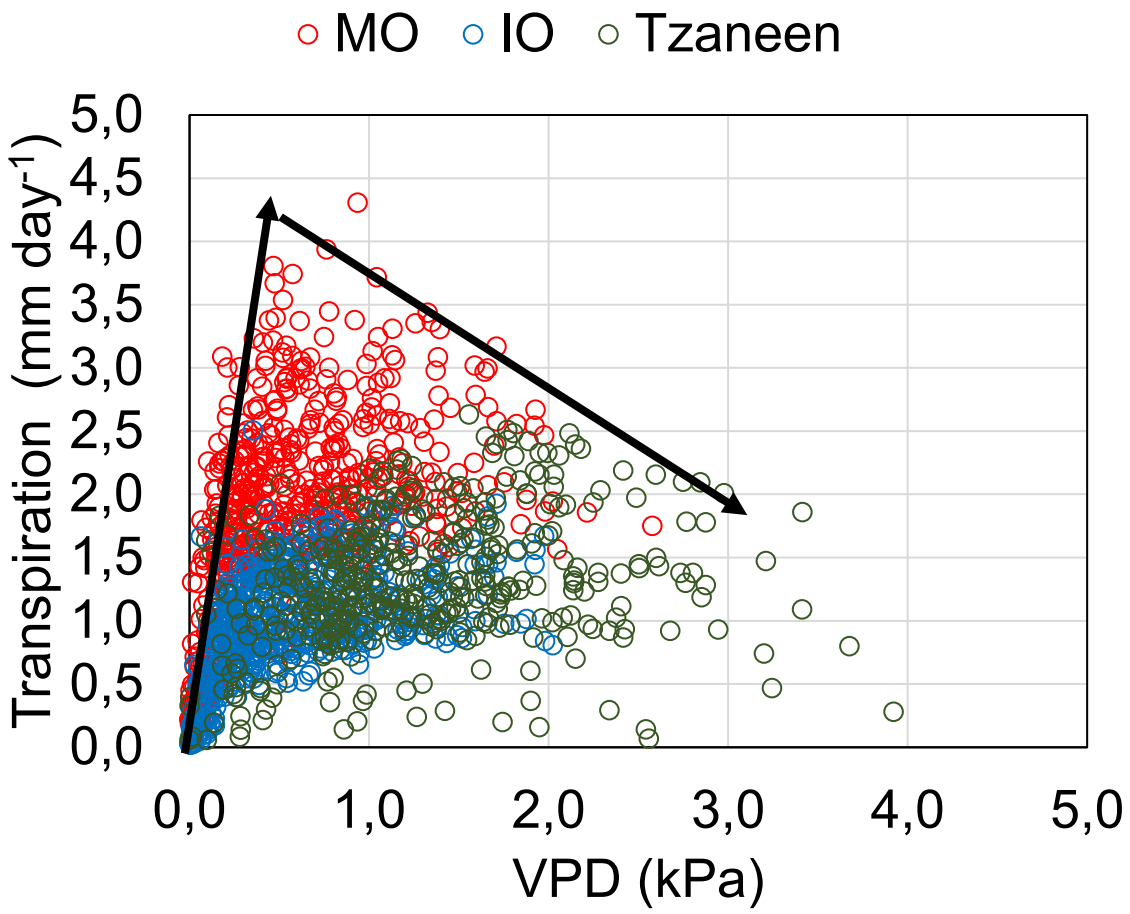


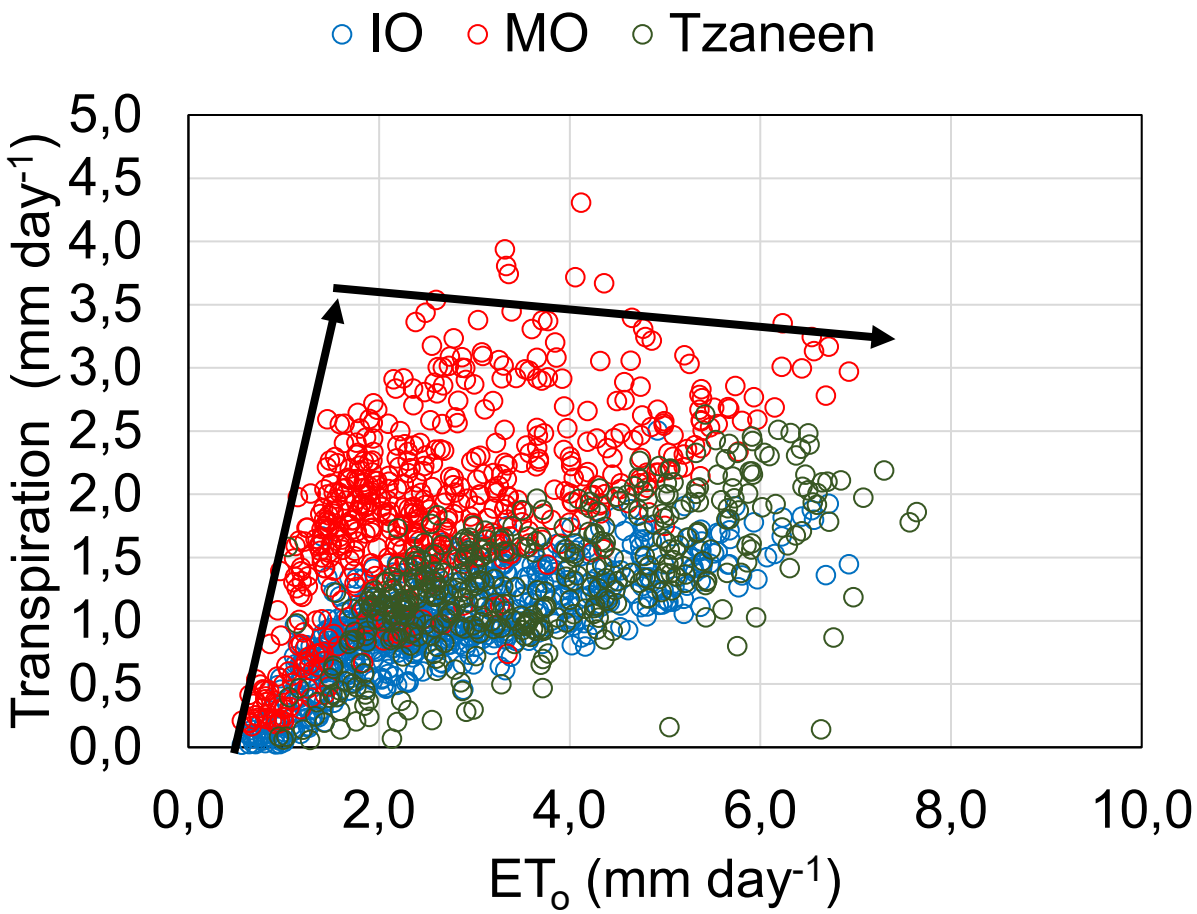


Evaporation from orchards

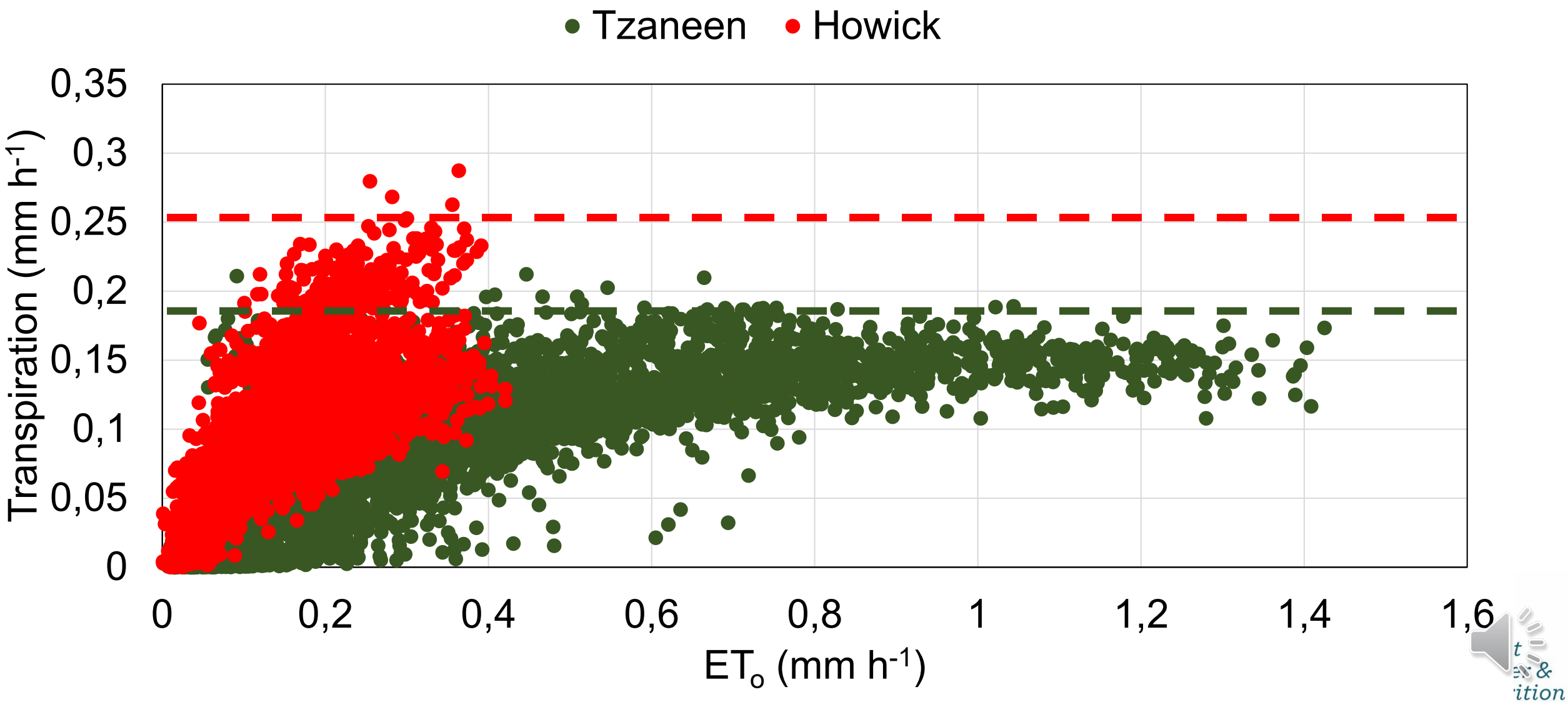
How can water management in young orchards be improved to minimize evaporation?

Response of T to environment





Maximum transpiration rate



Estimating transpiration

Crop coefficient

$T = K_t \times ET_o$

Penman-Monteith

$$\lambda E_C = \frac{\Delta (R_n - G) + \rho_a C_p g_a VPD}{\Delta + \gamma \left(1 + \frac{g_a}{g_c}\right)}$$

$$g_{c,j} = g_{c\,max} f(S_R) f(VPD_{air}) f(T_{air})$$

Multiplicative function

$$T = T_{max} f(S_R) f(VPD_{air}) f(T_{air})$$

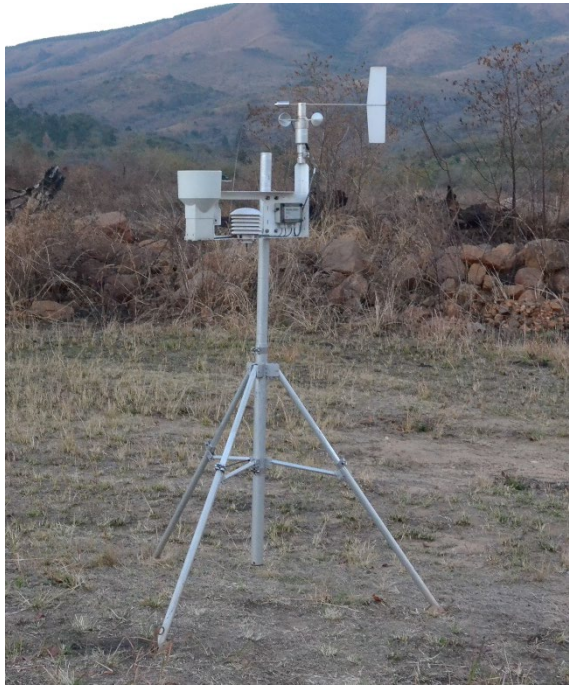
How can we estimate transpiration?

Solar radiation

Air temperature

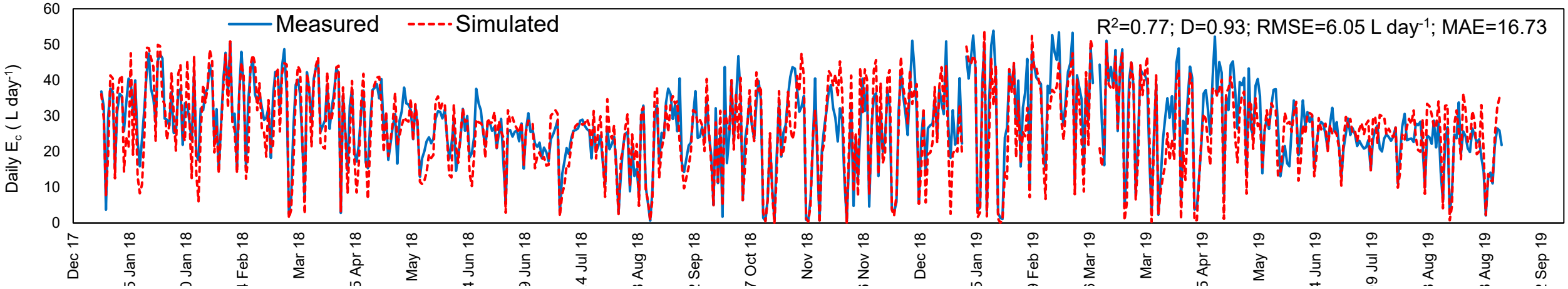
$$T = T_{max} f(S_R) f(VPD_{air}) f(T_{air})$$

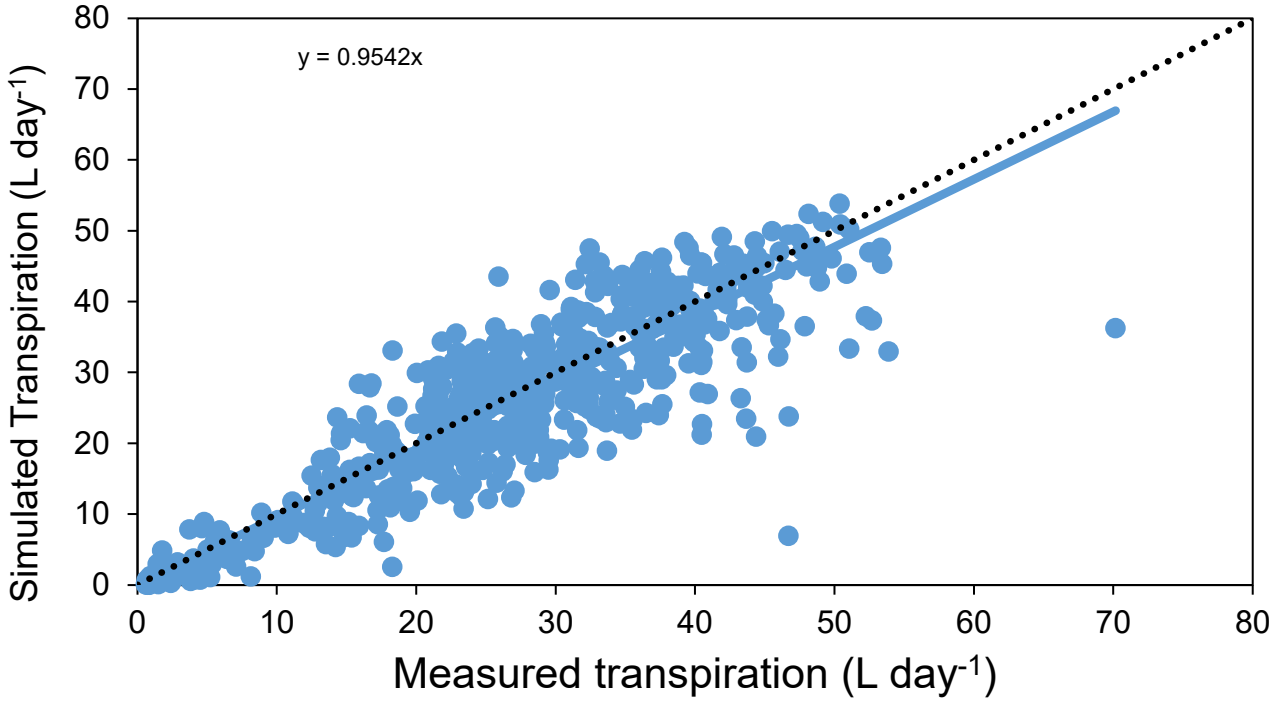
Vapour pressure deficit (how dry is the air?)

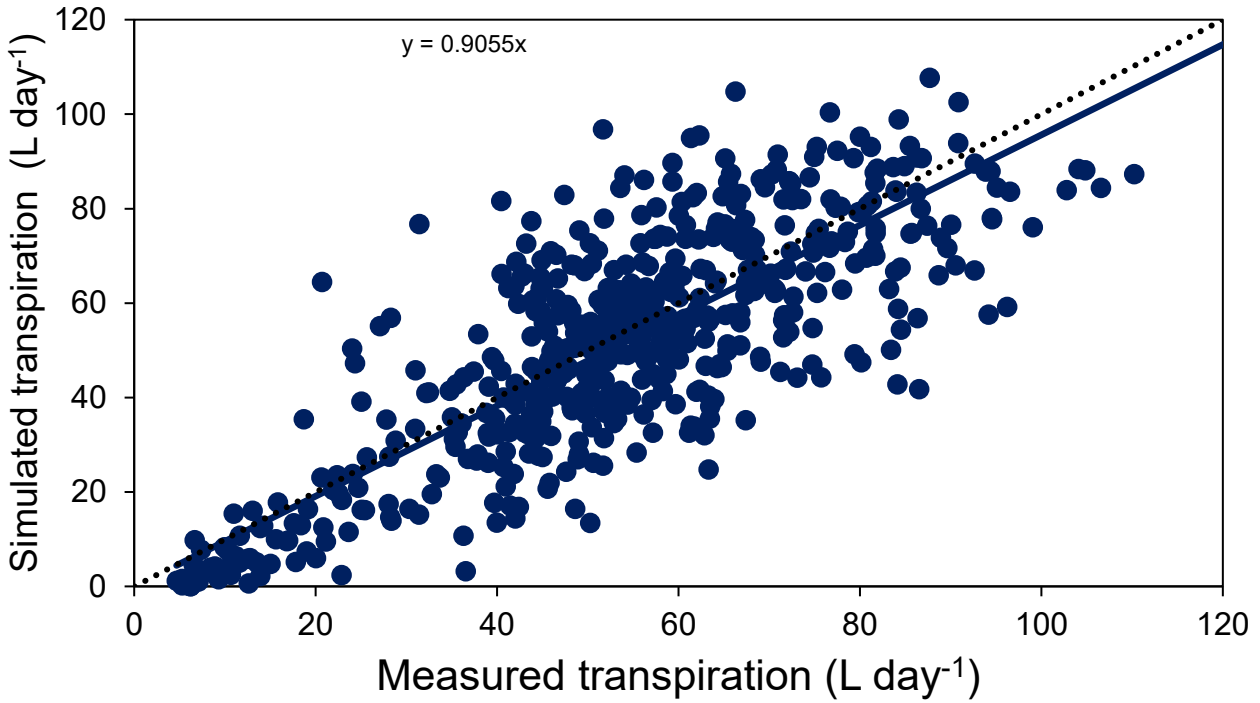


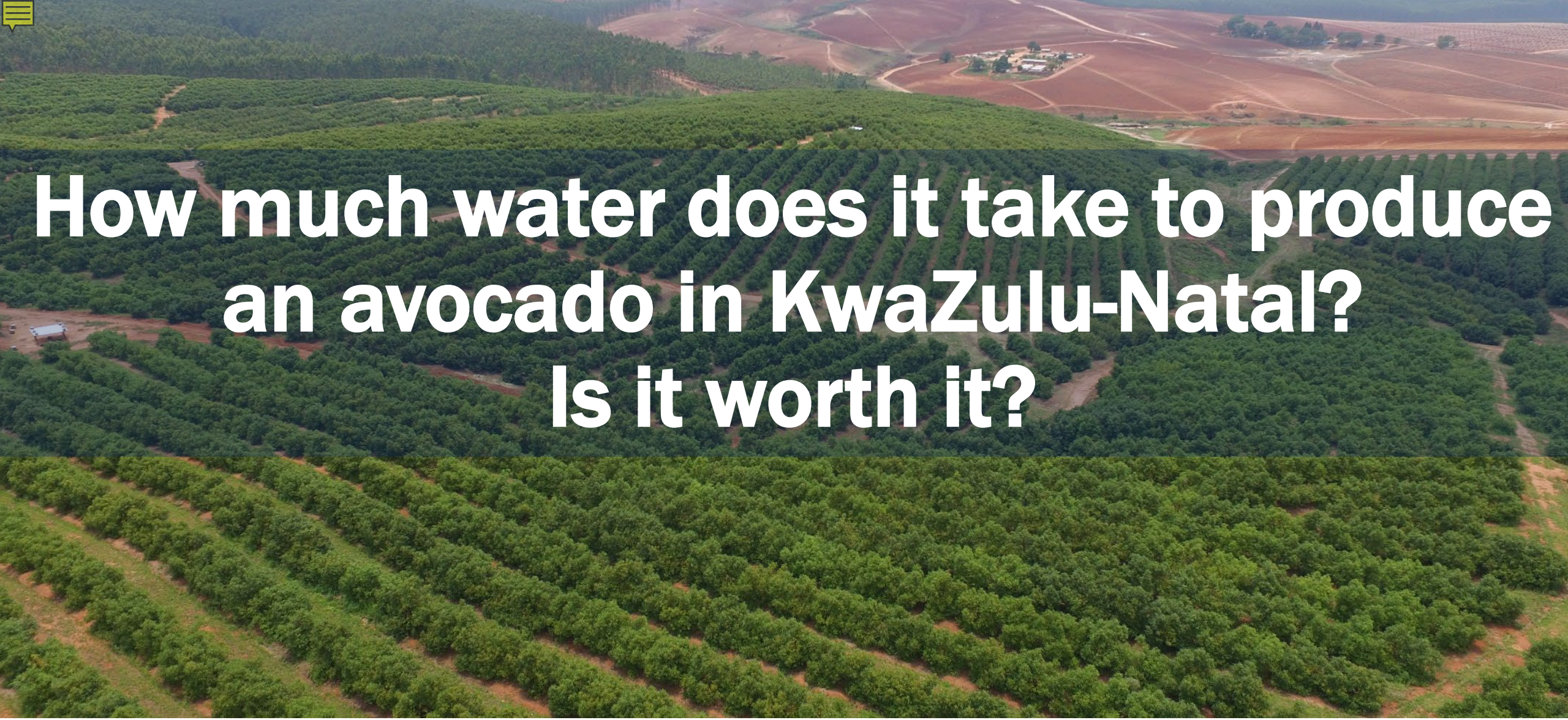
Standard automatic weather station

How well does the model work?









How much water does it take to produce an avocado in KwaZulu-Natal? Is it worth it?

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Plant Water & Nutrition

What is the value of the water?

* Annual ET from Sept to Sept

Mature orchard	2017/18	2018/19
Yield (kg ha^{-1})	12 442	12 085
Expected income (R ha^{-1})	246 139	308 846
ET_{ANNUAL} (m^3 ha^{-1})	10 090*	7 520*
Water use efficiency (kg m^{-3})	1.23	1.61
Water use efficiency (L kg^{-1})	716	625
Water use productivity (R m^{-3})	24.39	50.64

Do avocados use a lot of water?

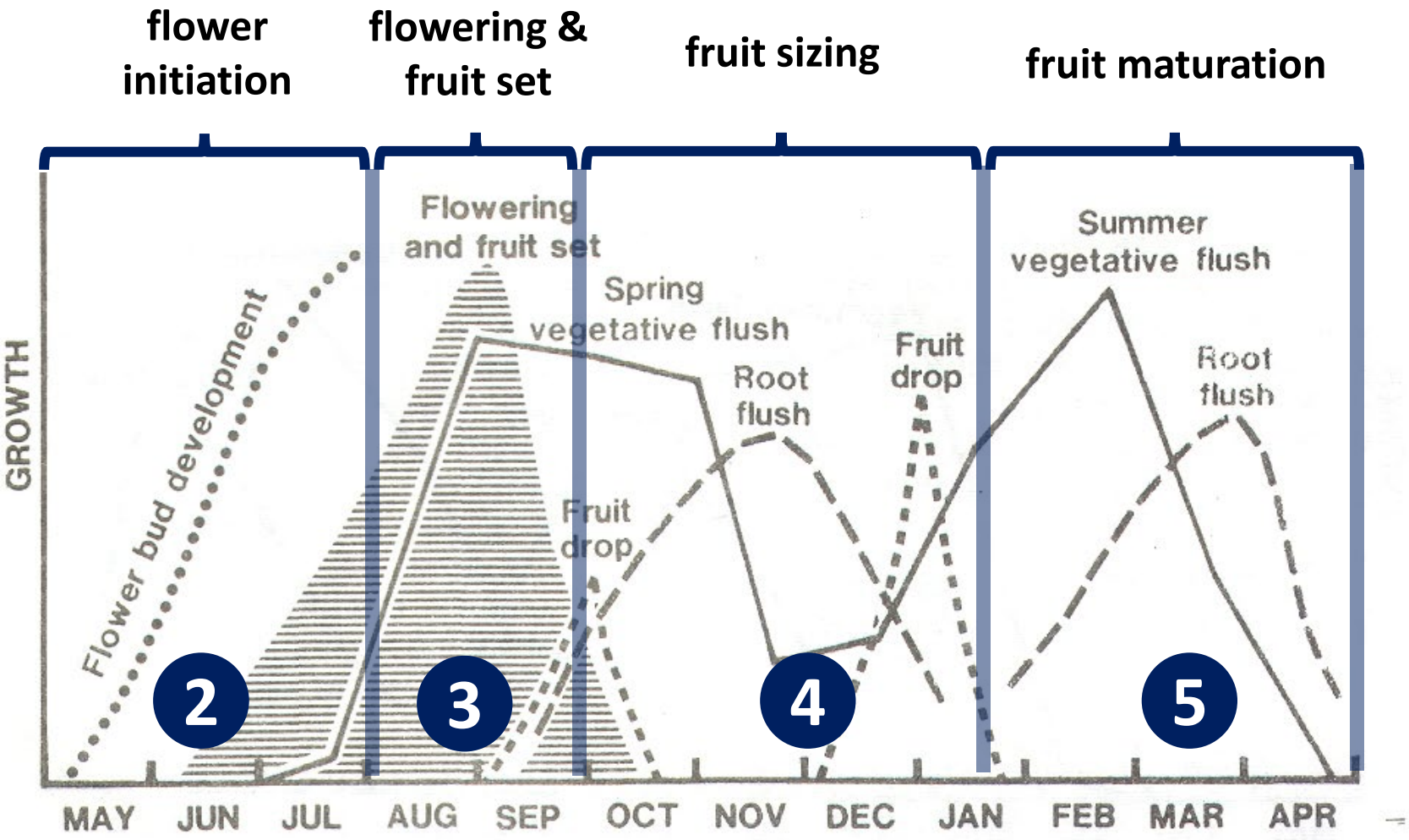
- Through better estimates of water use growers can design appropriate irrigation systems and schedule irrigation more judiciously
- By understanding the partitioning of ET into T and E_s it is possible to make water savings by reducing non-beneficial consumptive water use
- Under conditions in the study, avocado orchards do not use more water relative to many other fruit tree crops
- Yields are, however, lower than other crops
- Considering an average fruit mass of 250 g, then it takes approx. 150 - 200 L to produce a single avocado or 625 to 715 L for a kg of avocado

What happens when not enough water is available?

When was stress imposed?

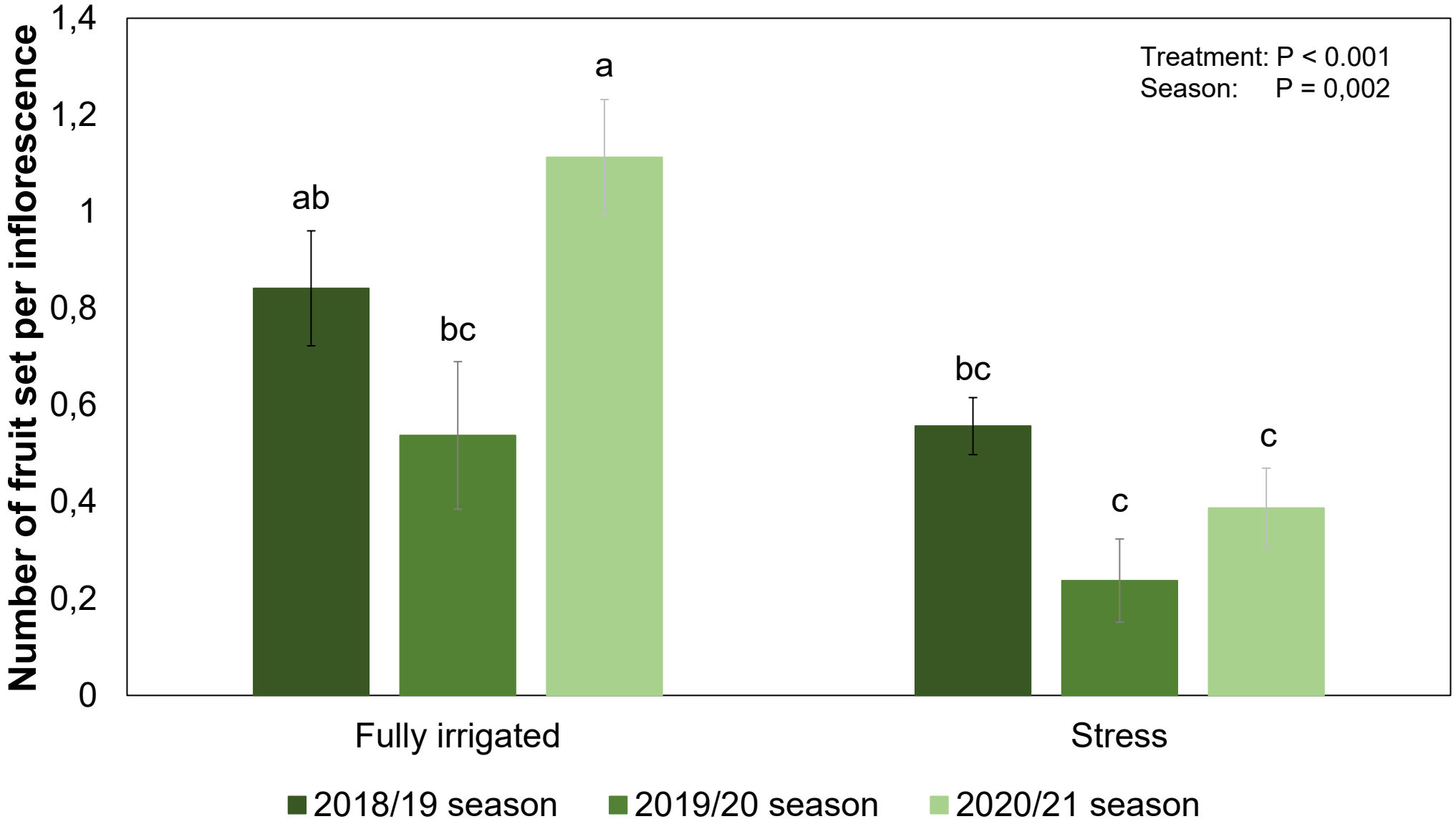
1

Well-watered control

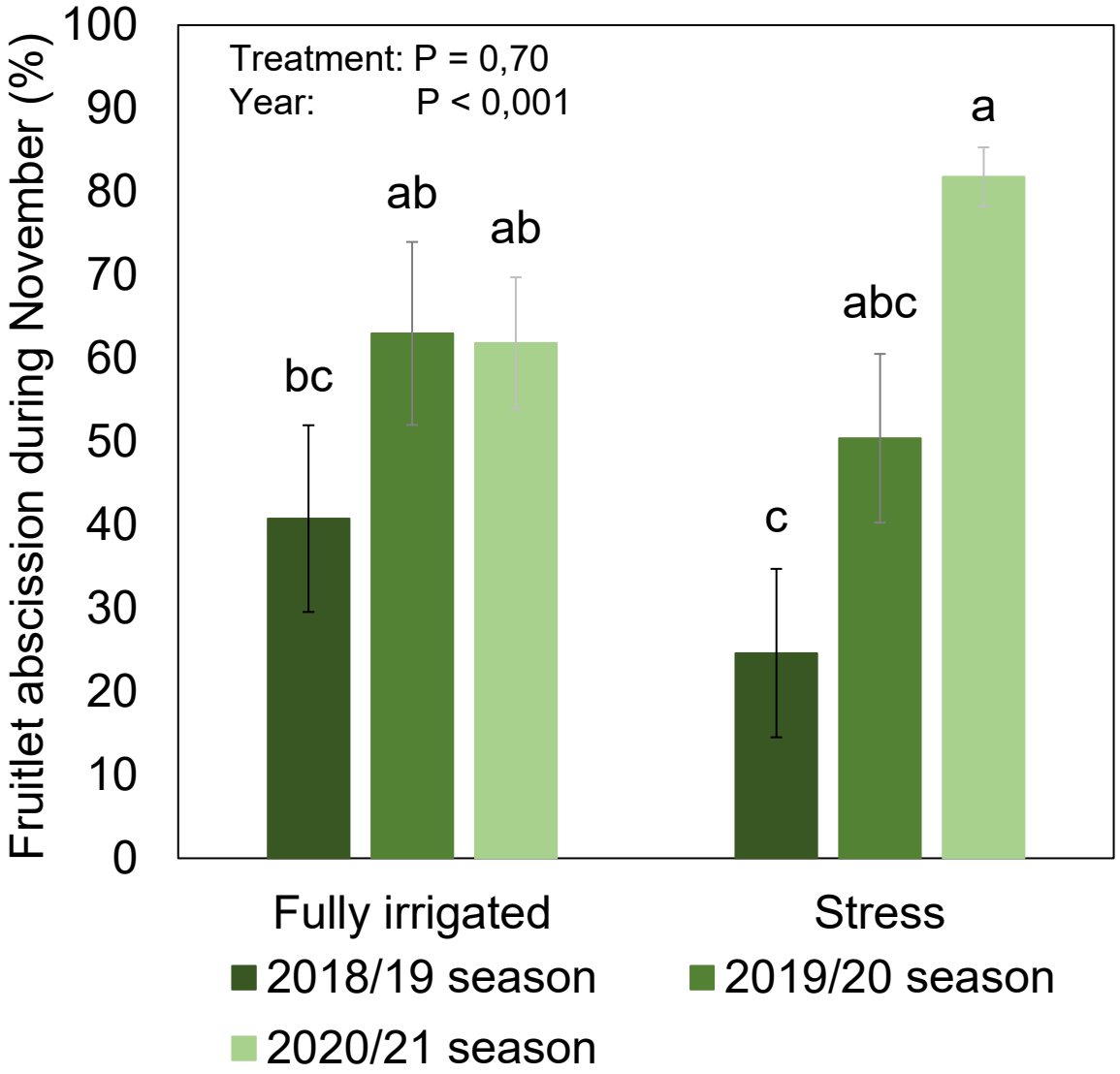


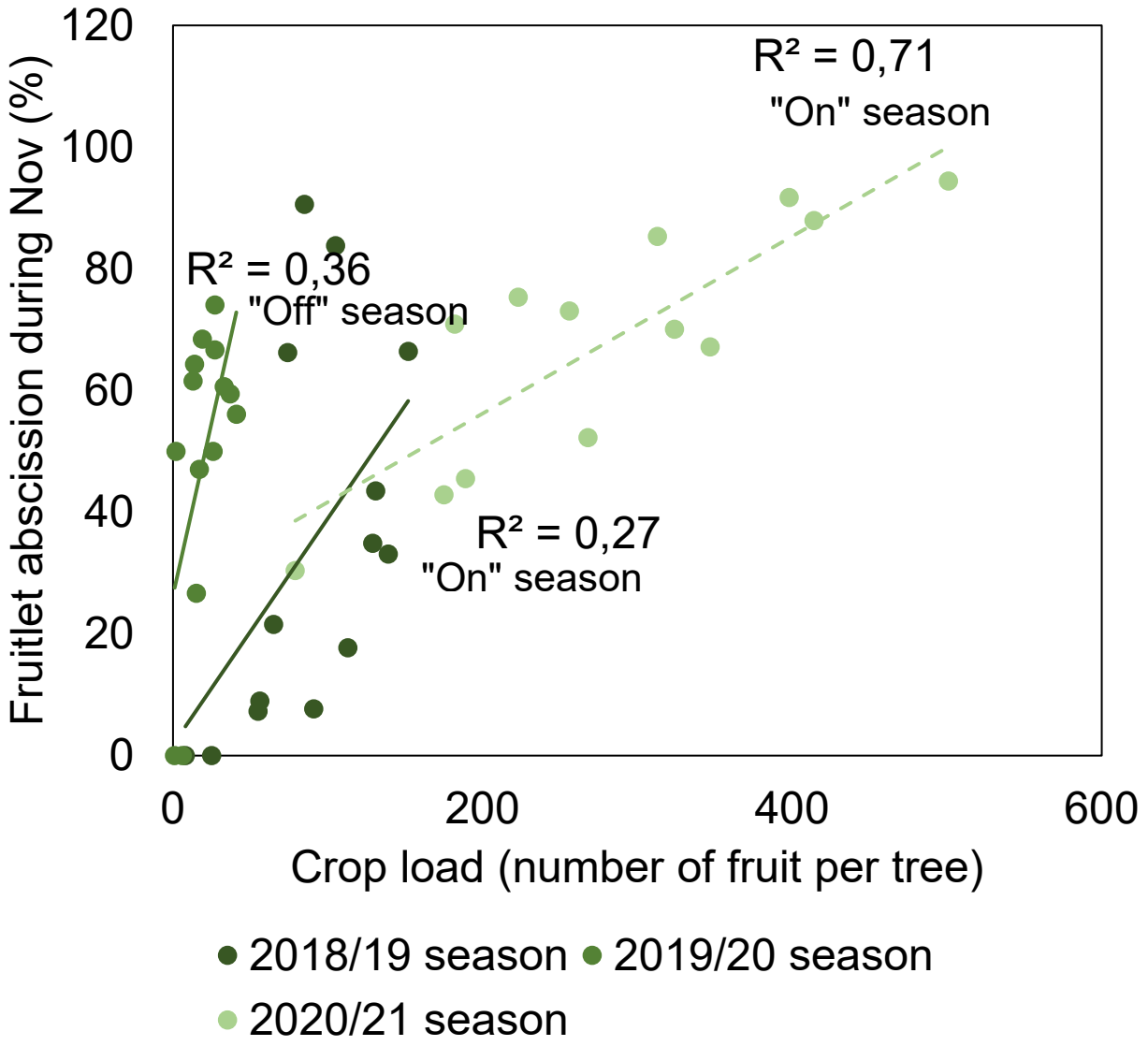
Data from the 2018/2019 and 2019/2020 seasons

Impact on fruit set?

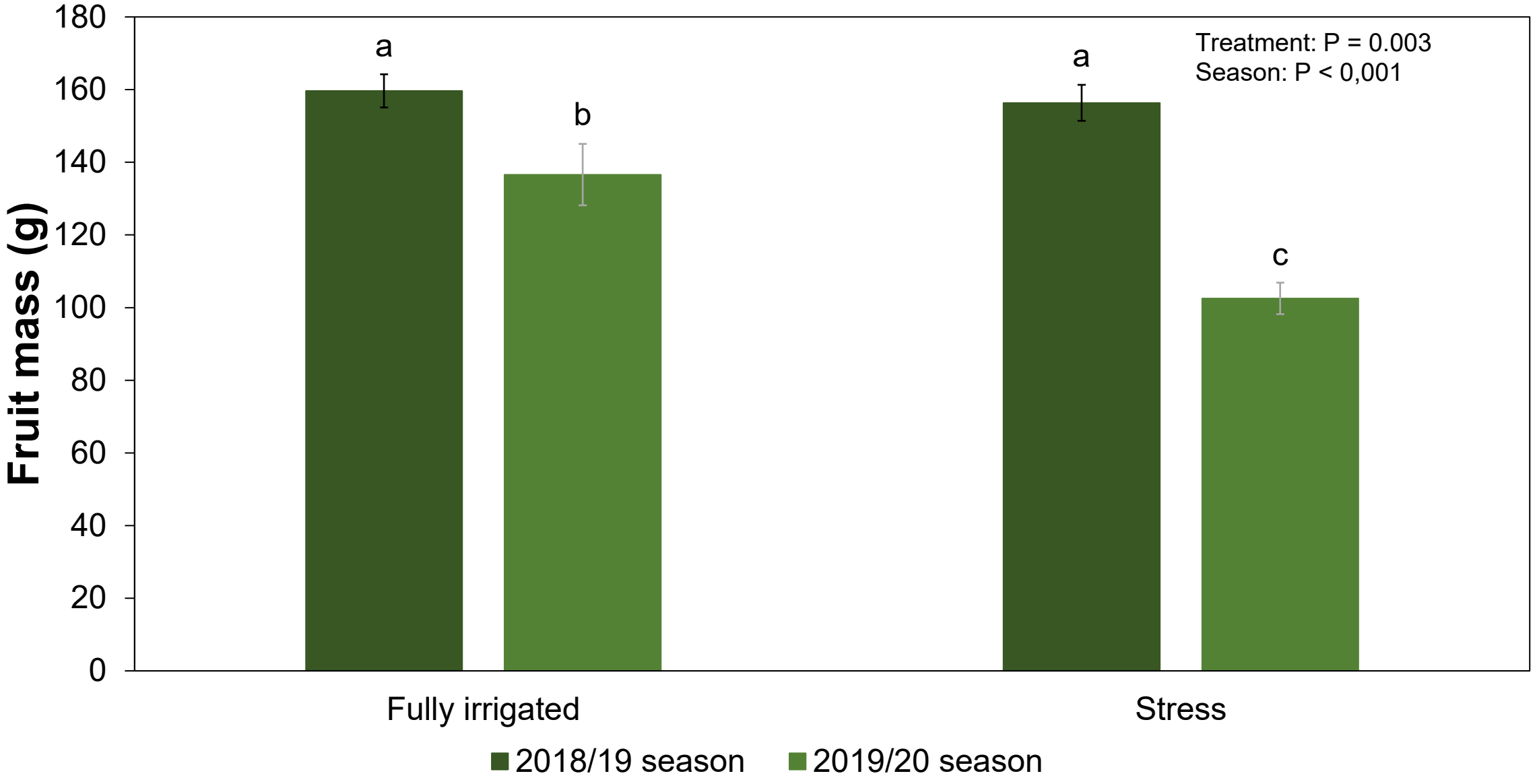


Impact on fruit drop?

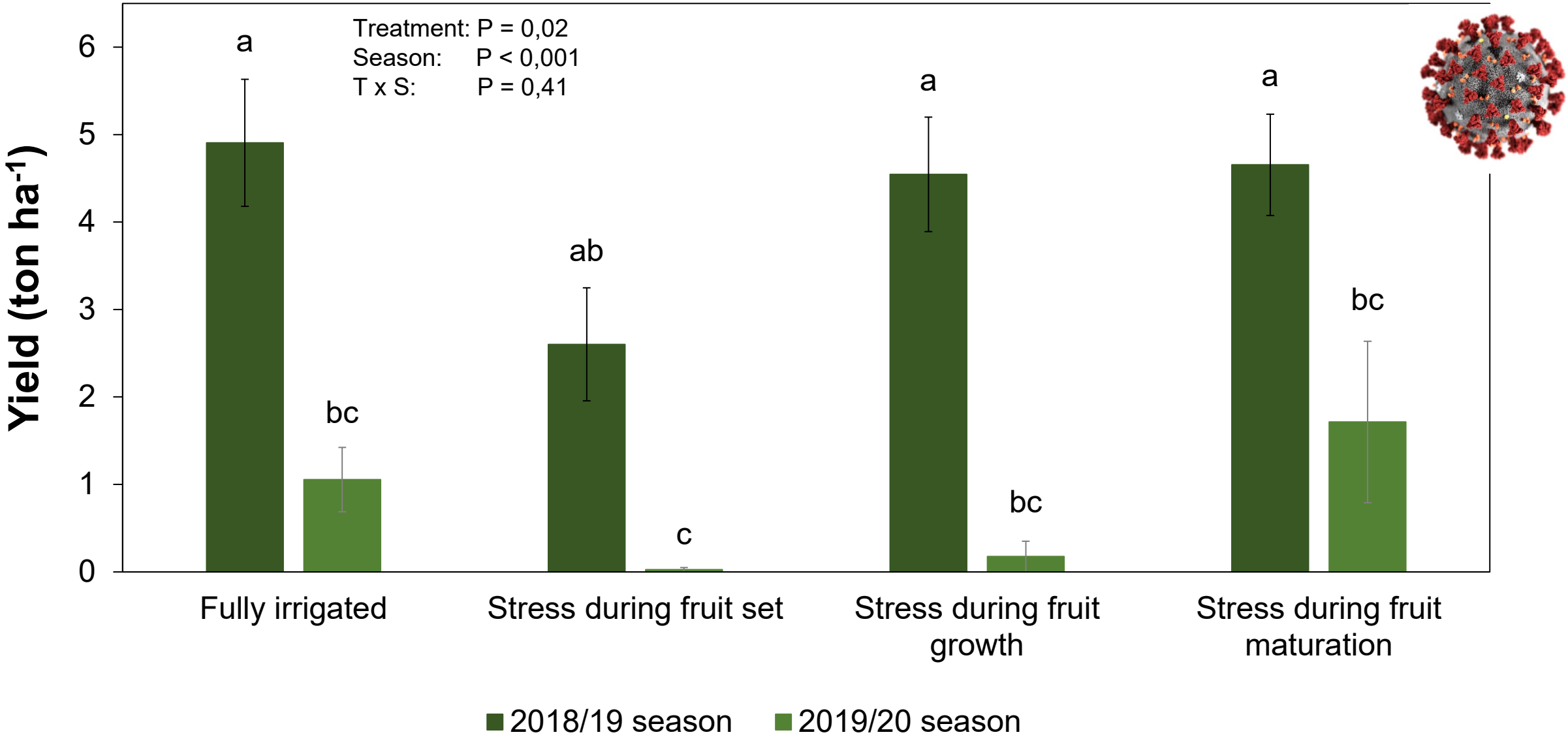




Effect on fruit size?



Impact on yield?



Water stress and avocados?

- Avocado trees, and therefore yields, are sensitive to moderate and relatively short periods of water deficits
- Stress during times of low rainfall seemed to be particularly harmful to final yield and this typically occurs during the fruit set stage – up to 50% fruit drop
- The probability for water stress during fruit growth is low in years with "normal" rainfall, but apply irrigation strategically during dry, as fruit growth can decline during these periods
- Water stress during fruit maturation can impact physiological disorders

ACKNOWLEDGEMENTS

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- SAAGA
- Members of the WRC reference group
- Growers – Juan Pienaar Avo Valley, Westfalia fruit (Westfalia Estates and Everdon Estates – Cecil Hackney, Bongeka Ndlovu, Zelda van Rooyen)
- Postgraduate students