How did a DANA event affect water status and thermal response of fruit crops?

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Introduction

- Extreme events associated with climate change are now being experienced with greater frequency and intensity worldwide, especially in the countries of the Mediterranean basin.
- The DANA phenomenon (Spanish acronym for *Depression Aislada en Niveles Altos*, meaning upper-level isolated atmospheric depression) occurs normally in autumn due to convective storms generated by the cold air in the upper layers of the atmosphere combined with warm winds coming from the Mediterranean Sea. Its effects are devastating, provoking flash-flooding and run-off with a huge capacity for soil erosion.
- This work aimed to assess the effects of the DANA event occurred on 12-13th September 2019 in Murcia (SE, Spain) on plant water status and thermal response of nectarine trees.

Material & Methods

EXPERIMENTAL SITE

YEAR: 2019 (day of the year, DOY: 158-329)
LOCATION: Murcia (SE, Spain)
CULTIVAR: 9-year old nectarine trees cv. Flariba
ROOTSTOCK: GxN-15
SPACING: 6 m x 3.5 m
IRRIGATION: 1 line x 4 emitters (4 L h^{-1}) per tree
SOIL TEXTURE: Clay-loam
FIELD CAPACITY (FC): 29%
DANA EVENT: 12-13th September (DOY 255-256)

Fig. 1. Effects of flooding two days after DANA event.

IRRIGATION TREATMENTS

- **CTL (well-irrigated): 100% ET_c**

$$ET_c = ET_0 \times Kc$$

ET_0: FAO-56 (Allen et al. 1998)
Kc: Abrisqueta et al. (2013)

- **DRY (non-irrigated)**

MEASUREMENTS

Θ_v Ψ_{stem} P_n, g_s T_c

ET_0, T_a, R_s, VPD: automated weather station

Telemetry system: AddVANTAGE

$$T_c - T_a \;;\; CWSI = \frac{(T_c - T_a) - (T_c - T_a)LL}{(T_c - T_a)UL - (T_c - T_a)LL}$$

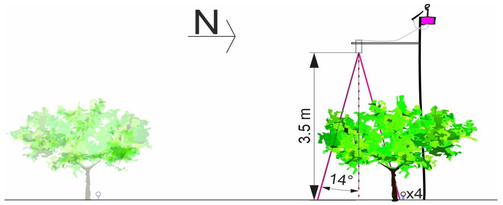

Fig. 2. Canopy infrared radiometer sensor placement.

Results

- **DANA event (470.4 mm) forced the disconnection of capacitance probes (Fig. 1), and made it impossible to measure plant water relations from DOY 255 to 275. Only infrared sensors and the weather station worked during that time.**
- **Irrigation in the CTL treatment was reestablished 20 days after DANA event.**

Table 1. Soil-plant-atmosphere water status data before (PRE) and after (POST) DANA event.

	(DOY 158-254)			(DOY 256-329)		
Climatic	**PREDANA**			**POSTDANA**		
Rainfall (mm)	12.2			519 (DANA: 470.4)		
Rs (W m^{-2})	397.9			243.9		
ET_0 (mm)	4.6			2.9		
T_a (ºC)	26.4			18.2		
VPD (kPa)	2.4			1.1		
Soil	**CTL**	**DRY**	**P**	**CTL**	**DRY**	**P**
Θ_v 0-0.5 m (%)	29.6	13.7	***	30	24.2	ns
Plant						
Ψ_{stem} (MPa)	-0.84	-2.08	***	-0.70	-0.82	ns
P_n (µmol m^{-2} s^{-1})	17.5	12.6	***	12.5	13.2	ns
g_s (mmol m^{-2} s^{-1})	306.7	175.5	***	163.4	140.1	ns
T_c (ºC)	38.6	44.1	***	27.2	26.9	*

*P: p-value: ***: p<0.001; *: p<0.05; ns: not significant*

- **BEFORE DANA: Significant differences in soil-plant water indicators between CTL and DRY treatments (Table 1, Fig. 3).**
- **AFTER DANA: Only significant differences in thermal-based indicators (Table 1, Fig. 3).**
- **CWSI in the DRY treatment was maximum (0.94) at DOY 232 (Fig. 3).**

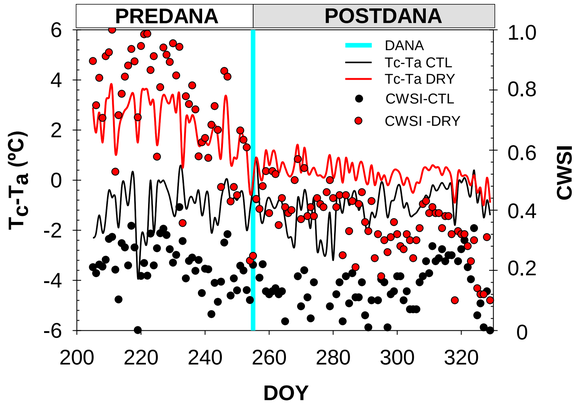

Fig. 3. T_c-T_a and CWSI values in the CTL and DRY treatments.

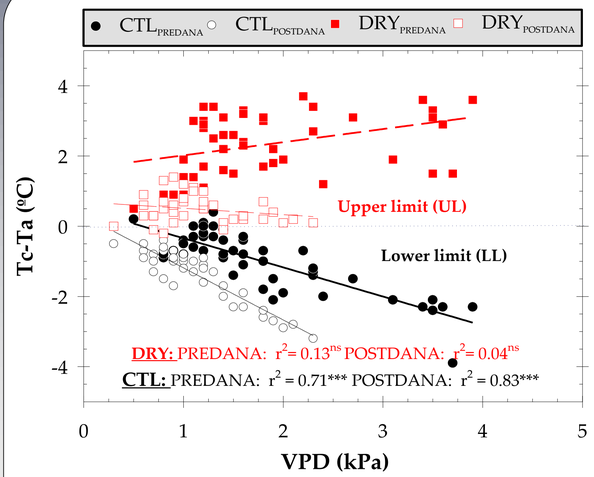

*Fig. 4. Relationship between T_c-T_a and VPD for CTL and DRY treatments. ***: p<0.001; ns: not significant.*

- **The relation T_c-T_a *vs.* VPD improved after DANA (Fig. 4).**
- **The strong relation T_c-T_a *vs.* Ψ_{stem} worsened after DANA (r^2 = 0.81*** to 0.32*) (data not shown).**

Conclusions

- After DANA (saturated soil conditions), the thermal indicators were more reliable than Ψ_{stem} for assessing the nectarine water stress.
- The empirical calculation of the CWSI required establishing different baselines before and after the DANA event.
- This work underlined the robustness of infrared thermography to continuously monitor plant water status under this type of weather disaster.

Acknowledgements

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