



Food and Agriculture
Organization of the
United Nations

GLOBAL
SYMPOSIUM on
SOILS and **WATER**

02-05 October, 2023

Soil and water:
a source of life





Food and Agriculture
Organization of the
United Nations

Improvement of Water Use Efficiency in an irrigated peach orchard under Mediterranean climate

Dr Rossana Monica Ferrara (CREA-AA, Italy)





Food and Agriculture
Organization of the
United Nations

The context

- First results of a national Project (the PON-Water4AgriFood (PNR 2015 – 2020, Area Agrifood; progetto ARS01_00825 - DD n. 1619 del 9 agosto 2019): to improve Mediterranean agrifood production under limited water conditions
- Fruit growing is a key sector for the Mediterranean economy, representing 17% of the total EU agricultural turnover (FAO, 2018)
- Peach is among the most representative fruit species in the Mediterranean Basin
- The dry climate in southern Italy is particularly suitable for late ripening peach cultivars, but they are **more water demanding**
- Climate change and future water limitations threaten Mediterranean fruit production
- Agriculture consumes about 70% of freshwater: there is the need of improving **water saving techniques**
- Management of soil and water can improve water use efficiency through: (i) decreasing soil evaporation using mulching material; (ii) drip irrigation system provides small and frequent water applications directly in the vicinity of the plant root zone decreasing water requirement



WUEc and Irrigation WPi

- Crop water use efficiency (WUEc) (Fernández et al., 2020)

$$WUEc = \frac{\text{Transpiration (Tr)}}{\text{Precipitation (P) + Irrigation(I)}}$$

Wang et al., (2015): effects
precipitation also on mulching

- Irrigation water productivity (WP) stands for the ability of a crop system to convert the irrigation water in marketable fruits

$$WPi = \frac{\text{Yield}}{\text{Irrigation(I)}}$$



Food and Agriculture
Organization of the
United Nations

The effect of mulching and drip irrigation

Soil & Tillage Research 221 (2022) 105392



ELSEVIER

Contents lists available at [ScienceDirect](#)

Soil & Tillage Research

journal homepage: www.elsevier.com/locate/still



Effect of film mulching on crop yield and water use efficiency in drip irrigation systems: A meta-analysis

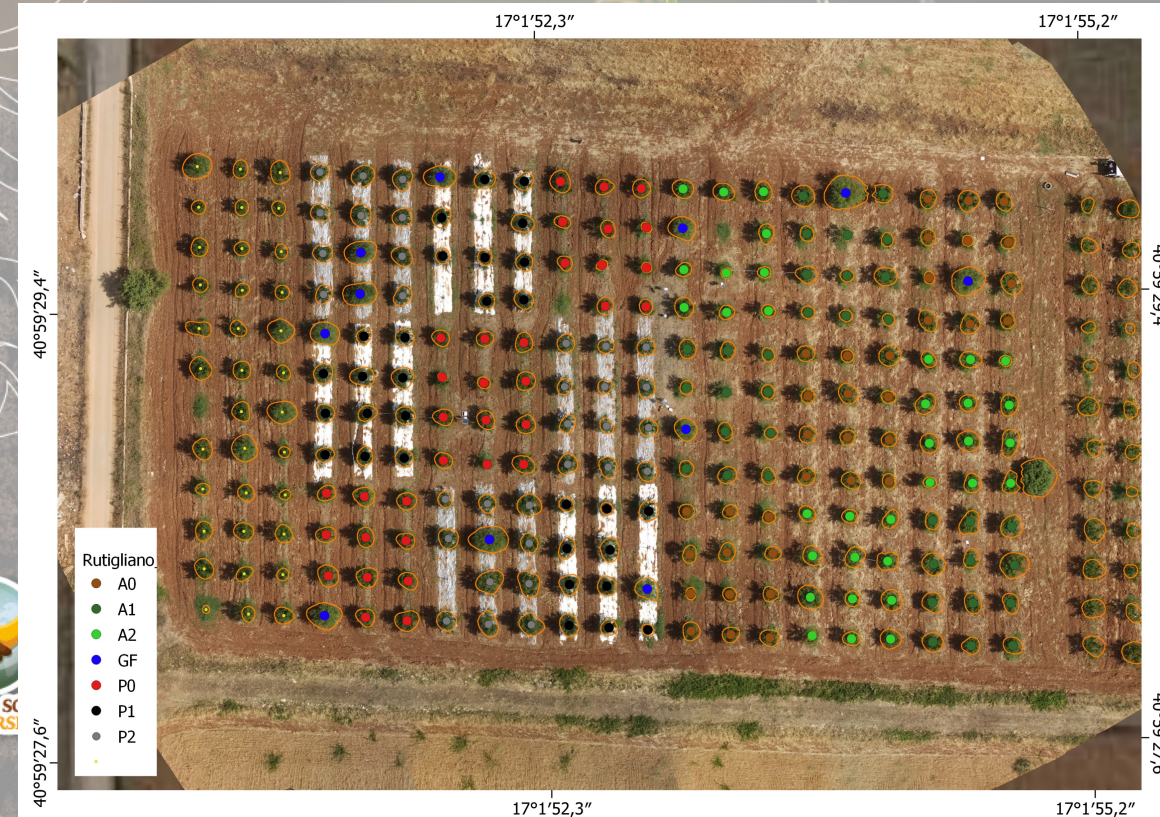
Wenqian Zhang^{a,b}, Aihong Dong^{a,b}, Fulai Liu^c, Wenquan Niu^{a,b,d,e,*},
Kadambot H.M. Siddique^f

The results showed that film-mulching drip irrigation (FMDI) increased CY and WUE by about **20% and 30%, respectively**, compared with nonmulching drip irrigation (NMDI)



The experimental site

- Experimental farm of CREA-AA - Rutigliano, Bari, 41° 01' N, 17° 01' E, altitude 147 m a.s.l.)
- Seasons 2021, 2022, 2023
- five-years old peach orchard (45 m x 60 m) of late ripening (cv. Redcall), grown in a traditional pot and grafted onto rootstock GF677, spaced 5.0 m × 5.0 m
- Drip irrigation (two 16 Lh⁻¹ drippers per tree)
- Full irrigation 100% ET_c, where ET_c = K_c × ET_o (FAO56, Allen et al., 1998)
 - 2021 → 117 mm
 - 2022 → 136 mm
 - 2023 → 113 mm





Food and Agriculture
Organization of the
United Nations

The trial – experimental design

- Randomized complete block design with three replicates for testing two different plastic mulching (PolyEur srl, Benevento, Italy) applied in May 2021:
 - P1: C/902 Black White Orchard → “white”, PAR diffusivity 75%, measured reflectance 38%);
 - P2: C/820 Black Silver Orchard → “silver”, PAR diffusivity 28%, measured reflectance 26%;
 - P0: no mulching - control



The trial – measurements of Transpiration

- TDM - (Granier, 1985, 1987) → sap flow velocity (J_{s0} , gm-2s-1)
- data were acquired continuously and stored as average at 15 minutes intervals → hourly data
- May – September each season
- 3 representative plants per treatment
- TDP30 sensor - FLGS-TDP Model XM1000 sap velocity system (DYNAMAX Inc, Houston TX 77099 USA) with CR1000X data logger (Campbell Scientific, Utah, USA)



Night-time

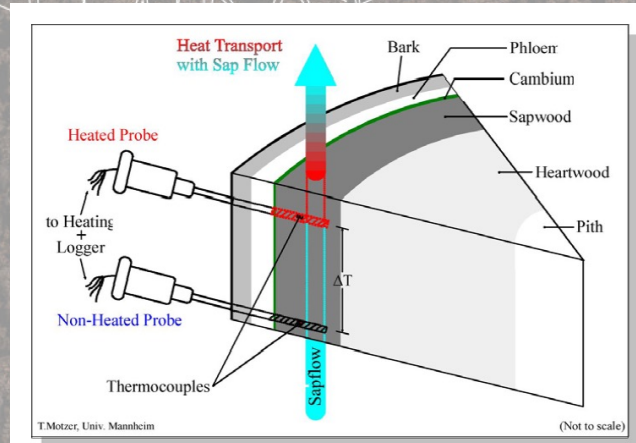
$$J_{s0} = a \left(\frac{\Delta T_{max} - \Delta T}{\Delta T} \right)^b$$

$$Tr = SWA \times J_{s0}$$

a=118.99
b=1.231



a=101.8
b=1.0815

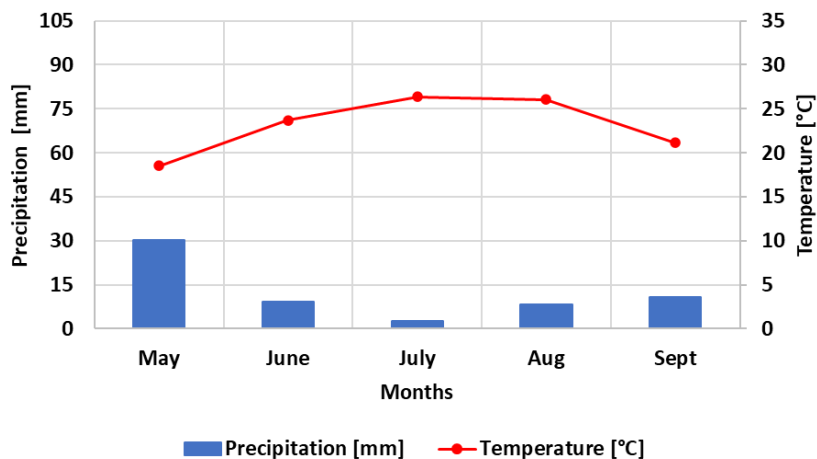


Results: Meteo

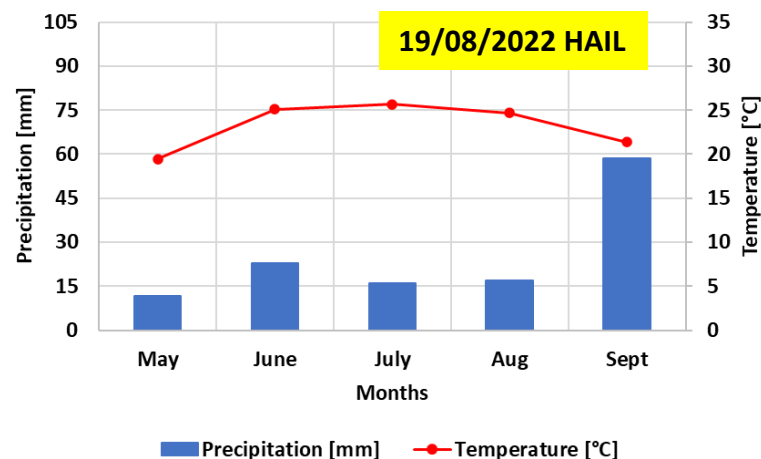


Food and Agriculture Organization of the United Nations

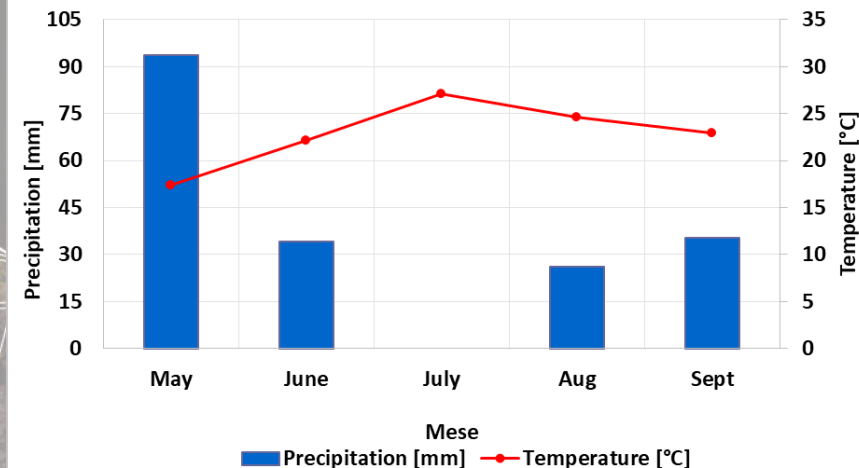
2021



2022



2023



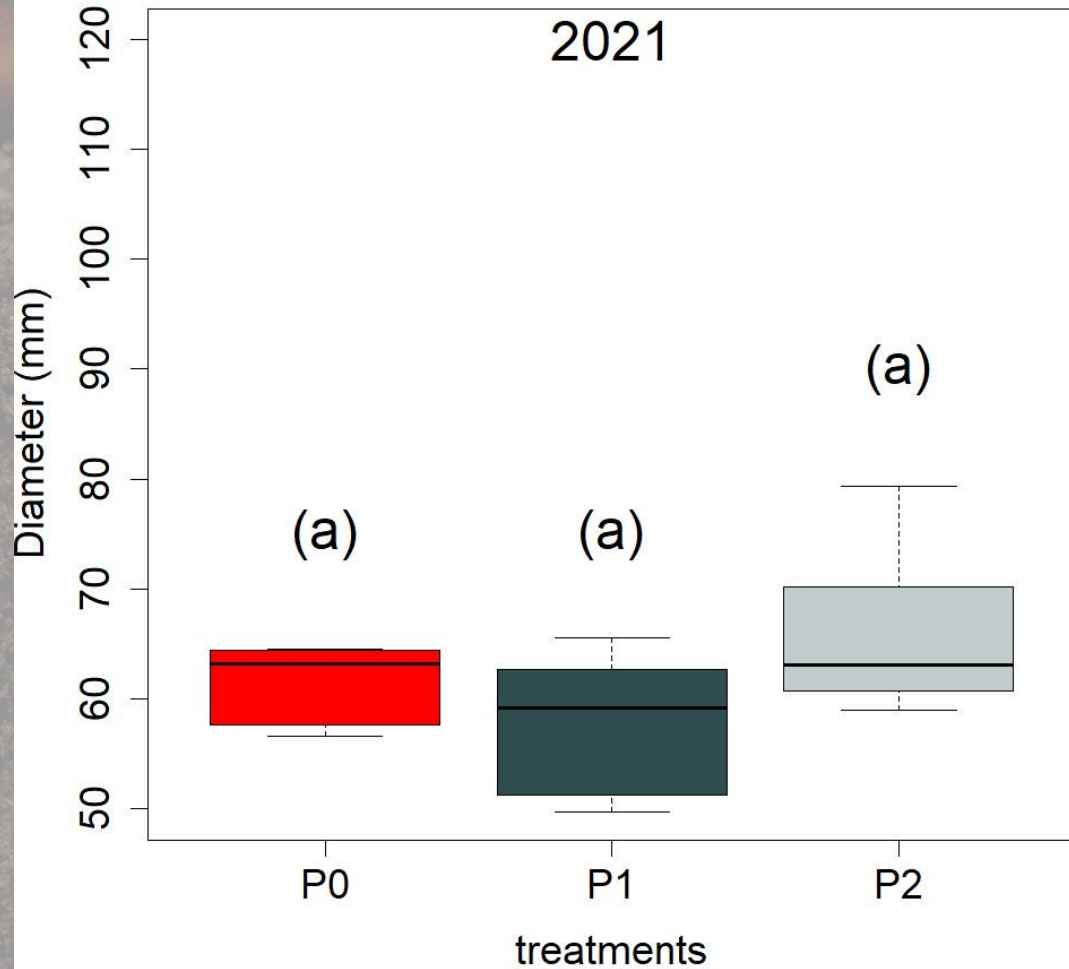
Season (May-harvest in Sept)	Rain (mm)	Irrigation (mm)	Irr+Rain (mm)
13/05-07/09/2021	53.1	116.5	169.6
01/05-06/06/2022	91.4	117.1	208.5
01/05-04/09/2023	153.8	102.9	256.7

$$WUEc = \frac{Tr}{P + I}$$

$$Tr = \text{SWA} \times J_{s0}$$

Results: Tree development

25/02/2021

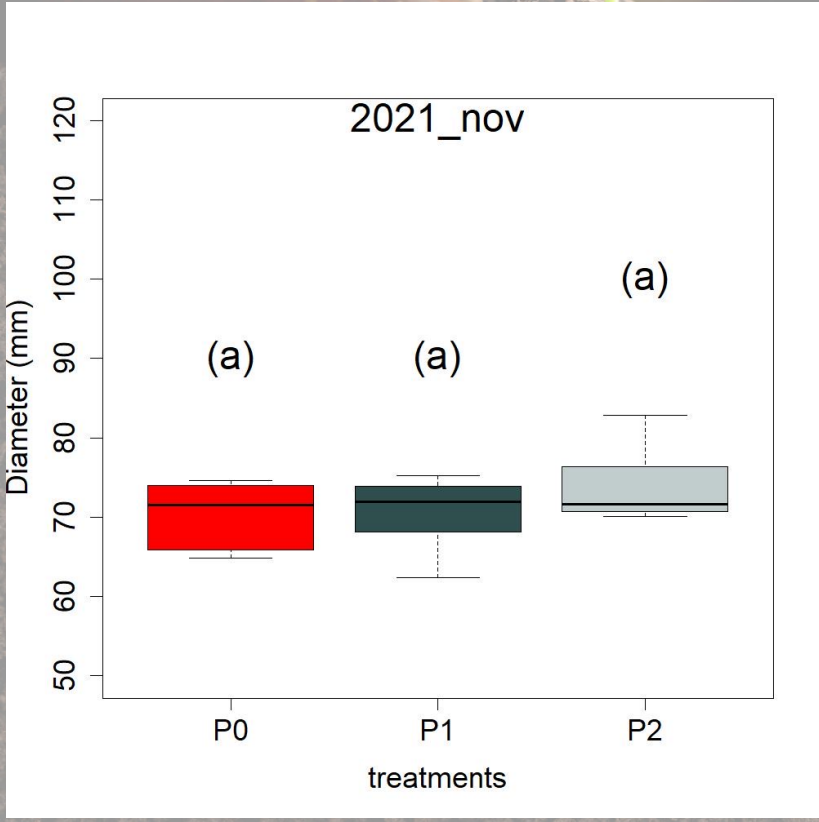
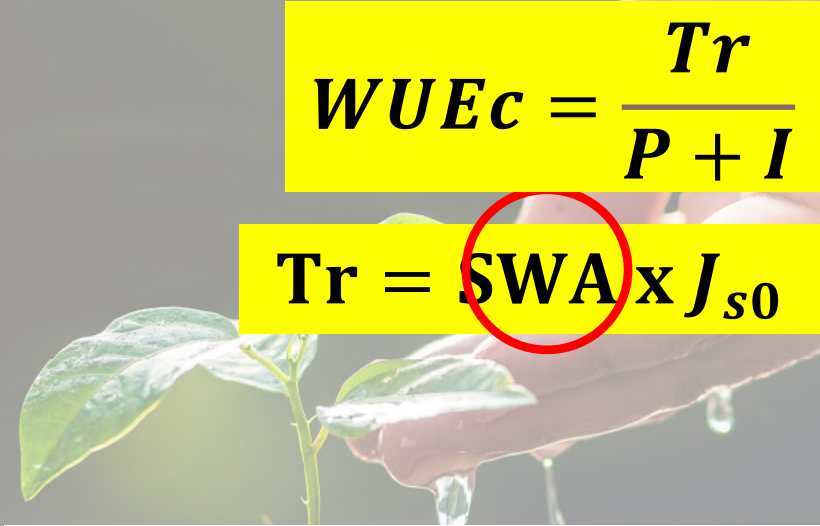


$$WUEc = \frac{Tr}{P + I}$$

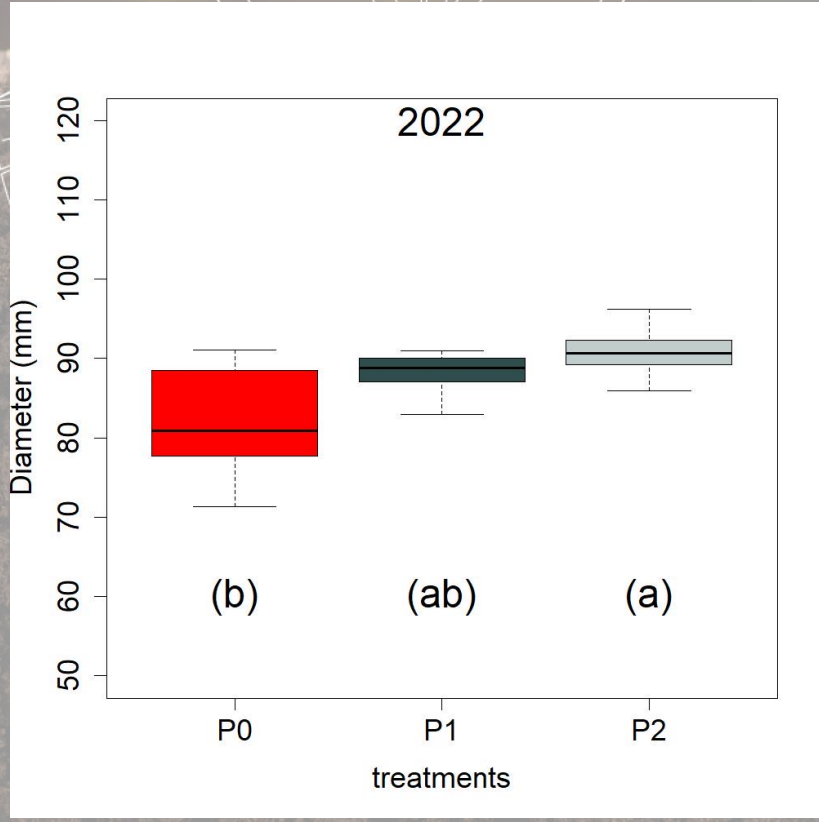
$$Tr = SWA \times J_{s0}$$



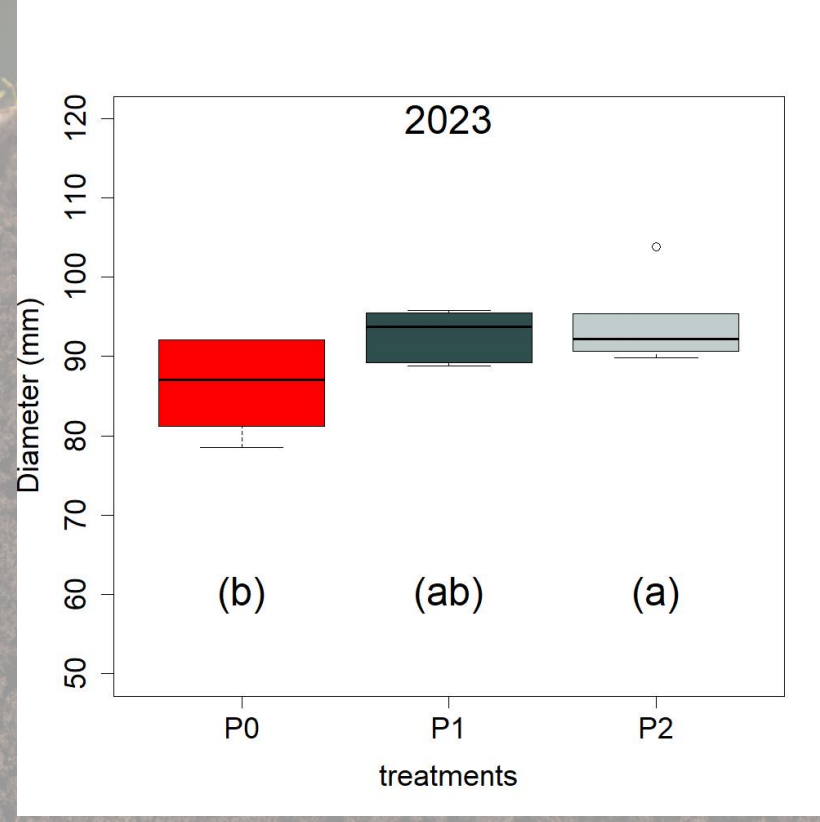
Results: Tree development



26/11/2021



06/12/2022

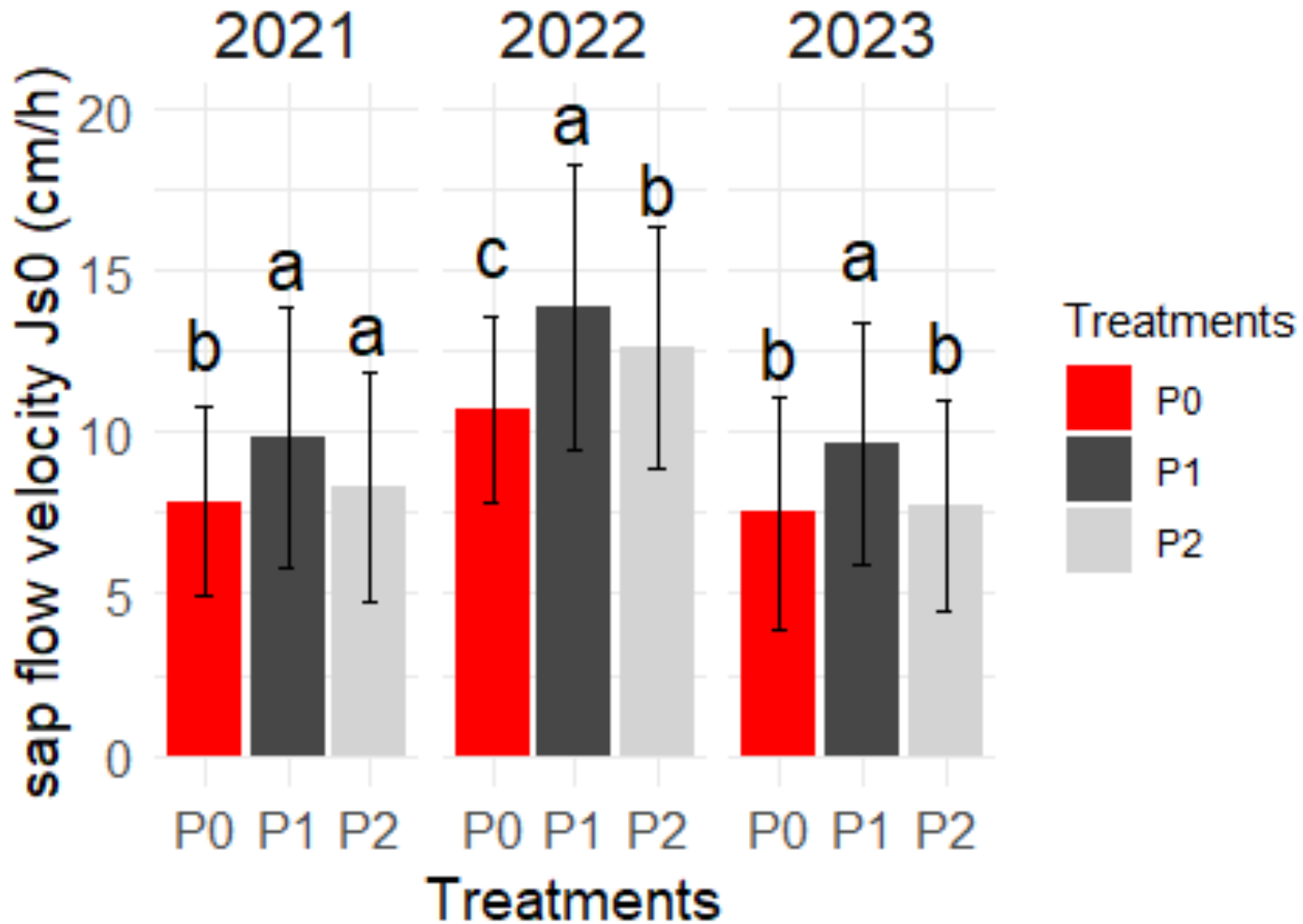


05/09/2023

Results: Sap flow velocity

$$WUEc = \frac{Tr}{P + I}$$

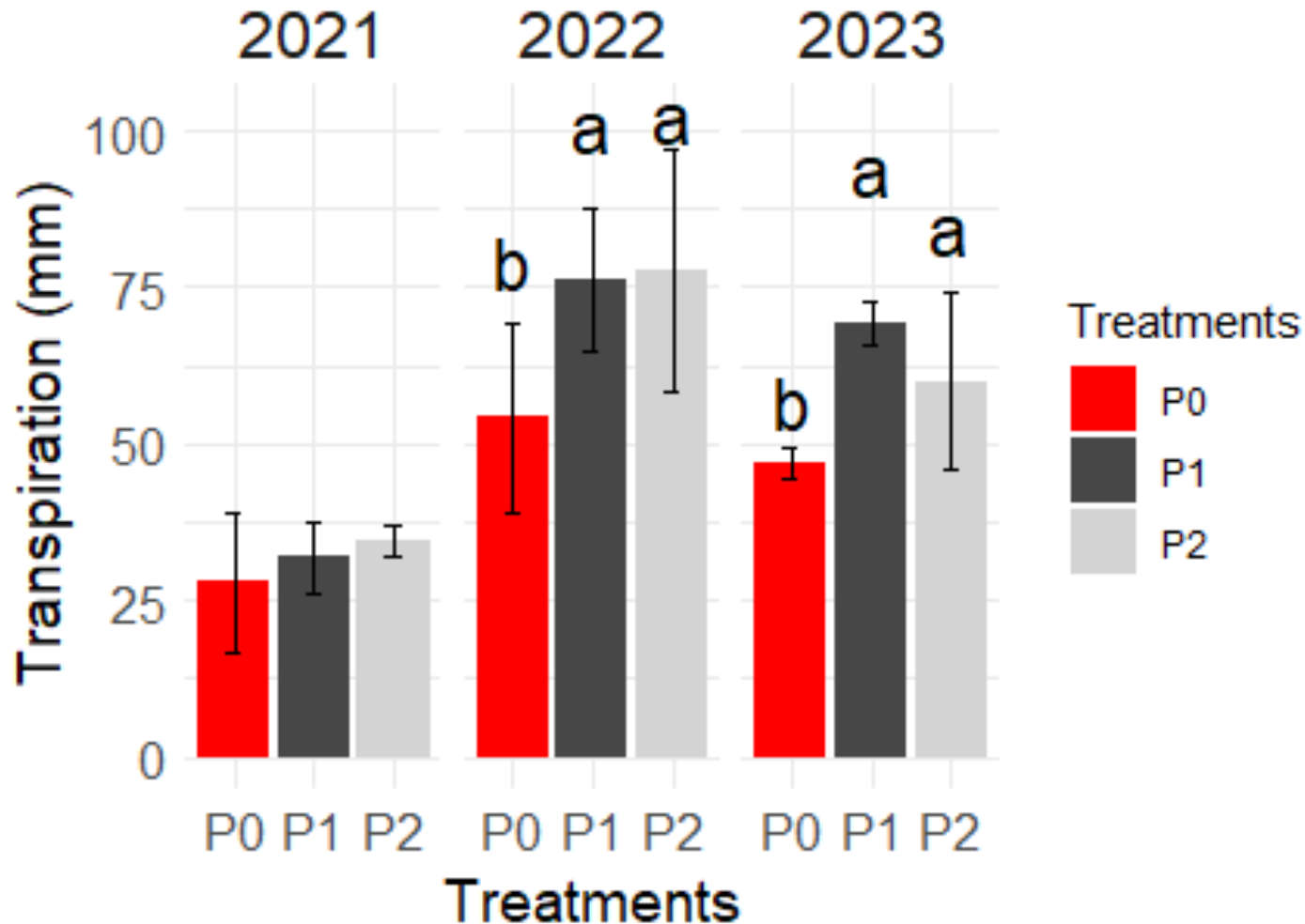
$$Tr = SWA \times J_{s0}$$



Results: Transpiration

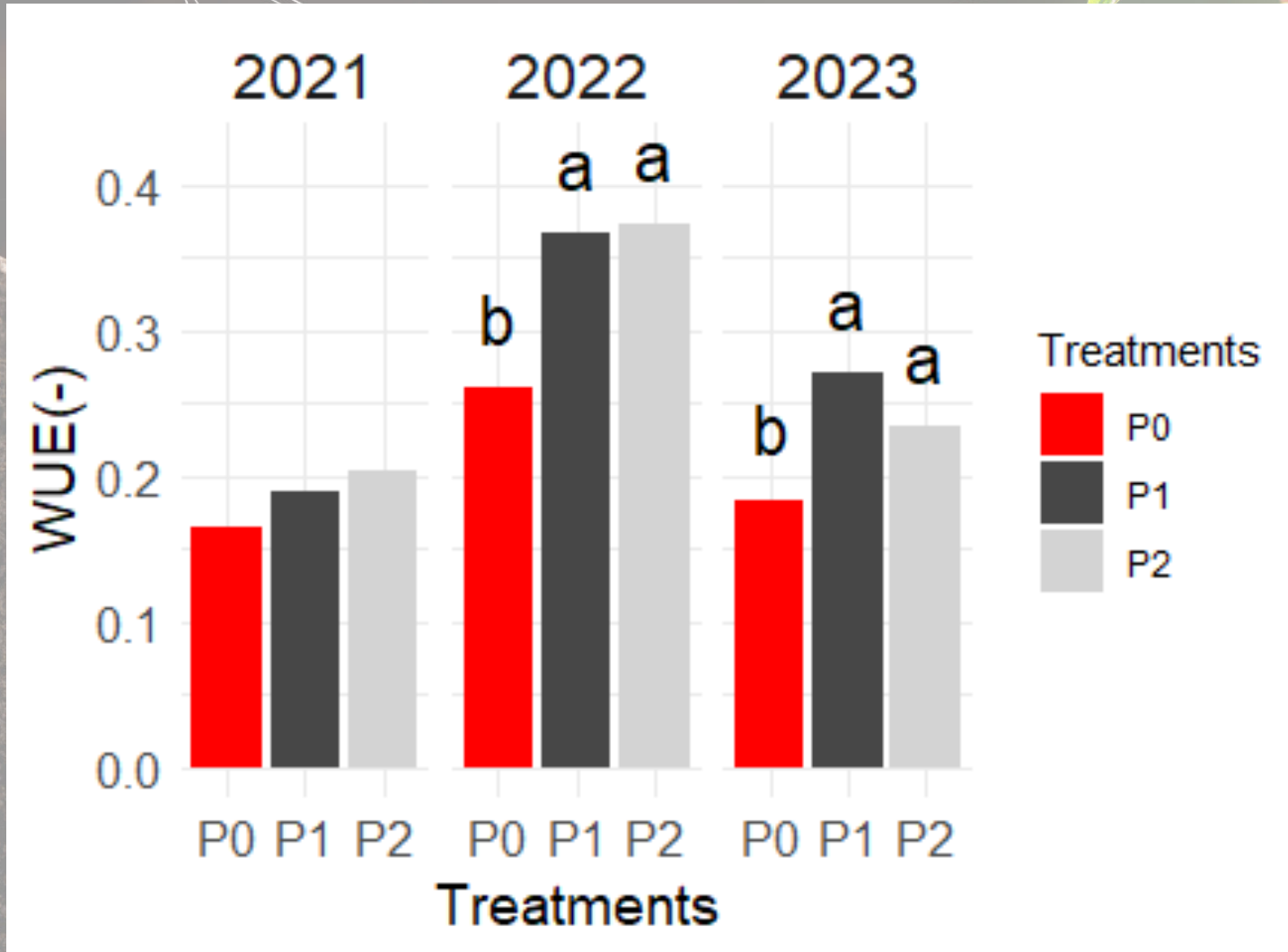
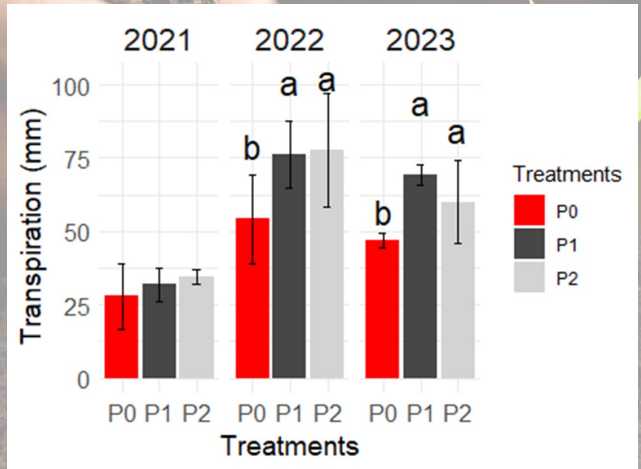
$$WUEc = \frac{Tr}{P + I}$$

$$Tr = SWA \times J_{s0}$$



$$WUEc = \frac{Tr}{P + I}$$

Results: WUEc

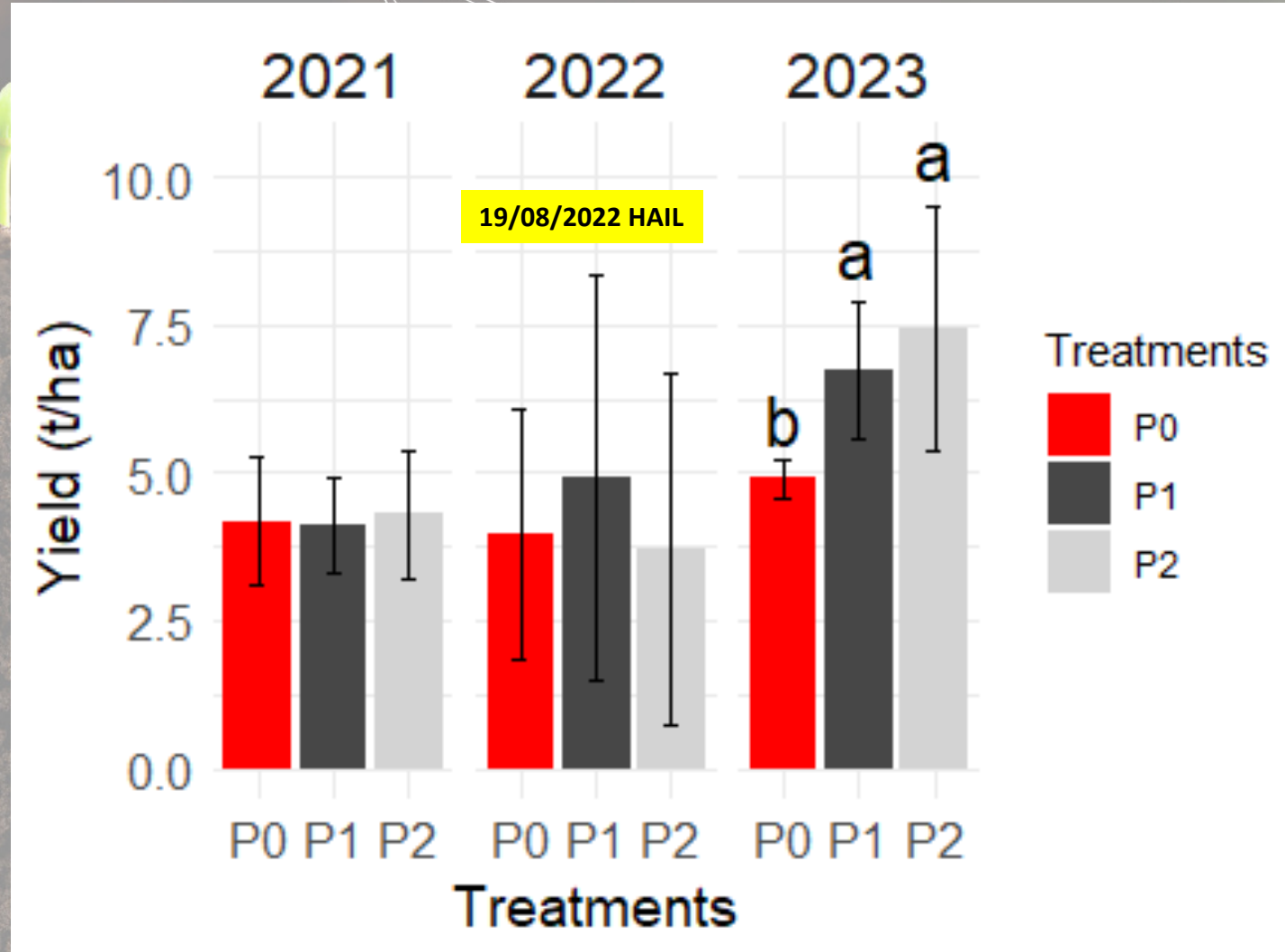


Results: Yield



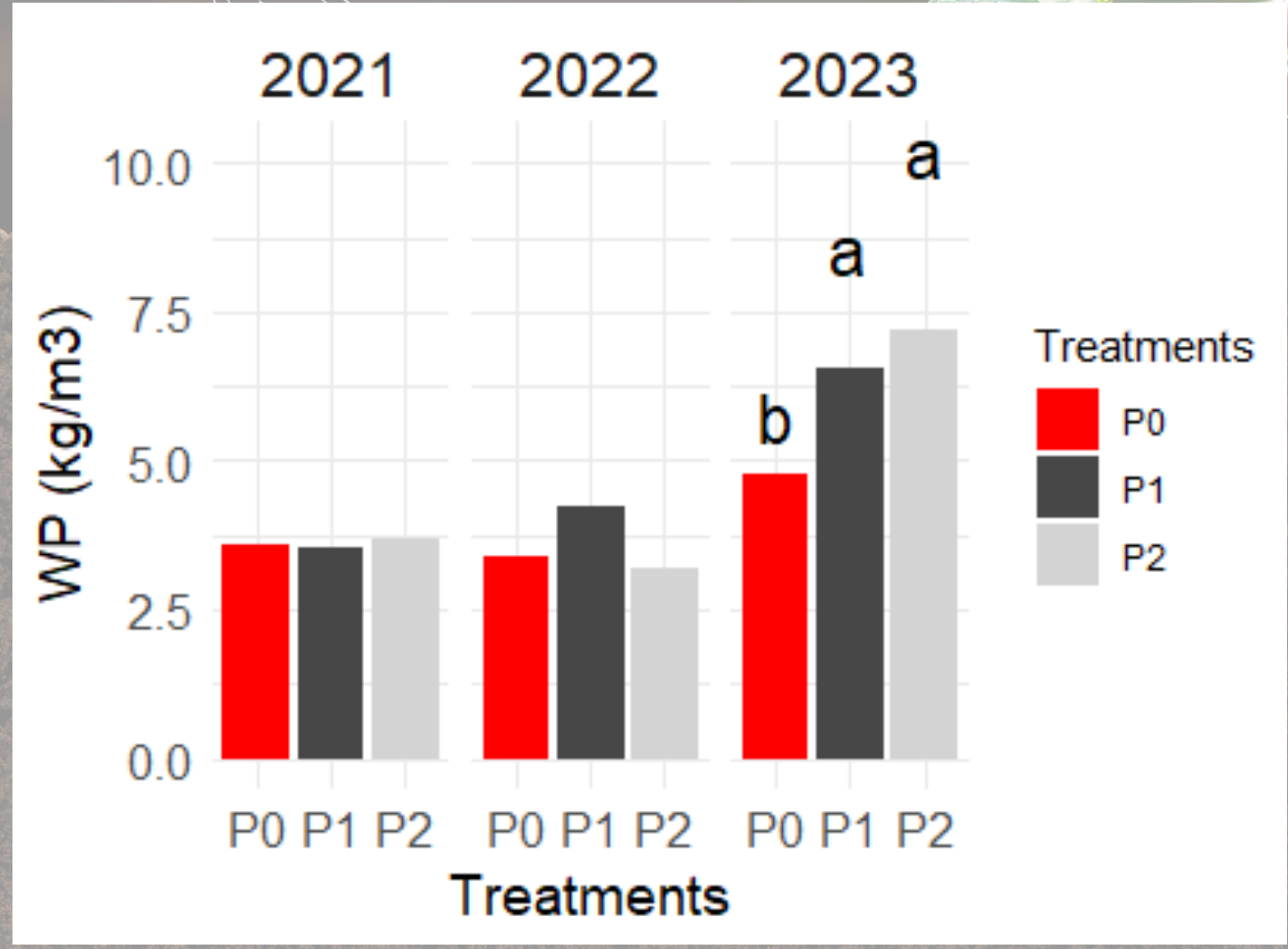
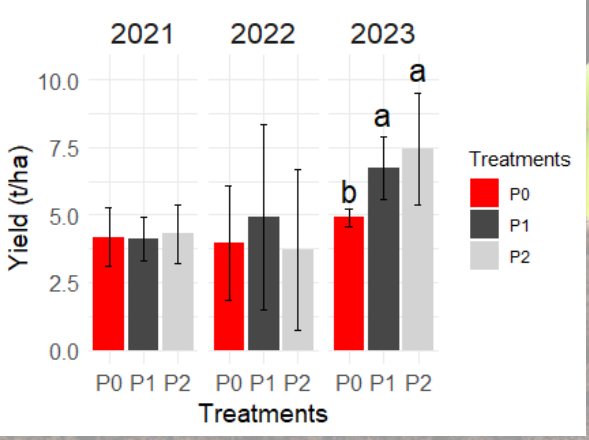
Food and Agriculture
Organization of the
United Nations

$$WPI = \frac{\text{yield}}{I}$$

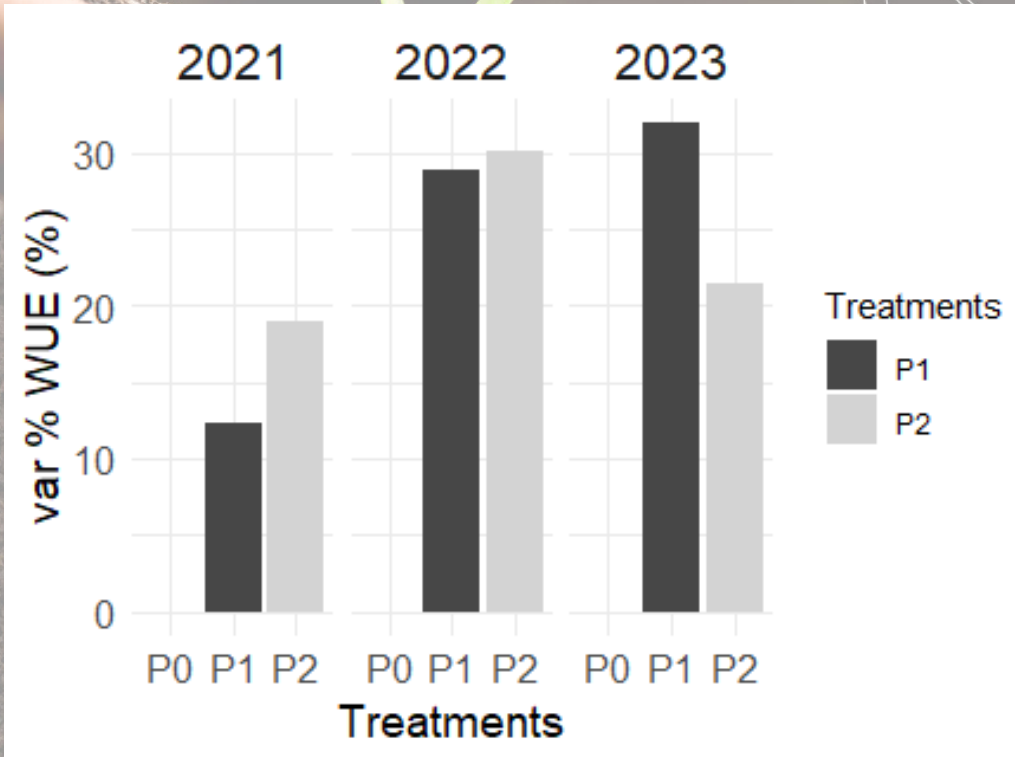


$$WPI = \frac{\text{yield}}{I}$$

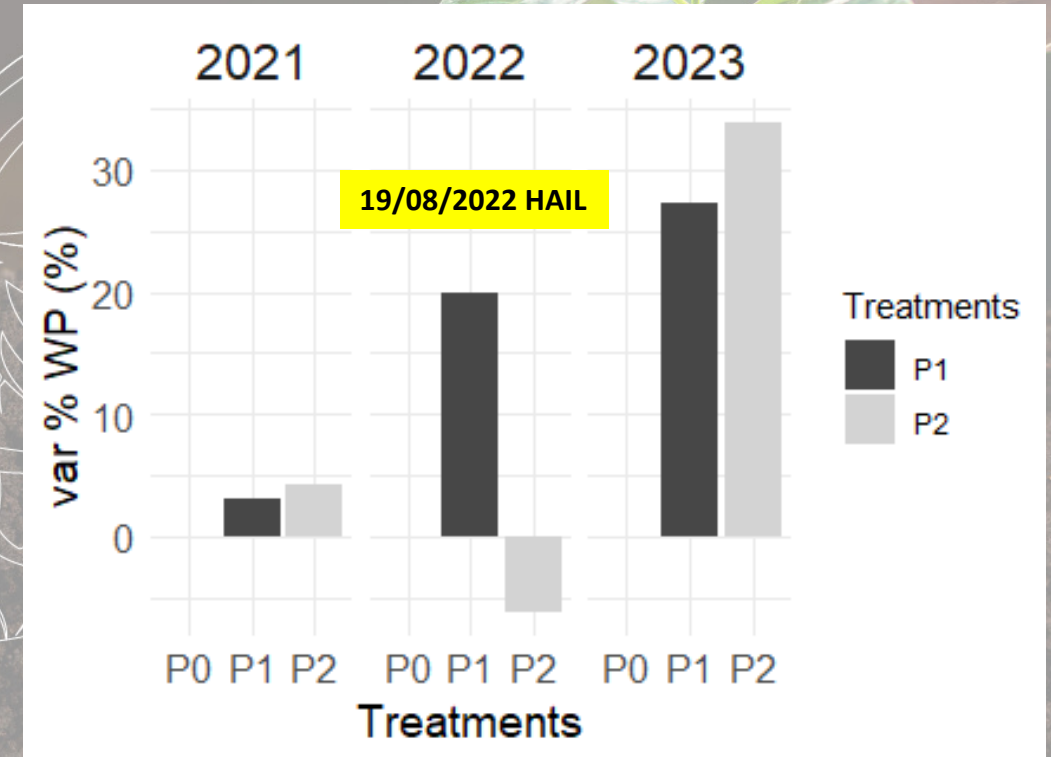
Results: irrigation WP



Results: percentage variation WUEc and WPI



P1: [+12%; +32 %]
P2: [+19 %; +30 %]



P1: [+3 %; +27 %]
P2: [-6 %; +34 %]



Conclusions

Mulching improves:

- Peach tree development starting from the second season
- Peach transpiration starting from the second season
- Yield: +27 % for P1 and +34 % for P2 in the third season
- WUEc: +24 % for P1 and P2 average of the three seasons
- Irrigation WP: +17% for P1 and +11% for P2 average of the three seasons



Food and Agriculture
Organization of the
United Nations

A background image showing a hand sowing seeds into soil, a small green seedling growing, and a larger plant with red fruit. A large white outline of a plant with roots is centered behind the text.

Thank you for attention

THANKS TO THE RESEARCH TEAM:

G. Rana; M. Mastroilli; P. Campi; A.F. Modugno; S. Ruggieri; N. Martinelli; L. Gaeta; C. Vitti; M. Mastrangelo; G. De Carolis; N. Sanitate; A. Montaghi, R. Bruno; M.G. Piarulli; P. Maggi, A. Azzolini; A. Ciurlia; V. Minorenti; O. Cappelluti; Teresa Mongelli, Vito Rocco De Michele; P. Quarto; F. Ruta