EVAPOTRANSPIRATION AND
TRANSPIRATION OF PEACH AND TABLE GRAPE

CASPE (Zaragoza)

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EVAPOTRANSPIRATION AND TRANSPIRATION OF TABLE GRAPE UNDER NETTING
INTRODUCTION

• The netting has a relatively low cost compared to total production costs in orchard crops.

• It is used to reduce pesticide applications, radiative load during summer and hail and bird damage.

• It might have an important effect on microclimate and crop water requirements.
OBJECTIVES
Use...

... Surface Renewal method (SR) to determine table grape ET grown under the netting and black plastic mulch ...

... Sap flow method (SF) to determine table grape T grown under the netting...

... in the semiarid conditions of the central Ebro River Valley in Spain.

• Also, derive crop coefficients adjusted for both netting and black plastic mulching effect

• It was supposed for these crop coefficients to include all effects of the netting (and mulching) on the ET$_c$ (T$_c$) through new coefficients that could allow scheduling irrigations of similar cropping systems following the guidelines by Allen et al. (1998)
MATERIAL AND METHODS
Site and crop

- Table grape (*Vitis vinifera* L.) evapotranspiration measurements of vineyard cv. Red Globe (years 2007 and 2008), and transpiration measurements of cv. Crimson and Autumn Royal (years 2008 and 2009)

> 80% ground cover
Surface renewal and micrometeorological variables measurement

A micrometeorological station was installed in the middle of the Red Globe vineyard to measure energy balance variables and derive $\text{ET}_c$

The micrometeorological station at the Red Globe vineyard had a net radiometer (Radiation and Energy Balance Systems, model Q-7), four soil heat flux plates (Hukseflux, model HFP01, two located within the row and two midway between two consecutive rows), a pyranometer (Kipp & Zonen, CM3), a switching anemometer (Vector Instruments, A100R) and an air temperature and relative humidity probe (Vaisala, model HMP45C)
Sap flow measurements

• The T-max approach was chosen to measure Crimson and Autumn Royal transpiration due to the relatively large xylem vessels of table grapes

• 2008
  2 vines of Crimson; one set of probes per vine

• 2009
  3 vines; both Crimson and Autumn Royal; 2 sets of probes per vine
Additional measurements

• A standard meteorological station was installed at the Crimson experimental subplot. It consisted of a pyranometer (*Kipp & Zonen, CM3*), a switching anemometer (*Vector instruments, A100R*), and an air temperature and relative humidity probe (*Vaisala, model HMP45C*). All sensors were installed above the canopy, just below the netting.

• Soil volumetric content, phenological stages by visual observation, canopy cover evolution by digital photography, and yield at harvest were also recorded.
RESULTS
Red Globe Evapotranspiration

Crimson and Autumn Royal Transpiration
Red Globe $ET_c$ - Crimson $T_c$ (2008)
Derivation of $K_{\text{ne}}$

The ratios of the seasonal averages (March to October) of Rn, u, T, and RH (daily values) recorded at the meteorological station in the vineyard to the corresponding averages recorded at the SIAR station were used to `adjust` the recorded values at SIAR station to estimate $\text{ET}_0$ `under the netting` using the FAO Penman–Monteith method.

The ratio of the seasonal average $\text{ET}_0$ `under the netting` to that obtained with the originally recorded meteorological variables was 0.63 for years 2007 and 2008, and later 0.67 for years 2007, 2008 and 2009.
Derivation of $K_{ne}$

According to this ratio, a rough reduction of 35% in $ET_o$ and thus $ET_c$ could be expected in our conditions by the presence of the netting and $K_{ne}$ can be considered to be around 0.65
Mulching coefficient ($K_{mu}$)

Allen et al. (1998) argued that the black plastic mulch increases transpiration while decreasing soil evaporation leading to a combined effect of reduced ET.

They recommended to use a broad value of $K_{mu} = 0.9$ when using the dual crop coefficient approach.
Crop coefficient and basal crop coefficient

\[ K_{c\_exp} = \frac{ET_c}{ET_o} \]

\[ K_{cb\_exp} = \frac{T_c}{ET_o} \]

Red Globe

Crimson and Autumn Royal

\[ y = 1.9051x^3 - 2.7244x^2 + 1.3084x + 0.3896 \]

\[ R^2 = 0.6879 \]
CONCLUSIONS
• The values of $K_{\text{cexp}}$ for the table grape vineyards studied in two experiments were lower compared with previously published $K_{c}$ due to the effect of the netting and the plastic mulching which decreased the ET$_{c}$.

• Both methods, Surface renewal and Sap flow gave results that were comparable for 3 different table grape cultivars and measuring seasons.

• A new reduction coefficient due to the netting (Kne) has been developed. Kne $= 0.63$-$0.67$

• When taking into account this coefficient alone (or together with the mulching coefficient reduction), there was a good agreement between our results and those from other works by different authors.
EVAPOTRANSPIRATION OF TWO DIFFERENT CYCLES OF PEACHES: LATE AND EARLY
Objectives

• Variability of evapotranspiration of two different cycles of peaches, late and early, under semiarid conditions at a commercial orchard.

• Obtention of crop coefficient curves as a function of cumulative thermal units.
Localization

Late (2009)

Early

Late (2010-11)

Late

Early

Late (2009)
Orchard characteristics

• Elevation: 120 to 200 m.
• FC = 29 %. WP = 13 – 14 %.
• Stoniness. Early, low to medium. Late, none to low.
• Cultivars. Early, Royal Glory. Late, Calante (Jesca in 2009).
• Open center training.
• Plant spacing: 3.0 m x 5.0 m (early); 3.7 m x 5.5 m (late).
• Height. Early, 3.5 m ± 0.3 m. Late, 2.7 m ± 0.2 m.
• Drip irrigation. Early, 24 l h⁻¹ tree⁻¹. Late, 30 l h⁻¹ tree⁻¹.
Measurements

- ET: eddy covariance method
  - 2 towers. 7 m height
  - Sonic anemometer 3D pointing to NW.
  - KH20 (early peach), Li-7500 (late peach).
  - Air temperature and relative humidity (Vaisala), net radiation.
  - Soil heat flux and soil temperature.
  - Span: 0.1 s. Storage: raw data and 30-min data.
  - Campbell software (in logger): Webb and oxygen correction.
- Ground cover fraction: ceptometer, every 3 weeks. Around solar noon.
- Leaf water potential. Around solar noon. Every 2-3 weeks. 3-4 leaves per tree, 4 trees each cultivar.
Phenology, LWP and ground cover

<table>
<thead>
<tr>
<th>Stage</th>
<th>Late</th>
<th>Early</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blooming</td>
<td>05-feb</td>
<td>10-feb</td>
</tr>
<tr>
<td>Pit hard</td>
<td>04-jun</td>
<td>18-may</td>
</tr>
<tr>
<td>Harvest begins</td>
<td>13-sep</td>
<td>25-sep</td>
</tr>
<tr>
<td>Harvest ends</td>
<td>06-oct</td>
<td>27-oct</td>
</tr>
<tr>
<td>Leaf fall</td>
<td>15-nov</td>
<td>15-nov</td>
</tr>
</tbody>
</table>

Leaf water potential

Ground cover fraction
• Total irrigation for EP, greater than for LP.
• EP received more irrigation water up to June to July (average, 36 mm month\(^{-1}\)). Later, LP received more (average, 24 mm month\(^{-1}\)).
- EP has not FII (little affected by water stress).
- LP has FII. Stage occurring around June – July.
- Farm manager applies deficit irrigation.
Monthly peach ETc

Values in mm month$^{-1}$

<table>
<thead>
<tr>
<th>Month</th>
<th>Late</th>
<th>Early</th>
<th>EP - LP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apr</td>
<td>40.8</td>
<td>54.3</td>
<td>13.5</td>
</tr>
<tr>
<td>May</td>
<td>85.6</td>
<td>114.3</td>
<td>28.7</td>
</tr>
<tr>
<td>Jun</td>
<td>95.6</td>
<td>142.9</td>
<td>47.4</td>
</tr>
<tr>
<td>Jul</td>
<td>99.9</td>
<td>155.1</td>
<td>55.2</td>
</tr>
<tr>
<td>Aug</td>
<td>92.6</td>
<td>126.8</td>
<td>34.2</td>
</tr>
<tr>
<td>Sep</td>
<td>73.0</td>
<td>74.4</td>
<td>1.4</td>
</tr>
<tr>
<td>Oct</td>
<td>37.4</td>
<td>42.5</td>
<td>5.1</td>
</tr>
<tr>
<td>Total</td>
<td>524.8</td>
<td>710.2</td>
<td>185.4</td>
</tr>
</tbody>
</table>

Total EP ETc (april to october) was about 35% greater than total LP ETc
Crop coefficients

\[ K_c = \begin{cases} 
 y_1 (T_1 - F_{TU}) + y_2 (F_{TU} - 0.022) / (T_1 - 0.022) & \text{if } F_{TU} \leq T_1 \\
 y_2 (T_2 - F_{TU}) + y_3 (F_{TU} - T_1) / (T_2 - T_1) & \text{if } F_{TU} \leq T_2 \\
 y_3 (1 - F_{TU}) + y_4 (F_{TU} - T_2) / (1 - T_2) & \text{if } F_{TU} > T_2 
\end{cases} \]

\[ R^2 = 0.6292 \]

\[ T_1 = 0.3126 \quad T_2 = 0.9534 \quad y_1 = 0.4590 \quad y_2 = 0.7266 \quad y_3 = 0.5216 \quad y_4 = 0.2780 \]
Conclusions

• Crop evapotranspiration of early peaches is greater than that of late peaches (about 35%).
• The differences between both cultivars increase up to July and become almost nil at fall.
• These differences likely are due to the lack of stage FII for LP and then the greater sensibility of LP to water stress.
• A curve of crop coefficient for early peaches as a function of thermal units have been fit.
¡Gracias!

THANK YOU!