Water supply effect on productive response of *Pinus pinea* grafted on *P. halepensis*.

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Introduction

Stone pine (*Pinus pinea* L.) traditional stands are characterized by their low productivity, strong interannual variations, and difficulties on harvest management. In this sense, grafted plantations aim to improve harvest management and to increase production in terms of precocity and quantity. Considering the current climatic scenario, the productive potential of the species may be distorted by the lack of rainfall at the beginning of the growing season being especially harmful in the marginal soils where *P. pinea* is usually grown. The evaluation of the effect of water supply on tree production becomes a challenge particularly under limiting/marginal agricultural soils and scarcity of water. In this context, 96 stone pines, grafted in a nursery onto Aleppo pine seedlings, were planted at IRTA-Torre Marimon (Caldes de Montbui) in 2008, close to an adult wild stand of *Pinus pinea* and under a block trial designed with three replicates.

Objective: To study the response in terms of production and vegetative behaviour of the grafted Stone pine subjected to different water regimes.

Materials & Methods

Since *P. pinea* is a rainfed species, a reference treatment (T_0) with the absence of water supply was considered. Two water regimes applied by drip irrigation were implemented: watering until the end of summer (T_1) and only in Spring (T_2). The water applied during the season was calculated weekly using the standard water balance method and considering the Kc of the oaks, since for pines Kc do not exist. From 10 to 15 years, the mean annual water supply was 1900 m^3/ha and 830 m^3/ha for T_1 and T_2, respectively. The soil was kept clean by mechanically weeding twice a year, and a clean-up pruning of trees was applied every three years. Since 2018, *Leptoglossus occidentalis* was chemically controlled. To monitor the production, the number of strobili, 2nd year cones and 3rd year cones were recorded per tree annually as well as the vegetative growth, trunk diameter, tree height and canopy surface.

Table 1. Irrigation provided in the two treatments: T_1 watering until the end of summer and T_2 only in Spring. Rainfall Apr-Set represents the accumulated precipitation (l/m^2) from 1st April to 1st September per year.

Year	Irrigation T1 l/m^2	Irrigation T2 l/m^2	Rainfall Apr – Set l/m^2
2018	131	52	218
2019	140	52	254
2020	180	67	353
2021	236	125	99
2022	253	131	226
2023	218	126	165

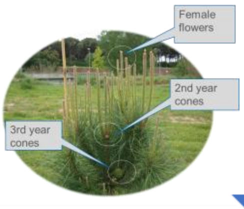

Image 1. Image of cones of different ages.

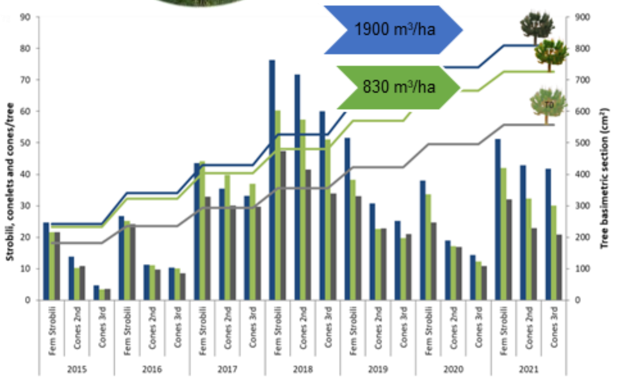

Figure 1. Number of reproductive organs held per tree (from 2015 to 2023). Growth in basimetric section (lines), cone production (bars) and irrigation (top frames) per tree and year are shown. Two watering treatments are represented as T_1 (blue colour), T_2 (green colour) and control T_0 (brown colour).

Results & Discussion

The results showed that trees under T_1 and T_2, had greater basimetric section and number of cones at all ages compared to rainfed trees (Figure 1). Support irrigation (T_1 and T_2) trended to increase the production (kg of ripe cones/ha) from 2018 onwards, since it was the year that the control of *L. occidentalis* in the plot. Differences of irrigation *vs* rainfed treatment were only significant in 2020 and 2023, both corresponding with year-on of production (Figure 2). Differences in the productive load (sum of the number of cones of different ages) and in the number of 3rd year cones/tree between the three treatments (Figure 1 & 4) were observed. However, no significant differences were observed between T_1 and T_2 when the weight of the harvest per tree was considered (Figure 4). An explanation of the absence of significance could be that T_2 had less ripe cones, but even with less cones their green weight at harvest was significantly higher *vs.* T_1 (Figure 4). Furthermore, water supply apparently did not help to smooth out the alternance pattern of *P. pinea* in bearing and neither the productive heterogeneity between trees even if they were grafted with the same clone (Figure 3).

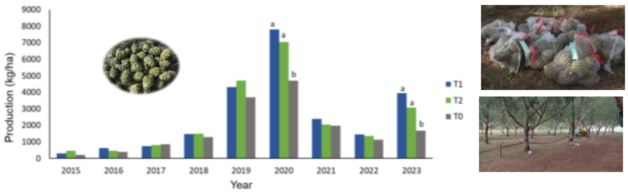

Figure 2. Evolution of production (Kg of ripe cones/ha). Different letters show significant differences (P<0.0001). Bars without letters do not show significant differences (P>0.05)

Image 2. Plantation in 2013 and 2019

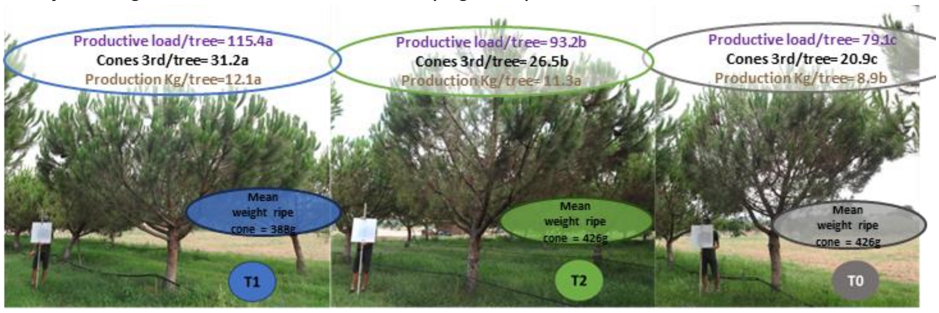

Figure 4. Average of productive load, 3rd year cones and kilograms of ripe cones for tree. Average of green weight of 3rd year cone (average between 2016-2023). Different letters represent significant differences between cones of different ages (P<0.0001).

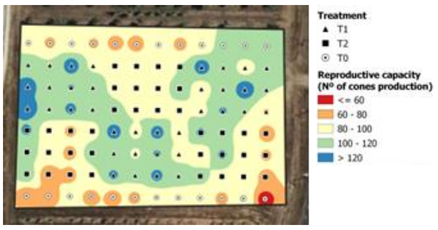

Figure 3. Spatial distribution of the mean reproductive capacity of pines exposed to different water regimes considering from 2016 to 2023.
*Reproductive capacity expressed as the sum of the cones of different ages held by each tree.

Conclusions

- ✓ The watering treatments applied in stone pine grafted on *P. halepensis* caused differences on productive and vegetative behaviours.
- ✓ T_1 and T_2 trees had more productive load compared to rainfed treatment.
- ✓ Therefore, the extra cost of irrigation extending the water supply till the end of summer, seems to not provide any productive benefit.