# TRAIN THE YOUTH! EFFECT OF WATER STRESS AND INTERCROPPING ON PEACH TREE GROWTH AFTER PLANTATION

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## Introduction

The successful performance and stability of agroforestry systems relies on reduced competition for light and soil resources between trees and the intercrop. One management strategy could therefore be to ensure that the crop roots are well distributed in the upper soil horizons, while tree roots are encouraged to forage in deeper horizons. In order for the latter to happen, the tree roots must have optimal growing conditions and at the same time be excluded by intense competition with crop roots from the upper soil horizons. One way of favouring optimal root growth is to diminish the shoot carbon demand so that carbon is diverted towards roots instead of shoots. Then combining shoot growth reduction with cover crop competition in the upper soil should force tree roots to grow deeper.

Shoot growth can be diminished through water stress, but net photosynthesis must remain at its maximum in order to maintain carbon fixation and allocation to roots. Our hypothesis is that there is a level of moderate water stress at which photosynthesis is not diminished while shoot growth is (Pellegrino et al, 2006). This study aims to investigate the effects of moderate water stress and grass intercrop competition on early shoot growth and net photosynthesis of peach trees during the first two growing seasons after plantation.

## Materials and Methods

A 2000m$^2$ drip-irrigated peach tree orchard with 475 one-year old trees was planted in January 2014 on a clay-loam soil in Southern France. Three water regime strategies were used and replicated three times: (i) strategy 1 (S1) corresponding to a well-watered situation and no intercropping (soil covered with a canvas), (ii) strategy two (S2) corresponding to a moderate deficit and no intercropping and (iii) strategy three (S3) corresponding to a moderate deficit with grass intercropping (*Festuca ovina* + *Festuca rubra*) continuous under the peach trees (both between and under tree rows).

Soil water potential in the tree root zone was monitored every day or every two days with tensiometers at 40, 60 and 80 cm depth. Readings at 40 cm depth were used to keep soil water status in a target range between 0 and -0.002MPa in S1 (no water stress), and between -0.04 and -0.06MPa in S2 and S3. The latter being a water deficit sufficient to limit shoot growth without impacting net photosynthesis (Pellegrino et al., 2006). This soil water status range was sustained for longer in 2014 (from budburst to end of irrigation) than in 2015 (from the end of the full leaf expansion period to end of irrigation) since we realised at the end of the 2014 growing season that S3 tree growth had been so reduced that the trees might die. First and second order shoot growth was monitored on 30 and 60 shoots respectively in each agronomic situation every fortnight. Net photosynthesis was monitored with a portable Licor 6200 every month in 2014 and every fortnight in 2015, on three fully expanded medium aged sun leaves per trees and on two trees per situation. Envelope curves from the Fermont et al. model (2009) were used to describe relationships between shoot growth and soil water potential.

## Results

Water deficit in S3 was higher in 2014 than in 2015 but was still moderate given that the level of soil water potential was close to soil water holding capacity (-0.01 MPa). First order shoot growth in S3 was half that of S1 and S2 in 2014, which relates to the greater water deficit (lower soil water potential) (**Figure 1**). At high soil water potential the range of shoot growth is broader than at low potential, indicating an effect on shoot growth below -0.03 MPa. Results are similar for the second order shoot growth (**Figure 2**), apart from shoot growth rate which is lower than for first order shoot growth. In both years, S3 first and second order shoot growth was always lower than in S1 and S2.

No correlation was found between soil water potential and net photosynthesis (Pearson correlation, p= 0.76), indicating that net photosynthesis was not impacted by those levels of moderate water deficit (**Figure 3**).

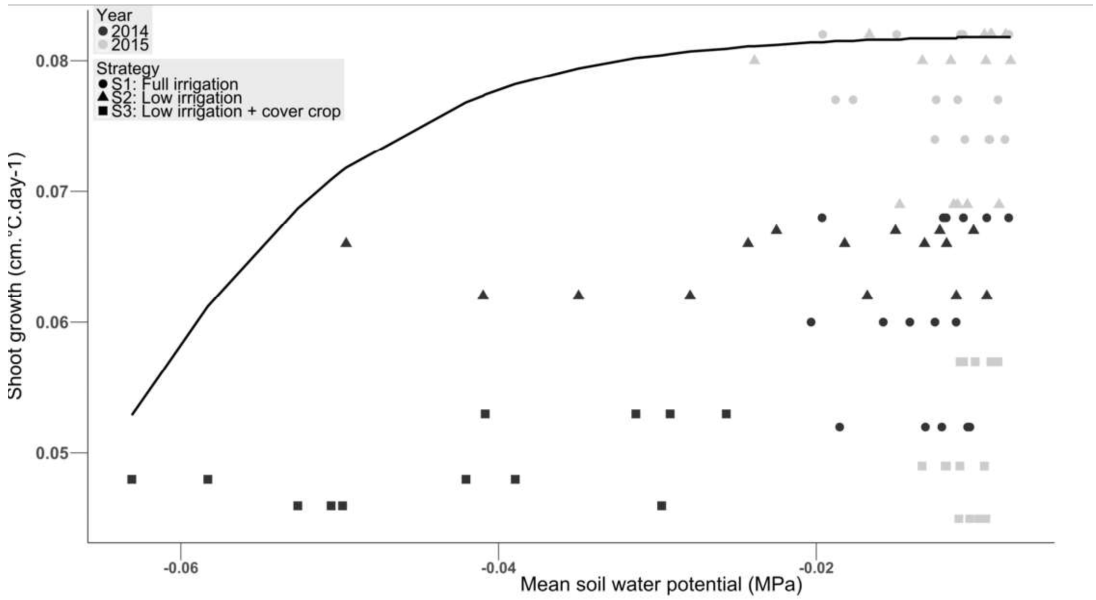


***Figure 1:*** *First order shoot growth (cm.°Cday$^{-1}$) plotted against mean soil water potential for the preceding two weeks in the root zone (mean of three depths:40,60 and 80cm) per agronomic situation per year. The black curve is the envelope fitted on data using the model of Fermont, et al, 2009*.

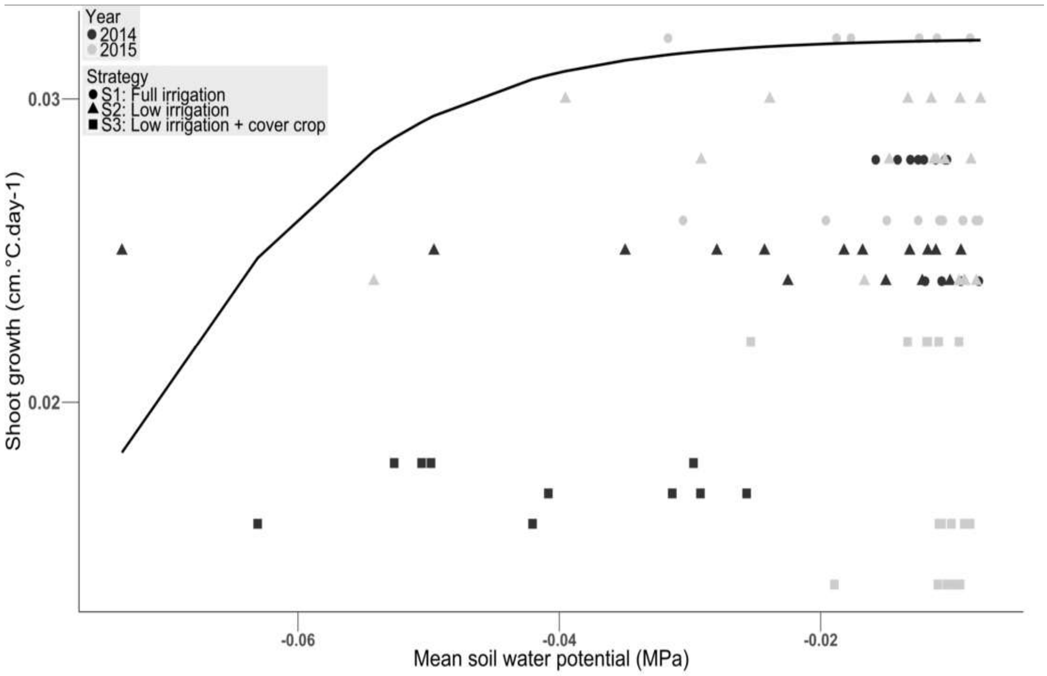


***Figure 2:*** *Second-order shoot growth (cm.°Cday$^{-1}$) plotted against mean soil water potential for the preceding two weeks in the root zone (mean of three depths:40,60 and 80cm) per agronomic situation per year. The black curve is the envelope fitted on data using the model of Fermont, et al., 2009.*

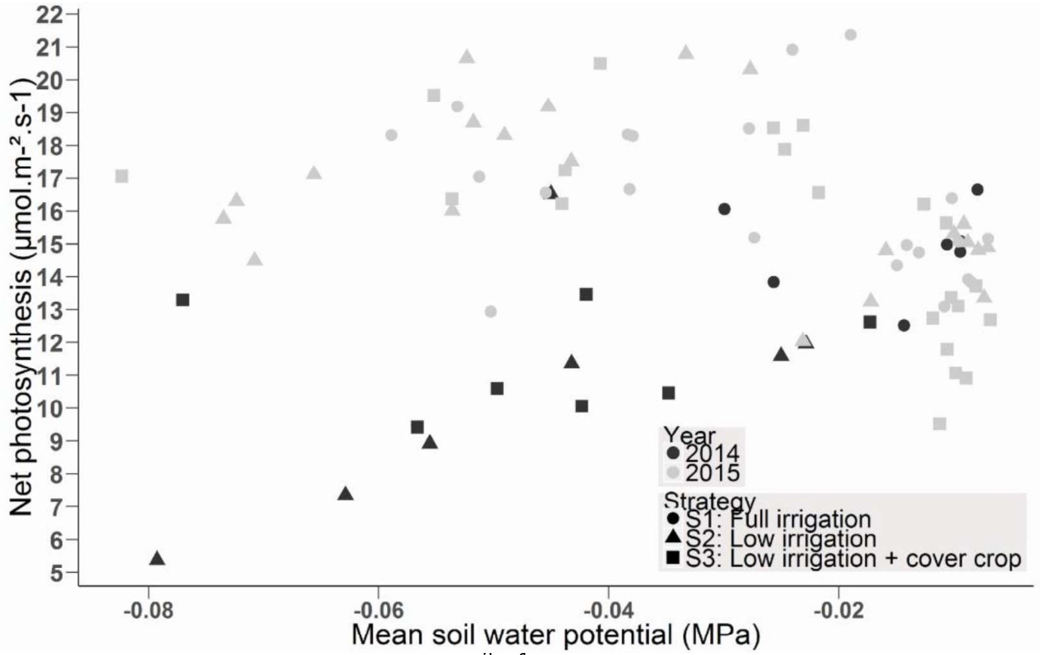


***Figure 3****: Net photosynthesis in µmol.m$^{-2}$.s$^{-1}$ (each point is a mean value of 6 measurements (3 leaves*2 trees)) plotted against mean soil water potential in the root zone (mean of three depths:40,60 and 80 cm) of that day per agronomic situation per year.*

**Discussion**

In both years, shoot growth was lowest in strategy 3 (moderate water constraint + cover crop). In 2014 it was decreased by water stress since low shoot growth correlates with low soil water potential. In 2015 shoot growth is still lower in S3 than in S1 and S2 even though the higher irrigation meant that there was no significant difference in water stress between the three strategies. This indicates that a factor other than water deficit is limiting shoot growth in S3. The lower growth in S3 may be caused by a carry-over effect from the preceding year. The trees started the 2015 growing season with lower carbon reserves to invest in fine root growth and could be outcompeted by grass roots. They also had fewer buds on their winter shoots to grow new shoots and develop sufficient leaf area to intercept light and grow rapidly. Another explanation may be that peach tree roots are slowing their overall growth due to the dry conditions in the upper soil horizons, caused by competition from crop roots, and are not able to grow into the deeper layers where water is available.

The range of water constraint applied in this experiment created a water stress which decreased peach tree shoot growth, but without decreasing net photosynthesis on a unit leaf-area basis. Rahmati et al., 2015, showed in a regulated deficit irrigation experiment that both shoot growth and net photosynthesis were decreased by water stress in peach trees. In our experiment, net photosynthesis was not decreased, but the level of water deficit was sufficient to have an impact on shoot growth. In order to control shoot growth vigour through water constraint it is therefore paramount to manage the irrigation strategy so that water deficit is as finely tuned as possible to achieve decreased shoot growth without impacting on net photosynthesis. Such management can eventually lead to an increase in Root/Shoot ratio and hence to favour root growth (results not shown, Forey et al, 2015). It means that for each tree species, the minimum water constraint that has an effect on growth must be first ascertained.

References:

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