



Cropping cereals among timber trees

Coping with climate warming in Mediterranean countries

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Facing climate change

Global food production should at least double by the end of this century to meet the needs of the increasing human population. However, crop yield potential has stagnated (Ray et al. 2012), and some reduction in the crop yields is expected as consequence of climate change (Brisson et al. 2010).

The increasing number of early warm events in temperate regions are causing heat-stress during the grain filling phase, and drought during the period of stem elongation. This has strong negative consequences on crop yields. In the last few years, in several regions of Spain, cereal crops have not been harvested because of the lack of grain in the plants. Consequently, new cropping practices that mitigate the harmful effects of climate change, and crop species and cultivars better adapted to new climate conditions, are demanded by farmers.



View of the walnut trees in February (left) and May (right) with cereal cultivated in the alleys. *Ref: E Juarez*



Trial with different cultivars of cereal in a walnut plantation for timber of the Bosques Naturales company, Carpio del Tajo, Toledo, Spain. *Ref: G Moreno*

Cropping among trees

Silvo-agriculture can be regarded as an adaptive cultivation system that can help to mitigate the negative effects of climate warming and help meet the challenges arising from the increased frequency of extreme weather events. Spaced trees can help to regulate the climate beneath them by reducing extremes of temperature, providing crops with shelter against wind and lowering evaporation from the soil surface. Indeed, it is already well documented that trees have a major role in Mediterranean wood-pastures in stabilizing grass production through the typically variable seasonal rainfall (Gea et al. 2009; Moreno et al. 2013).

However, most of currently available cultivars for cropping have been selected under full sunlight conditions, and, therefore, there is a need for cultivars which are able to photosynthesize at moderate radiance levels. Combining early maturing winter crops, especially cereal cultivars, with late sprouting deciduous trees seems a promising combination that may provide higher crop yields when compared to those grown in open fields.



View of the cereal (Triticale) in April when trees are sprouting. *Ref: G Arenas*



Advantages

Partial shade, of up to 40%, can help reduce the damage to cereal crops caused by spring heat waves affecting Mediterranean countries with increasing frequency.

Trees, through their deep root systems, are able to capture some residual nitrogen leached below the root system of annual plants, which reduces the risk of nitrogen leaching.

Fine tree roots can be vertically and horizontally modified by the presence of the crop, thereby developing deeper rooting profiles than in pure plantations. This reduces the competition for soil nutrients and water.



Dendrometers used to monitor tree growth.
Ref: E Jaurez



State of different cultivars growing among trees (C: barley; T: wheat; TT: triticale). Ref: G Arenas

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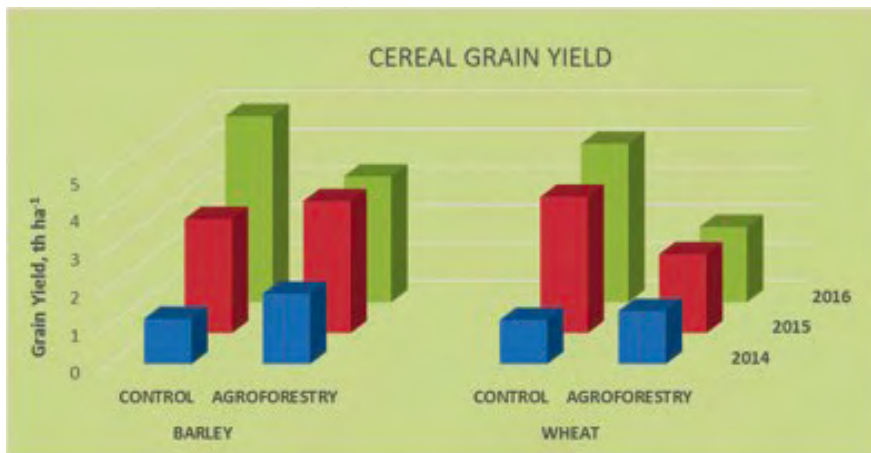
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Tree growth

Trees grow slower when combined with cereal crops, regardless of the cereal specie and cultivar. Spring rains seem to mitigate the detrimental effect of crops on trees.



Crop yield

Grain yield is usually lower under partial shade (up to 40%) when compared to that grown in open fields. However, in years that experienced heat waves in early spring, the growth of cereal plants in open fields was hampered and, consequently, the yields were higher under trees. The presence of trees was more positive for barley than for wheat.

Recommendations

Short-cycle winter cereals that flower and mature quickly (early May) and late sprouting deciduous trees (e.g. some hybrid walnuts and chestnut for timber) are preferable, as this combination ensures that competition for light and soil resources is minimized. Tree lines should be oriented north-to-south to maximize and homogenize the light received by the crop.

Wide alleys (up to 20 m width) reduce crop-tree competition and also tree-tree competition. Timber plantation of low density (100-200 trees/ha) are appropriate for silvoarable combinations. The alley width should be adapted to accommodate farm machinery.

As irrigation is frequently needed for trees, watering by drip irrigation is recommended to begin immediately after crop harvesting. This will prevent uneven crop maturation across the alley.

Further information

- Brisson et al. (2010). Why are wheat yields stagnating in Europe? A comprehensive data analysis for France. *Field Crops Research* 119: 201–212.
- Gea-Izquierdo et al. (2009). Changes in limiting resources determine spatiotemporal variability in tree-grass interactions. *Agroforestry Systems* 76: 375–387.
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- Ray et al. (2012). Recent patterns of crop yield growth and stagnation. *Nature Communications* 3: 1293; doi: 10.1038/ncomms2296.