

MANAGING LIGHT IN THE MODERN ORCHARD

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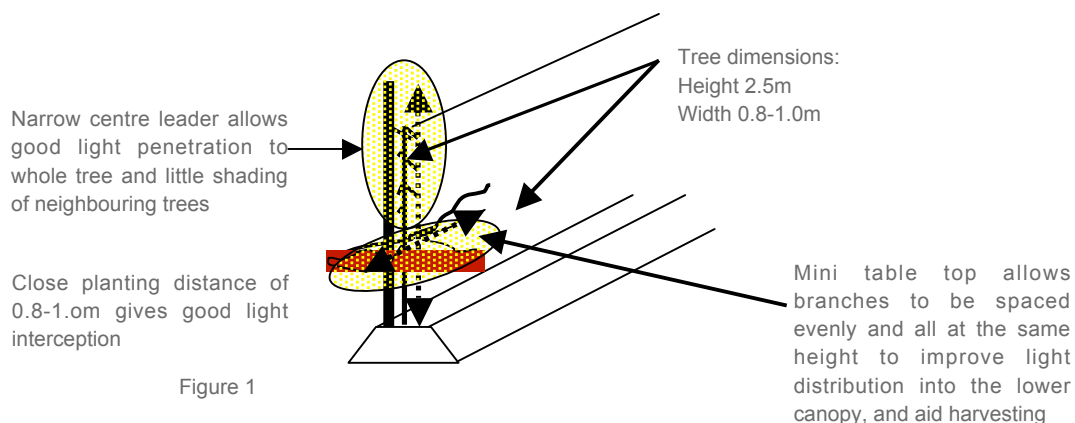
Growers planting new orchards can now reap the benefit of many studies into the importance and effects of light in orchards which in summary, have found that an increase in the available light leads to improvements in both production and quality.

Early studies conducted by John Jackson and John Palmer at East Malling in the 1970s showed the improved ability of small 'A' shaped trees to intercept more of the available light. These studies showed that the calculated values of light interception over the surfaces of model hedgerows dropped dramatically at points below the top of the tree. In hedgerow trees the same width at the top as at the bottom received less than 20% light over three quarters of the surface. In an 'A' shaped tree only the bottom half received less than 20% and at the base light interception was almost four times that of the conventional hedgerow. Hedgerow trees show average light intensities of less than 15% full daylight in the centre of the trees.

Better understanding of the importance of light led to the development of more intensive planting systems with subsequent improvements in yield and quality. Over the past decade most new orchards in northern Europe have been planted in single rows at densities between 2,000 and 3,000 trees per hectare, which gives both excellent light interception through good coverage of the ground with fruiting wood, as well as good light distribution through the tree itself which is so important for fruit quality. More recent studies into the influence of light on cropping have continued to underline the importance of managing trees to receive as much of the available light as evenly round the tree as possible.

The pictures below of three Gala trees show different degrees of in-tree shading due to the density of the canopy, and width of the leader. Note also the density of the shadow on the ground indicating the degree of shading by the tree canopy.

CONCEPT ORCHARD TREE DESIGN



Light affects many physiological processes in the tree being its source of energy and all these processes are essentially dependent on light. During photosynthesis energy from sunlight is used to synthesise sugars from CO₂ in the air to produce large amounts of dry matter for the growth of leaves, branches, roots and fruit. The efficiency of this process is dependent on the light level, temperature, and the availability of water and nutrients from the soil.

Leaves growing in the sun have much higher rates of fixation than leaves in the shade. If shade leaves are exposed to the sun (eg after summer pruning) they never catch up with leaves that have been in the sun all season. Furthermore, the pattern of light falling on leaves as they emerge and develop has a lasting influence on their ability to produce photosynthates that go to fruit development and growth. There is now indication that even the light levels experienced by the bud as it differentiates during the previous summer can have an influence on the quality and size of the leaves produced the following spring (Tustin et al. 1992).

In experiments to investigate the effects of shade, Middleton and McWaters (2002) consistently found that fruit set was lower in shaded trees, and in a five year trial showed that shaded trees developed approximately 19% fewer buds than uncovered trees. The vegetative vigour of trees and shoots grown under shade is significantly greater than those grown in full sun. The combined effect of this is that shaded trees and shaded parts of trees crop less and grow more, setting in place a vicious circle of the extra growth creating yet more shade.

Early spur leaves are the primary source of carbohydrates for the developing fruitlets and therefore have a major influence on fruit size. The leaves on bourse shoots provide photosynthates for shoot growth and do not generally contribute any carbohydrates to the fruit. This is more pronounced with shoots growing in shade than shorter shoots growing in full sun which do make a contribution to fruit growth later in the season.

Clearly then it is vitally important that the fruit grower manages his trees to have an open canopy throughout the whole year and uses all the techniques available to ensure that especially the spur leaves are working as efficiently as possible by exposing them to good quality light. It is not good practice to employ winter pruning techniques that create excess growth and then try and correct this by summer pruning, as both the spur leaves and the developing fruit buds will be subject to lower than optimal light levels at critical times.

Tree training systems that are designed to create an open canopy right through the season have been demonstrated to produce the highest consistent yields. The trellis systems developed in New Zealand were good examples of this. The Concept Orchard (Figure 1) designed by the author for the HDC combine the benefits of a close planted 'A' shaped tree with a mini table top to fix branches in positions that would intercept as much light as evenly as possible across the whole canopy.

This system ensures that every spur leaf receives similar amounts of light which, as well as ensuring regular good yields throughout the tree, will also improve many aspects of fruit quality.

Light has a major influence on the development of fruit colour. It has also been demonstrated that exposure to sunlight plays an important role in the determination of final fruit size (Dennis, 2003). Apples grown under shade have been found to have lower sugar levels. The accumulation of the most abundant flavanoids in the skins of Elstar and Jonagold showed a strong dependency on fruit position on the tree, with outer fruit accumulating more than inner fruit (Awad et al., 2000). In his chapter on Light Relations in 'Apples Botany, Production and Uses' (published by CABI 2003), Grappadelli states that the following fruit characteristics are negatively affected by shade: fruit size, fruit colour, soluble solids concentration, firmness, calcium content and to a lesser extent potassium, phosphorus and magnesium content.

With increasingly sophisticated means of testing individual apples through the grading process it is essential that the variability in fruit quality associated with the different light levels in the tree is reduced as much as possible.

As customers become more discerning in their demands for not only visual quality, but also eating characteristics, growers will have to maximise the available light in their trees by adapting their growing techniques in the following areas:

Winter pruning

Concentrate on structural pruning to ensure an open canopy by removing whole branches and sub branches. Avoid many small cuts and tipping branches that stimulate vigorous regrowth leading to increased shading.

Growth control

Ensure that all possible means of growth control are employed to keep an open canopy throughout the season. It is essential that control starts early in the season to control the flush of growth that occurs straight after flowering. This growth competes with the developing fruit and can negatively affect fruit set, fruit size and quality.

Crop load

The spur leaves can only receive enough light to support two or three fruits. Thinning is essential to manage the crop load and maximise the potential sugar and mineral content of the fruits.

Summer pruning

If inter pruning and growth control have been managed effectively then the need for summer pruning should not arise. However the removal of the odd strong non-cropping shoot at any time in the summer and the pruning of one year shoots after growth has ceased will allow more light onto the spur leaves and improve fruit quality. The aim must be though to manage the trees in such a way that summer pruning is unnecessary.

Ensuring that light is evenly distributed through the canopy, and that all parts of the tree are open to receive as much light as possible, right through the growing season, is probably the most important aspect of tree management and productivity. Success in this area should result in improved yields of good looking fruit with superior flavour and eating quality.

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