Summary 201

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Influence of trellis system and shoot positioning on light interception and distribution in two grapevine cultivars with different architectures: an original approach based on 3D canopy modeling

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• A number of canopy structure indices have been developed to aid in evaluating the performance of a trellis system, such as *canopy surface area*, *exposed leaf area*, or *canopy density*, all of which are based on field measurements. Still, the respective merits between a *sprawl* (free-standing) and a *VSP* (vertical shoot positioning) trellis system remain a matter of debate, partly because of the difficulty to extrapolate results from a given situation to other environments and cultivars.

• An alternative to field measurements would be to calculate those measurements from a 3D virtual representation of the vines, coupled to a model that would inform us of the light interception taking place in each type of trellised canopy (radiative transfer model). Using this approach,which is based on just a small amount of field data, these authors' goal was to calculate the impact of 4 canopy systems: 1) "**gobelet**" –or vase-, 2) **bilateral free cordon** –or sprawl-, 3) **VSP with one pair of catching wires**, and 4) **VSP with two pairs of catching wires**, on 3 sets of canopy structure parameters: 1) spatial distribution of leaf area, 2) light interception at the canopy, and 3) light microclimate in the fruiting zone. Finally, they did the above for each of 2 cultivars with contrasting architectures: 1) **Grenache** (erect shoots), and 2) **Syrah** ("procumbent" or drooping shoots).

• The simulations are a bit complicated and you are advised to refer to the text for details. Briefly, the 3D model assumes that the vine canopy can be represented by a cloud of discrete leaves surrounded by a canopy "envelope". The model is able to define this "envelope" based on the characteristics of each cultivar/trellis pair, and then distributes the leaf area in the resulting volume inside the envelope. Then, two programs are used to simulate radiative transfer into the canopy: one calculates the interception of light by the plant and the soil; the other calculates the scattering of light by the different parts of the canopy.

• The models used by the authors generated a huge amount of information. So they defined the following canopy indices to integrate that information:

LA I = **leaf area index** = average shoot leaf area multiplied by number of shoots

CSA = **canopy surface area** = boundary area of the geometric shape defined by the canopy

LAD = **leaf area density** = leaf area divided by the volume of the geometric shape defined by the canopy

LIE = **light interception efficiency** = fraction of incoming radiation that did not reach the ground

SLA = **sunlit leaf area** = sum of leaf area intercepting more than 10% of incoming radiation

• Let's see the results. **Canopy indices**. 1) Grenache had higher primary leaf area index (LAI), or leaf area in the primary shoots, than Syrah, across trellis systems. 2) **The shoot positioning systems** (VSP-1 wire and VSP-2 wires) **produced denser canopies** (18 to 24 m^2/m^3 LAD values) than the free-standing systems (gobelet and bilateral free-cordon, 12 to 18 m^2/m^3). This effect was more marked in Grenache than in Syrah. LAD increased from the periphery of the canopy to the inner zone, with LAD "isovalues" having a spherical shape in the un-trellised systems, and a vertically elongated profile in the trellis systems. Fruit was located directly within, or immediately below, the zone of the highest LAD.

• **Light interception by the canopy**. 1) As expected, light interception efficiency (LIE) increased with increasing leaf area. Syrah always had higher LIE than Grenache. **The VSP-2 wire clearly had the worst light interception performance**. 2) The authors also calculated the ratio of leaf area that was exposed to the light, or ratio of sunlit leaf area (SLA) to leaf area (LA). This ratio was heavily dependent on leaf area index (LAI). SLA decreased drastically when LAI increased from 1.5 to 4.0 m^2/m^2. VSP-2 wire had the lowest proportion of sunlit leaf area.

• **Light microclimate in the fruiting zone**. 1) Radiation intercepted by clusters decreased sharply with increasing leaf area index (LAI). For instance, intercepted light decreased from 10% to 1% when LAI values increased from 1.5 to 4.0 m^2/m^2, and was about 2% when LAI exceeded 2.5 m^2/m^2. **Clusters in the free-standing training systems were exposed to much higher light levels than those in the shoot-positioned systems**. These differences were more marked in Grenache than in Syrah.

• 2) The authors also tracked the light exposure of the clusters at the various times of the day. They found a drastic difference across varieties, more so than across trellis systems. For Syrah, exposure to sunlight reached a high peak around midday for the free-standing systems, and was lower in the morning and in the afternoon, whereas this effect was not observed with Grenache, which showed similar patterns with most training systems. The gobelet system showed the greatest variability in cluster exposure, ranging from both deep shade to strong sunlight around midday.

This study proves the usefulness of 3D virtual representations to infer canopy indices based on simple field measurements. Its main conclusion is that free-standing systems (gobelet, bilateral free cordon) have greater light interception and sunlit leaf area than shoot-positioned systems. The authors highlight the important challenge of adapting the trellis system to both the *cultivar* and the *climate*. For instance, in the south of France, they consider a bilateral free cordon a good choice for Grenache. For Syrah, the problem is more difficult to solve. Even though it tends to be grown in this area in VSP systems, the authors believe that a free cordon would be a good alternative <u>in conditions of moderate vigor</u>.

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