CHAPTER 4
Measurement of basic leaf water potential

1. Concept of basic leaf water potential

It is the reference measurement for assessing a plant's water status. This measurement is performed using a pressure chamber known as a Scholander chamber. The process involves estimating, by applying pressure from a neutral gas to a leaf, the cells' capacity to retain water. The less free water there is in the plant, the greater the pressure required to extract it. The result, the pressure needed to extract sap from the leaf, is expressed in bar or MPa, always as a negative value.
This potential represents the plant's water status at a given moment and can be measured on any leaf at any time, depending on the objectives. It can be used, in particular, to monitor changes in water stress throughout the day. There is significant variability between leaves, and its interpretation can be problematic. It is generally preferable to measure basal leaf and stem water potential.

Measuring the baseline leaf water potential allows us to estimate the water status of the plant.
At the end of the night, when transpiration is negligible and the plant has replenished its water reserves, the sap tension within the plant is considered to be in equilibrium with the soil water potential in the root zone. Measuring the leaf water potential at this time, called the baseline leaf water potential, therefore provides information on soil water availability and indicates the plant's water status, due to lower variability in environmental conditions.
Soil suction tension can be expressed in units of pressure or water height.
Often, a specific unit is used, the pF, which is the logarithm of the negative pressure H expressed in cm of water.
$pF = \log H$

H: water head expressed in cm of water column
A pressure of 1 atmosphere (1013 hPa) corresponds to a pressure of 1000 cm of water column and a pF of 3.

The soil matrix potential increases as the water content decreases. It is on the order of 330 hPa, or pF=2.5, for the field capacity of a soil.
The wilting point of a plant varies from species to species. The volume of water available to plants, called the "available water capacity" (AWC), includes the "readily available water capacity" (RAC) and the "survival water capacity" (SAC) or "difficult to use water capacity" (DUC); it depends on the soil depth and nature.

2. Sampling

Measurements are taken on a sample of 5 healthy leaves per treatment, taken from the basal part of a primary shoot, from 5 marked plants with identical vegetative expression

and free from trunk diseases. To avoid edge effects, the selected plants are located in the middle part of a basic plot.
Measurements during the season will always be taken on the same feet.

3. Measurement
The measurement is taken in the early morning, before sunrise (from 2:00 AM until dawn). There has been no precipitation in the four days preceding the measurement. The weather conditions at the time of measurement must be consistent from one measurement to the next (wind, humidity).

Four points are necessary to characterize the plant's water status during the vegetative period. The first must be taken before the onset of stress, when the soil's available water capacity is not yet depleted. A measurement at bunch closure, one at mid-veraison, and one before harvest constitute a suitable framework.

The base potential is measured with a pressure chamber (known as a Scholander chamber) equipped with a compressed nitrogen source, a flow regulator and, if possible, a precision pressure gauge (0.001 MPa).

The leaf, dry and whole, is harvested just before measurement by breaking the petiole at its point of attachment to the node (it is therefore not possible to pick the leaves beforehand and store them). The petiole's tip is trimmed with a sharp cutter to avoid crushing the tissue. It is then inserted into the opening of the lid. A seal is made around the petiole, and the leaf is placed in the chamber, which contains a piece of damp cotton wool.

The chamber is pressurized very gradually (the accuracy of the measurement is highly dependent on the rate of pressure increase). An increment of 0.002 (beginning of season, no stress) to 0.004 MPa (end of season, proven stress) is recommended.

The water potential is noted when moisture appears on the cross-section of the woody bundle of the petiole. This value corresponds to the chamber pressure displayed by the manometer, up to a sign.
The value of the basic potentials is the average of the measurements taken on the determined modality.

Reminder: Check that the lid is correctly positioned before pressurizing the chamber.

Thresholds

- 0.2 MPa < phfb : no water stress

- 0.3 MPa <

phfb < -0.2 MPa: low water stress - 0.5 MPa < phfb < -0.3 MPa: low to moderate

water stress

- 0.8 MPa < phfb < -0.5 MPa: moderate to severe water stress

- phfb < -0.8 MPa: severe water stress

4. Relationship between soil moisture and water potential

For the same water potential, soil moisture differs from one soil to another. See illustration in the figure below.

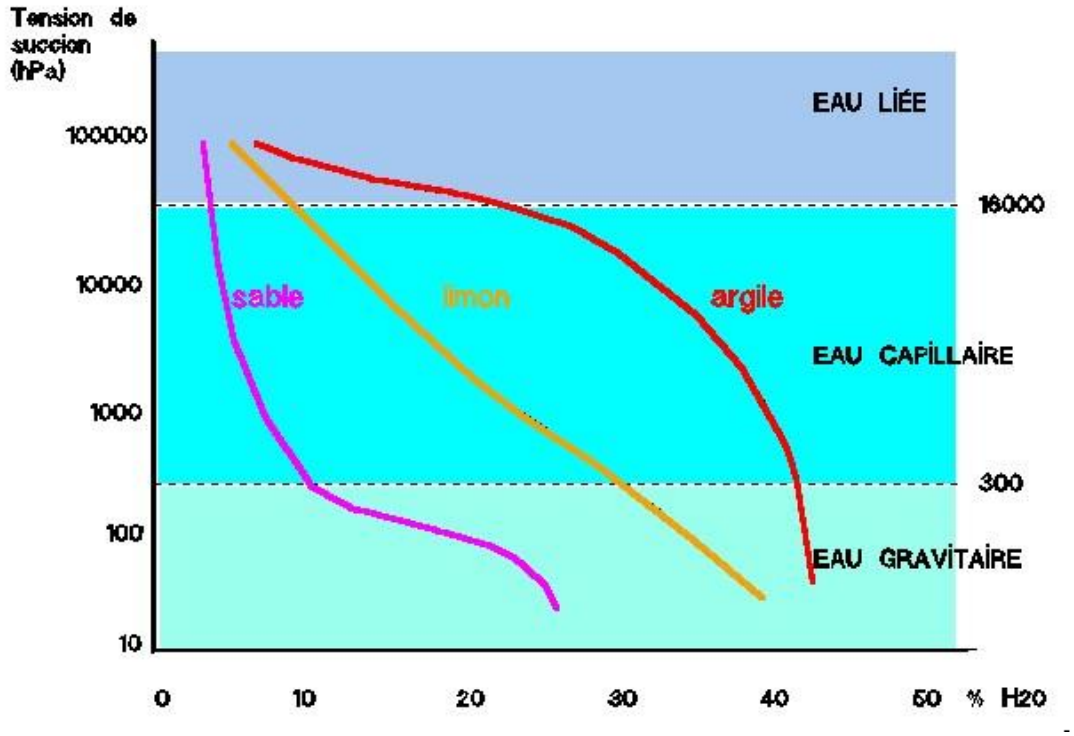

Figure 17. Relationship between soil moisture and water potential

Figure 18. Measurement of leaf water potential using the pressure chamber (Scholander)

This potential (phfb) is measured for a plant with all stomata closed and represents the available water in the environment. The measurement is taken at the end of the night, before sunrise. It is a reliable indicator that has allowed for the establishment of solid reference thresholds.