NON-DESTRUCTIVE / REAL-TIME
GEOLOCATED MEASUREMENTS (GPS)
LARGE SURFACE OF ANALYSIS (50 CM²)
MULTI-WAVELENGTHS (UV-VIS)
RECORDED & SORTED DATA
ANY PLANT – LEAVES & FRUIT
MULTIPLEX RESEARCH™, A POWERFUL TOOL

Based on research of the CNRS (National Center for Scientific Research) and the University of Paris-Sud Orsay, this new multiparametric portable optical sensor can perform real-time and non-destructive measurements of plant polyphenol and chlorophyll contents. By using two known properties of plant fluorescence, the screening effect of polyphenols and the reabsorption by chlorophyll, it can assess these compounds in vivo.

**POLYPHENOL measurement**

Near-infrared chlorophyll fluorescence 2 is measured under a first reference excitation light 1 not absorbed by polyphenols. It is compared to a second sampling light specific to a particular type of polyphenols (e.g. green 3 for anthocyanins or UV-A 4 for flavonols). Only a fraction of this light reaches the chlorophyll in the mesophyll and can generate near-infrared fluorescence.

**CHLOROPHYLL measurement**

The SFR (Simple Fluorescence Ratio) is directly related to the chlorophyll content of the sample. It is the ratio of chlorophyll fluorescence measured in the near-infrared 2 to the chlorophyll fluorescence measured in the red 3, whatever the excitation in the visible. Because of the overlapping of the absorption and the emission spectrum of chlorophyll, re-absorption occurs at shorter wavelengths (red) but not at longer (near-infrared) wavelengths.

The comparison of these two excitations quantifies the screening effect due to polyphenols and therefore the content of the latter in the epidermis.

In the above example, the flavonol content in the epidermis of a tobacco leaf is measured.
**Strengths**

- **INNOVATIVE**
  Portable fluorometer with light-emitting diodes ranging from UV to visible. It is insensitive to ambient light thanks to its synchronised “PAM” detection. Non-contact measurements can be performed in single-shot or continuous mode on a 50 cm² surface (whole leaves and fruits) with a GPS positioning.

- **MULTI-WAVELENGTHS**
  With its 4 excitation channels (blue, green, red and UV) and its 3 detection channels (blue or yellow, red and near-infrared), the MULTIPLEX RESEARCH™ measures 12 individual signals for a multiparametric analysis.

- **MANY INDICATORS**
  Fluorescence ratios (related to flavonol, anthocyanin, chlorophyll contents, etc.) are calculated and recorded along with individual signals, as well as other fluorescence indices linked to nitrogen nutrition (NBI®), fruit quality (FERARI®) or different abiotic stresses (BRR).

- **INTERNAL GPS**
  The MULTIPLEX RESEARCH™ comes with an internal GPS which allows to geolocalize data.

- **4 POWER CONFIGURATIONS**
  The MULTIPLEX® user can choose the configuration the best adapted to the sample type. This enables to avoid low signal or saturation.

- **PORTABLE AND AUTONOMOUS**
  With its dual ergonomic handle, its 2.5 kg and its high capacity Li-ion battery, the MULTIPLEX RESEARCH™ can be used both in the field and the laboratory. Moreover, its processor and its internal memory as well as its real-time display make it totally autonomous (no computer is required).

- **EASILY MANAGEABLE DATA**
  The MULTIPLEX RESEARCH™ allows 4 levels of classification and can register more than 1 million data on an SD-card. They can then be exported. The data are in a format compatible with any data processing software.

**EXAMPLES OF APPLICATIONS**

Measurements of anthocyanin content on several apple plots (Pink and Jazz varieties)

Pink is a late variety that turns pink during maturation. On the contrary, Jazz is an early variety that turns red. This graph shows obvious differences in coloring of these two varieties: higher anthocyanin content for Jazz. This graph shows also a faster blushing for Jazz compared to Pink. Jazz is harvested in mid-September and pink in mid-October.

The NBI® (Nitrogen Balance Index) is the Chlorophyll/Flavonols ratio. When a plant is in optimal conditions, it favours its primary metabolism and synthesises proteins (nitrogen-containing molecules) containing chlorophyll, and few flavonols (carbon-based secondary compounds). On the contrary, in case of nitrogen deficiency, it directs its metabolism towards the production of flavonols. Thanks to this new index, an earlier and more pertinent information about the nitrogen status of cultures is obtained (see references).
TECHNICAL SPECIFICATIONS – MULTIPLEX RESEARCH™

**Measured material**
Any plant material: leaves, needles, berries, fruits and seeds

**Measured parameters**
- 12 fluorescence signals
- SFR_R and SFR_G: chlorophyll indices
- FLAV: flavonol index
- NBI*: nitrogen status, SFR/FLAV ratio
- ANTH: anthocyanin index

It is possible to customize the signals measured by the fluorimeter, upon request.

**Measurement process**
Pressure on one of the two main buttons

**Measured area**
- 50 cm² (8 cm diameter)
- 28 cm² (6 cm diameter)
- 12.5 cm² (4 cm diameter) as an option

**Acquisition time**
1 measurement < 1 s

**Storage capacity**
1 million of multiparametric measurements (512 Mo SD card)

**Measurement modes**
- One shot or continuous mode
- 4 levels (file, group, sample and measurement numbers)

**Temperature range**
From 5 to 45°C

**Light sources**
LED (pulsed operation)

**Detectors**
Silicon photodiodes

**User interface**
3.2” graphic LCD panel with touchscreen

**Data downloading**
SD-card / USB connection for data transfer in continuous mode

**Battery**
External Li-ion rechargeable battery

**Battery life**
10 hours

**Charge time**
3 hours

**Total weight**
2.5 kg (without battery)

**Size**
340 mm x 280 mm x 170 mm

**Positioning**
Internal GPS

**Relative accuracy**
< 2.5 m (CEP, 50%, 24 h static)

**Languages**
English, French, Spanish and German

**Safety**
- Strap
- Battery connector
- SD-card and USB connector
- GPS antenna connector
- Measurement area
- LCD touchscreen
- Optical head
- Excitation channels
- Detection channels
- Mask
- Ring for leash
- Battery

**REFERENCES**

- The chlorophyll fluorescence ratio F735/F700 as an accurate measurement of the chlorophyll content in plants. Remote Sensing of Environment 69: 296-302
- **Assessment of anthocyanins in grape (Vitis vinifera L.) berries using a non-invasive chlorophyll fluorescence method. J. Agric. Food Chem. 55: 1053-1061**
- **UV-induced blue-green and far-red fluorescence along wheat leaves: a potential signature of leaf ageing. J. Exp. Bot. 54: 757-769**
- **Optically assessed contents of leaf polyphenolics and chlorophyll as indicators of nitrogen deficiency in wheat (Triticum aestivum L.). Field Crops Res., 91: 35-49.**