

Environmental Plant Physiology Research
Department of Plant and Soil Sciences
Mississippi Agricultural & Forestry Experiment Station

Instrumentation

K. Raja Reddy

krreddy@pss.msstate.edu



Li-COR-2000- plant canopy analyzer



- The LAI-2000 calculates Leaf Area Index and other canopy structure attributes from radiation measurements made with a “fish eye” optical sensor.
- Measurements made above and below the canopy are used to determine canopy light interception at five angles, from which LAI is computed using a model of radiative transfer in vegetative canopies.

Li-COR-6400- portable photosynthesis system



The LI-COR 6400 utilizes gas exchange principles to measure the photosynthesis rates of plants.

Measurement parameters

Net photosynthesis rates are expressed as ($\mu\text{mol CO}_2 \text{ m}^{-2} \text{ s}^{-1}$)

Stomatal conductance are expressed as ($\text{mmol H}_2\text{O m}^{-2} \text{ s}^{-1}$)

Chlorophyll Fluorescence expressed as (Ratio of Fv/Fm)

ASD Spectroradiometer



The FieldSpec portable spectroradiometer offers the modular Goetz spectrometer engine with a spectral range from 350 nm to 2500 nm

Measurements : Measures **reflectance** of given plant material and is ideal for numerous remote sensing and research applications



Spectral Range	350-2500 nm
Spectral Resolution	3 nm @ 700 nm 10 nm @ 1400/2100 nm
Sampling Interval	1.4 nm @ 350-1050 nm 2 nm @ 1000-2500 nm
Scanning Time	100 milliseconds

SmartSpec-3000 spectrophotometer



The UV/visible SmartSpec 3000 spectrophotometer has a working wavelength range of 200–800 nm.

It is the perfect tool for routine applications such as:

- Quantitation of DNA, RNA, and oligonucleotides
- Quantitation of proteins via the Bradford, Lowry, and BCA assay methods
- Monitoring bacterial culture growth
- Simple kinetic assays
- *Wavelength scans with peak detection*

Infra-red thermometer gun



An infrared (IR) thermometer measures the thermal temperature of the plant leaves or a crop canopy. Once plants go into water stress, they begin to close their stomata and cease to transpire, causing the plant to "heat up" and the canopy temperature to rise.

Measurement:

Canopy Temperature Depression (°C) = Canopy Temperature (°C) – Air Temperature (°C)

EC-meter



Electrical conductivity meter measures 5 parameters including conductivity, TDS, salinity, pH, and temperature using one electrode

Measurement: Electrical conductivity of a solution

Digital UVX radiometer



This digital UVX Radiometer is used with one of the three interchangeable sensors (ordered separately) for measuring 254nm, 365nm and 302nm UV wavelengths.

The UVX's range switch provides selection from three intensity ranges:

0 to 20 mW/cm²

0 to 2000 micro W/cm² and

0 to 200 micro W/cm²

Soil auger



Made of stainless steel, no pollution for the sample.
With foot step type. Convenient, fast, reduce labor intensity.

Measurements: Taking of soil samples from field

Li-COR-250 A- light meter – quantum sensor



- Accurate measurements are obtained under all natural and artificial lighting conditions.
- Colored glass filters are used to tailor the silicon photodiode response to the desired quantum response.
- An interference filter provides a sharp cutoff from 400 to 700 nm, which is critical for measurements under vegetation where the ratio of infrared to visible light may be high.

The LI-191 Line Quantum Sensor



- The Line Quantum Sensor spatially averages PPFD over its one-meter length.
- Measuring PAR within a plant canopy can be very difficult because of the non-uniformity of the light field.
- The LI-191 Line quantum Sensor reduces the number of individual readings required because it effectively averages PPFD over its one-meter length.
- One person can quickly make plant canopy PPFD measurements in many plots in a short period of time.

Global radiation sensor



- Rugged pyranometer for the measurement of global radiation, the sum of both the direct and diffuse components of solar irradiance.
- A set of thermocouples measure the temperature of a horizontal surface exposed to sunlight. An electronical transducer converts the raw signal into a voltage linearly dependent on incident solar power.

Grain moisture Tester



- Decisions can be made when to blend grain based on moisture levels thus mitigating a wet, harvested product.
 - Decide whether or not to dry grain based on moisture content.
 - Periodic moisture level monitoring of stored grain can prevent additional expenses of drying.
-
- DICKEY-john Corporation has a full product line that is calibrated to the official air oven.
 - The DICKEY-john moisture tester product line offers fast, accurate analysis on moisture and test weight (bulk density) based on official references.

SPAD meter



- The SPAD 502 Chlorophyll Meter instantly measures the amount of chlorophyll content, a key indicator of plant health.
- Simply clamp the meter over leafy tissue, and receive an indexed chlorophyll content reading (0-99.9) in less than 2 seconds

Measurement: Indirect measurement of leaf chlorophyll content

Fluro-pen 100 (Chlorophyll Fluorescence)



- FluorPen is a portable, battery-powered fluorometer that enables quick and precise measurement of chlorophyll fluorescence parameters in the laboratory, greenhouse, or in the field.

Measurement: Chlorophyll fluorescence

Em-5b moisture sensors



- The Soil Moisture Sensor uses capacitance to measure the water content of soil (by measuring the dielectric permittivity of the soil, which is a function of the water content).
- Simply insert this rugged sensor into the soil to be tested, and the volumetric water content of the soil is reported in percent.
- Range: 0 to 45% volumetric water content in soil (capable of 0 to 100% VWC with alternate calibration)
- Accuracy: $\pm 4\%$ typical
- Resolution: 0.1%

Watch dogs- sensors (Temperature and moisture)



- Water resistant (IP56) stainless steel case
 - Select measurement intervals from 1 to 120 minutes
 - Log 2,000 to 8,000 intervals
 - Internal sensors
 - Integral non-replaceable battery
 - Choose from temperature-only or temperature/humidity models
- Hey log temperatures ranging from 14° to 185°F (-10° to 85°C) with accuracy of $\pm 2^{\circ}\text{F}$ ($\pm 1.1^{\circ}\text{C}$) and features a battery life of up to 10 years, depending on measurement interval.
 - Water resistant case protects internal sensor and circuitry. Record soil temperature or track shipments of perishable commodities.

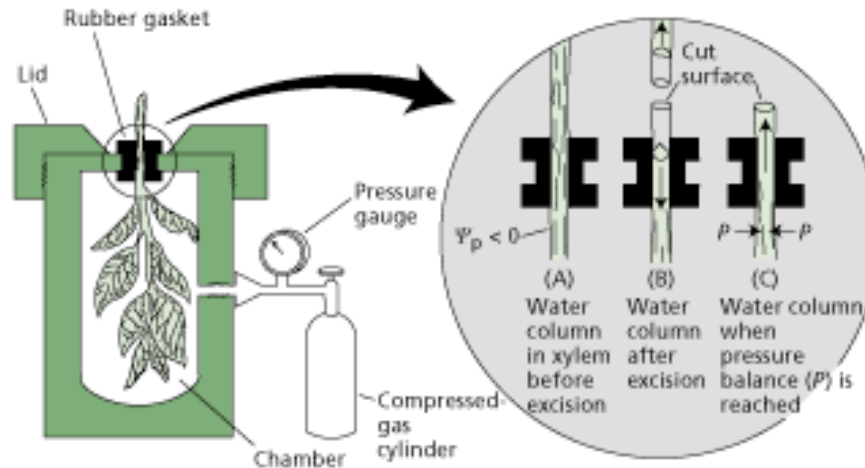
ML2X- theta probe soil moisture sensor



- The ThetaProbe measures volumetric soil moisture content by the well established method of responding to changes in apparent dielectric constant. Easy data logger connection (DC in DC out)
- Excellent temperature and salinity stability Dual purpose: either hand-held for spot readings or left in-situ for data logging.
- The ThetaProbe type ML2x measures volumetric soil moisture content to within 1%. The ML2x has decisive advantages over other technologies, offering precision and reliability at an affordable price.

Pressure chamber

(Leaf water potential measurement)



- In this technique, the organ to be measured is excised from the plant and is partly sealed in a pressure chamber. Before excision, the water column in the xylem is under tension. When the water column is broken by excision of the organ (i.e., its tension is relieved allowing its Ψ_p to rise to zero), water is pulled rapidly from the xylem into the surrounding living cells by osmosis.
- The cut surface consequently appears dull and dry. To make a measurement, the investigator pressurizes the chamber with compressed gas until the distribution of water between the living cells and the xylem conduits is returned to its initial, pre-excision, state.
- This can be detected visually by observing when the water returns to the open ends of the xylem conduits that can be seen in the cut surface. The pressure needed to bring the water back to its initial distribution is called the *balance pressure* and is readily detected by the change in the appearance of the cut surface, which becomes wet and shiny when this pressure is attained.

LI-3000 Area Meter



- The LI-3100 Area Meter is designed for efficient, exacting measurements of both large and small objects. User-selectable area resolution of either 1 mm² or 0.1 mm² is available without having to change optics.
- Samples are placed between fixed guides on the lower transparent belt and allowed to pass through the LI-3100. As a sample travels under the fluorescent light source, the projected object is reflected by a system of three mirrors to a linear array camera within the rear housing. This unique optical design results in high accuracy, dependability and speed.
- Biological applications for the LI-3100 include measuring small leaves with precision similar to that obtained when measuring large objects. A wide variety of leaves can be measured; from small samples such as wheat, rice or alfalfa, to larger samples such as corn, tobacco, and cotton.

Visible Multifilter Rotating Shadowband Radiometer



- Measures Sun's irradiance at 6 bands, 415, 500, 615, 673, 870 & 940 nm; measures total horizontal, diffuse & direct portion of the spectrum.

Ultraviolet Multifilter Rotating Shadowband Radiometer



- This measures solar irradiance at 300, 305, 311, 317, 325, 332. & 368 nm; used to estimate optical depth.

Mercury Thermometers



The traditional thermometers to monitor daily maximum & minimum temperature; housed in a doubled-louvered wooden box mounted at about 1.25 m high.

The red is for minimum & the mercury one for the maximum temperatures. They stay at those until tilted.

Ultraviolet (UV-B) Monitoring Pyramometer



This gadget measures Sun's UV-B radiation from 280-320 nm; measured UV radiation is being used to project Harmful Sun's UV so that beach goers can apply the right kind of sunscreen lotions (SPF) to protect against cancer causing radiation.

Rain Gauge



An instrument used to measure liquid precipitation by meteorologist or hydrologists; often the amounts used to estimate crop yield.

Wind/Weather Wane/Anemometer



A tool used mounted on an elevated structure to measure wind direction; the largest weather wane is located in Jerez, Spain; the term "weather wane" is also used for people who changes opinion.

Thermocouple



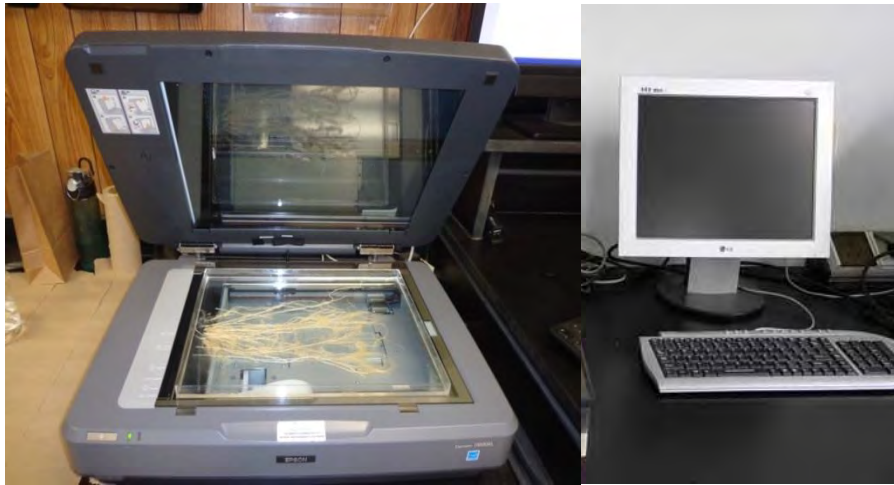
To measure of air temperature

Class A Evaporation Pan



A cylinder or circular pan with 120.7 cm diameter, 25 cm in height is used to measure evapotranspiration; this provide guidance for irrigation of the crops.

Win-RHIZO Dual Scan Optical Root Scanner



- WinRHIZO is an image analysis system specifically designed for root measurement in different forms.
- It can do morphology (length, area, volume...), topology, architecture, and color analyses.
- It is made of a computer program and image acquisition components that can be combined to meet different needs.
- WinRHIZO automatically analyses washed roots.

HOW TO DIGITIZE AND ANALYSE ROOTS

1. Root positioning

Simply place the roots directly on the waterproof trays.

2. Acquire the image

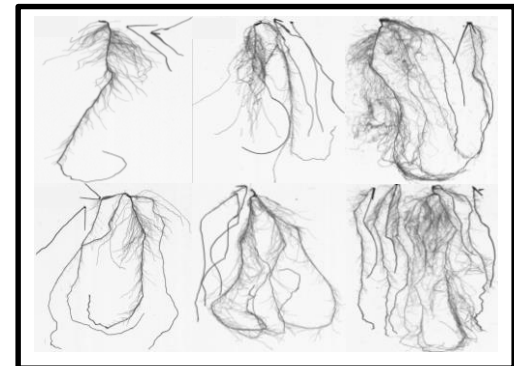
Click the scanner icon to digitize the roots and wait a few seconds for the scan to complete and the image to appear on screen.

3. Analyze the roots

A few seconds later, the analysis is complete and roots found by WinRHIZO are identified by lines in the image.

4. Save the measurement data

The last step of the analysis is data saving. WinRHIZO knows when data are ready to be saved and does this automatically.



Dualex[®] 4



SCIENTIFIC

FLAVONOLS & CHLOROPHYLL-METER

DUALEX[®] SCIENTIFIC, AN INNOVATIVE TOOL

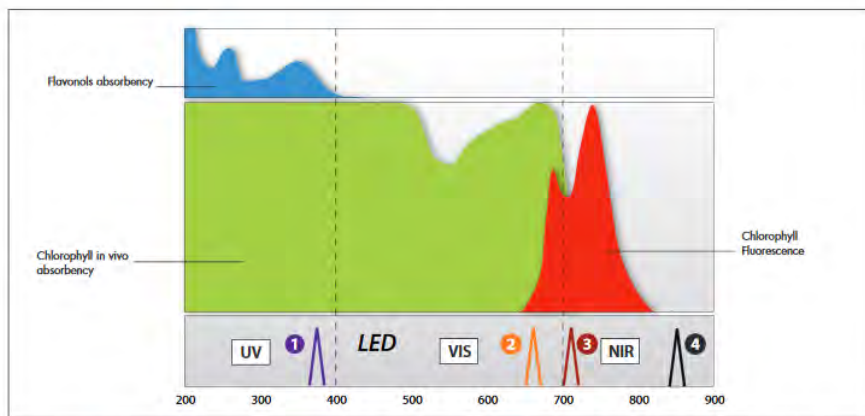
Resulting from a CNRS (National Center for Scientific Research) research team and the University of Paris Sud Orsay, this new leaf-clip can simultaneously and accurately monitor the chlorophyll- and flavonols-content from the leaf epidermis. Versatile, it is dedicated to plant science and agriculture. Used both on cereals, vine or perennials, this tool is simple to use. Measurements are instantaneous and non-destructive. They require no prior adjustment, and no sample preparation. Therefore, measurements can either be done in the laboratory or in the field, in all conditions of temperature and ambient light.

FLAVONOLS measurement

Flavonols have the property of being UV absorbers, and therefore to screen the chlorophyll absorption wavelengths within this spectrum. FORCE-A uses this role of natural UV filters to identify and quantify these molecules.

CHLOROPHYLL measurement

The optical properties of chlorophyll allow an accurate and rapid measurement by transmittance. A first wavelength very close to red ② quantifies the chlorophyll and a second in near infrared ③ can take into account the effects of leaf structure.



A wavelength in the UV ① is compared to a second wavelength in the red ②. Both wavelengths excite the fluorescence of chlorophyll, but only UV is affected by the presence of flavonols.

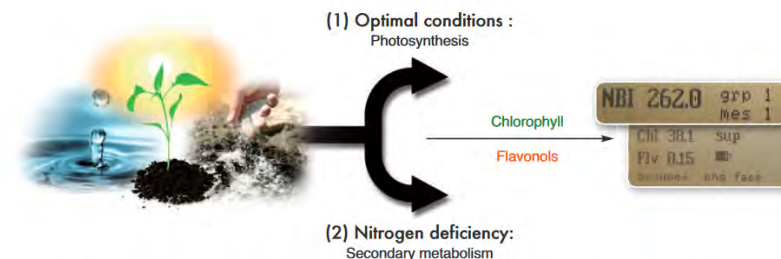
By using these two wavelengths, the DUALEX[®] SCIENTIFIC calculates a numeric value directly correlated with chlorophyll content in the measured sample.

$$\text{Flavonols absorbency} = \log \frac{\text{Infrared Flu. excited by Red}}{\text{Infrared Flu. excited by UV}}$$

$$\text{Chlorophyll content} = \frac{\text{Infrared Trans.} - \text{Red Trans.}}{\text{Red Trans.}}$$

EXAMPLE OF APPLICATION : MONITORING OF NITROGEN STATUS A NEW INDEX, THE NBI[®]

Several years of research and experimentation showed that polyphenols, specifically flavonols, are indicators of nitrogen status of plants. Indeed, when a plant is in optimal conditions (1), it achieves its primary metabolism and synthesizes proteins (nitrogen-containing molecules) containing chlorophyll, and some flavonols (carbon chains). On the contrary, in case of nitrogen deficiency (2), it directs its metabolism towards the production of flavonols by the diagram below:



By using a new indicator called NBI[®] (Nitrogen Balance Index) which is the ratio Chlorophyll/Flavonols (or Nitrogen/Carbon), it is now possible to get an earlier information about the nitrogen status of cultures.

Instant and accurate direct EC measurement



Why measure EC?

The salinity of the soil, irrigation water or fertilizer solution is an important parameter affecting the root zone environment of your plants. Any of these factors can have a significant effect on plant growth and quality. The presence of high salt levels is your warning sign to make adjustments. Low-salt levels could lead to nutrient deficiencies. Don't wait for trouble, measure before the damage shows in your plants.