

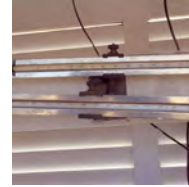
Environmental Plant Physiology Laboratory
 Department of Plant and Soil Sciences
 Mississippi Agricultural & Forestry Experiment Station

Instrumentation

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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.

Thermocouple



To measure of air temperature and that parameter is being used in many applications including crop phenological models that estimate crop growth stages

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 electronic transducer converts the raw signal into a voltage linearly dependent on incident solar power.

Quantum Sensor



- The quantum sensor measures Photosynthetically Active Radiation (PAR, in $\mu\text{mol of photons m}^{-2} \text{s}^{-1}$). It provides accurate measurements—in the open, in greenhouses, under plant canopies, or in growth chambers—for most broad-spectrum light sources, including natural sunlight, artificial, or mixed sources.

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 (UV-B) Monitoring Pyranometer



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.

Ultraviolet Miltifilter Rotating Shadowband Radiometer



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

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.

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.

Pad – Pot Culture System



SPAR System, the Units



SPAR System, the Units

Irrigation and Nutrient
Delivery Systems

Forced-air Dryers

SPAR System – Control Room



SPAR System, the Units

Ultra-Low (-80°C) Freezers

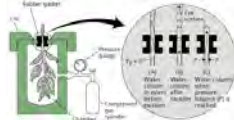


2 Freezer are available for storage of collected material for various physiological, biochemical and molecular analysis.

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.

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.

apogee
INSTRUMENTS

Soil Oxygen sensor



Typical Application

Applications include: measurement of O₂ in laboratory experiments, monitoring gaseous O₂ in indoor environments for climate control, monitoring of O₂ levels in compost piles and mine tailings, monitoring redox potential in soils, and determination of respiration rates through measurement of O₂ consumption in sealed chambers or measurement of O₂ gradients in soil/porous media.



CR1000 Measurement and Control Data logger



The CR1000 is our most widely used data logger. It can be used in a broad range of measurement and control functions. Rugged enough for extreme conditions and reliable enough for remote environments, it is also robust enough for complex configurations. Used in applications all over the world, it will be a powerful core component for your data-acquisition system.



AM 16/32 Relay Multiplexer



The AM16/32B multiplexer significantly increases the number of sensors that you can measure with a Campbell Scientific data logger. It interfaces with the data logger and adds terminals so that you can wire additional sensors of almost any type.

Dualox[®] 4
FLAVONOIDS & CHLOROPHYLL-METER

SMALLER SCIENTIFIC, MORE INNOVATIVE TOOL

Having the Dualox 4 in your laboratory or field allows you to measure chlorophyll and flavonoid content in a wide range of plant species. The Dualox 4 is a portable, rugged, and easy-to-use instrument that provides accurate and reliable results. It is designed for use in a variety of environments, from the laboratory to the field. The Dualox 4 is a powerful tool for researchers and practitioners in a wide range of fields, including agriculture, horticulture, and environmental science.

FUNCTIONS

Measures the quantity of chlorophyll a+b, chlorophyll a, and chlorophyll b in a wide range of plant species. The Dualox 4 is a portable, rugged, and easy-to-use instrument that provides accurate and reliable results. It is designed for use in a variety of environments, from the laboratory to the field. The Dualox 4 is a powerful tool for researchers and practitioners in a wide range of fields, including agriculture, horticulture, and environmental science.

ADVANTAGES

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EXAMPLE OF APPLICATIONS: MEASUREMENT OF CHLOROPHYLL AND FLAVONOIDS

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Em-5b Soil 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).
- Range: 0 to 45% volumetric water content in soil (capable of 0 to 100% VWC with alternate calibration)
- Accuracy: ±4% typical
- Resolution: 0.1%
- Simply insert this rugged sensor into the soil to be tested, and the volumetric water content of the soil is reported in percent.

Digital Refractometer (Brix meter)



The Brix/RI-Chek is suitable for numerous applications in various industries, including:

- Agriculture
- Beverages
- Beer
- Food
- Industrial
- Wine

- The Brix/RI-Chek is a versatile, pocket-sized digital refractometer that raises the bar for performance and value.
- The powerful, multi-scale instrument is easy to operate and provides quick results. The Brix/RI-Chek has an IP65 dustproof/water resistant rating so it can be used in virtually any environment.

Fluro-Pen 100 (Chlorophyll Fluorescence)



- **FluroPen 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

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

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.

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.

Canopy- and Pot-gas exchange system



- Could be used for variety of things for field and pot-culture application.
 - ✓ Whole plant photosynthesis in pots
 - ✓ Whole plant respiration in pots
 - ✓ Whole plant water use in pots
 - ✓ Canopy photosynthesis
 - ✓ Canopy and soil respiration
 - ✓ Canopy water use
 - ✓ Canopy trace-gas analysis in cover crops and soil systems

Li-COR-6400- Portable Photosynthesis System



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

Measurement parameters

Host of measurements related to photosynthesis, stomatal conductance, transpiration, chlorophyll fluorescence.
Also, one could perform light- and CO₂-photosynthetic response curves and related parameters.

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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.

Watch Dogs- Sensors (Temperature and Relative Humidity)



- 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 ±2°F (±1.1°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.



Infrared Radiometer



Plant canopy temperature measurement for use in plant water status estimation, phenotyping, phenomics, road surface temperature measurement for determination of icing conditions, and terrestrial surface (soil, vegetation, water, snow) temperature measurement in energy balance studies.

Infra-red Thermometer



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:

$$\text{Canopy Temperature Depression (°C)} = \text{Canopy Temperature (°C)} - \text{Air Temperature (°C)}$$

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

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.

FieldScout Direct Soil EC Meter 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.

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 applied 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

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.

Win-RHIZO Dual Scan Optical Root Scanner



HOW TO DIGITIZE AND ANALYSE ROOTS

- 1. Root positioning**
Simply place the roots directly on the water-proof 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.

- 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.



BioTek Epoch Microplate Spectrophotometer



With its monochromator-based optics, Epoch™ Microplate Spectrophotometer offers a filter-free, wide wavelength range for UV-Vis absorbance measurements in a variety of microplate formats, and in 2 µL samples when the available Tack3 plate is used. Epoch is controlled with the Gen5 Software interface, with simple programming and powerful data analysis. This robust, low-maintenance microplate spectrophotometer is the most cost-effective system available, ensuring even greater value over time.

Cost-effective monochromator-based absorbance

200 nm to 999 nm for UV-Vis applications

Micro-volume detection with the Tack3 plate

Wavelength scanning, endpoint, and kinetics

Walkaway processing: available BioStack compatible configurations

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

Thermo Scientific Refrigerated Centrifuge



Operating Features:

- Capacity: 400mL (4x100mL)
- Touch keypad microprocessor control (EASyControl II)
- Digital display that shows all run parameters
- Variable speed/RCF/time control
- QUICK RUN key for short spins
- Choice of two acceleration and nine braking curves for sensitive samples
- Memory retains current settings
- With optional rotor/adaptor combinations, accept tubes from 0.2 to 100mL



Digital Dry Block Heater



- Precision temperature stability ensures reproducibility of results.
- Custom block modules provide flexibility for heating different size tubes.
- Built-in temperature sensing probe for outstanding temperature accuracy and control.
- Timer function allows the user to accurately monitor the heating time.

EC-Meter



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

Measurement: Electrical conductivity of a solution

Precision Refrigerated Incubator



Operating Features:

- 20 cu ft (566 L), 120 V 60 Hz
- -10 to +50 °C
- Ideal for BOD Applications
- Energy Efficient Design - with Cooling Switch

Campbell Scientific CR1000 datalogger



Use:

- Used to log incubator temperature data using type T thermocouples (copper/constantan)
- Can also be programmed to utilize a wide variety of sensors.