Portable canopy analysis system for crops

SunScan uses field measurements of PAR in crop canopies to provide valuable information about Leaf Area Index and biomass production.

- Measures incident and transmitted PAR in plant canopies
- Direct display of Leaf Area Index (LAI)
- Unique BF5 Sunshine Sensor reference measures Direct and Diffuse components of incident light
- Usable in cloudy, clear and changeable conditions
- Portable, weatherproof and battery powered

Introduction

SunScan is a simple and flexible system for measuring and analysing the incident and transmitted Photosynthetically Active Radiation (PAR) within crop canopies. It provides vital information about the penetration of PAR into crops, and is essential in work such as comparative crop studies, for separating out the effects of cultivar and treatment. It is particularly well suited to low regular canopies (as found in many agricultural crops).

SunScan users don't have to wait for special weather conditions – the probe can be used in most light conditions (but best near mid-day).

SunScan Probe

The probe has an array of 64 PAR sensors embedded in a 1m long probe, and is connected via an RS-232 cable to a handheld PDA. As a reading is taken, all the sensors are scanned and the measurements are transmitted to the PDA.

The average light level along the probe is calculated, and all of the individual sensor readings are available if required for detailed PAR mapping. An operating button on the probe handle enables successive readings to be taken quickly and simply on demand. Alternatively, unattended logging can be conducted under program control from the PDA. Readings are in units of PAR quantum flux (μmol.m⁻².s⁻¹) and units of LAI (m².m⁻²).
**SunScan System choices**

*SunScan is modular and expandable. Researchers can specify a system that suits their own performance requirements and budget:*

<table>
<thead>
<tr>
<th>System type</th>
<th>Features and advantages</th>
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<tr>
<td><strong>SS1-COM Complete System</strong></td>
<td>The full system provides a powerful canopy analysis tool. It can instantly calculate LAI, measure PAR interception using either spot readings or unattended logging, and measure sunflecks.</td>
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<td><em>This is the complete package of SunScan items, including SunScan Probe, SunData Software, PDA, Sunshine Sensor type BF5, tripod and carrying case.</em></td>
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<td><strong>SS1-COM-R4 Complete System with Radio Link</strong></td>
<td>The radio link has a range of 100 to 200m and replaces the cable between the SunScan Probe and BF5 - particularly useful in taller canopies or where readings are required at widely spaced locations.</td>
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<td><em>Includes a radio link between the modified SunScan Probe and the BF5 Sunshine Sensor.</em></td>
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<td><strong>SS1-STD3 Standard System</strong></td>
<td>The Standard System is able to make the full range of SunScan measurements, including LAI. The probe has to serve as its own above-canopy reference, so requires steady light conditions.</td>
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<td><em>The Standard System comprises the SunScan Probe, SunData Software and PDA.</em></td>
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SunData software modelling

SunScan uses a sophisticated model of light transmission through a uniform canopy, based on work by Campbell (1985), and Norman and Jarvis (1975) and taking into account the following factors:

- Direct & Diffuse incident light
- Leaf PAR absorption
- Canopy Leaf Area Index
- Canopy Leaf Angle Distribution
- Transmitted fraction
- Solar zenith angle
- Canopy leaf angle distribution
- Leaf PAR absorption

Solar zenith angle is calculated from the actual time, latitude and longitude. Leaf Angle Distribution and Leaf Absorption are estimated by the user. All other variables necessary to calculate LAI are measured directly.

Because the relative contributions of direct and diffuse incident light are measured at the same time as the transmitted PAR, readings can be made in a wide range of daylight conditions. However, we advise against taking measurements when the sun is strong and near the horizon, when large errors may occur. The assumptions and calculations made in the SunData Software are fully explained in the user manual, along with practical advice on how to use the system effectively.

Sunshine Sensor type BF5

SunScan features a unique optional reference sensor which measures the direct and diffuse components of light simultaneously above the canopy.

The special shading pattern of the dome[1] is matched to an array of photodiodes in such a way that at least one photodiode always sees an unobstructed solar disc and at least one is always in full shadow.

The BF5 uses this information to calculate whether the sun is shining and to measure the direct and diffuse components of solar radiation, avoiding the need for the shade ring adjustments required with conventional diffuse light sensors (levelling is the only adjustment required).


Data analysis and storage

Rugged PDA type RPDA2

The RPDA2 is an exceptionally robust handheld PDA which collects and analyses readings from the SunScan Probe. Raw readings, and derived functions such as LAI, can be displayed, reviewed and stored in the field by the SunData Software; groups of readings can be averaged if required.

Readings are stored in the internal memory which holds >1 million readings, or in widely available CompactFlash cards which provide removable data storage. Collected data can be transferred easily to a PC.

Unattended logging with RPDA2

The SunData Software can automatically take readings and averages from the SunScan Probe, at user-defined intervals from 1 second to 24 hours. This can be used for example to obtain diurnal readings of canopy light interception at a particular location.

Radio link

The radio link connects the SunScan Probe and the BF5 reference sensor, eliminating the need for a long connecting cable. The link operates over the 434MHz licence-free frequency and can transmit up to 250m line-of-sight or 100m to 200m in vegetation.

The radio link system comprises an add-on module for the BF5 reference sensor (BF5-RL4) and a specially modified SunScan Probe (SS1-RL4).
Delta-T can also supply HemiView, a system for obtaining and processing hemispherical images of plant canopies. If your research involves high irregular canopies such as forests, please download a HemiView data sheet.