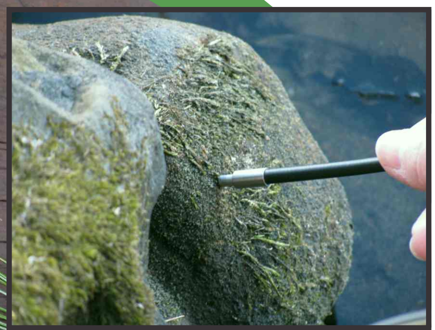
OPTI-SCIENCES, INC.

CCM-300 - The Chlorophyll Content Meter for all leafs including *very small leaves* & difficult to measure samples



Applications

Chlorophyll content measurement of:

- Conifer needles
- Turf grasses
- Arabidopsis
- Immature Rice
- Small leaf grain grasses
- Fruit
- CAM plants such as: Agave, Prickly pear cactus & Pineapple
- Moss & Lichens
- Stems & petioles
- Filamentous Algae on rocks

The CCM 300 Uses a proven fluorescence ratio technique for chlorophyll content measurement.

Features

- Direct readout in chlorophyll content
- Much larger reliable measuring range than absorption style meters. Get better results at higher chlorophyll content Levels. Great for nitrogen management.
- Provides reliable results regardless of leaf or sample size, thickness, and shape, with a high degree of correlation with chemical tests.
- Affordable
- Measurement modes are included for discrete single measurement, and sample averaging of measurements.
- Choice of fluorescence ratio readout or direct readout in relative chlorophyll content.
- Almost unlimited measurement storage - up to 2 gigabytes of non volatile flash memory.
- USB output / files are comma delineated & may be opened directly in Excel or other spread sheets.

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Measures chlorophyll content reliably from 41 mg m^{-2} to 675 mg m^{-2}

Gitelson 1999

Nitrogen management measurements require comparisons of sample plants to well fertilized plants. However, leaf absorption based technology has been shown to provide reliable measurements up to only about 400 mg m^{-2}. Gitelson's ratio fluorescence method has been shown to measure reliably up to 675 mg m^{-2}, providing better measurements of well fertilized plants and better results for nitrogen management work.

The Chlorophyll Content Meter - *for Almost Everything Else*

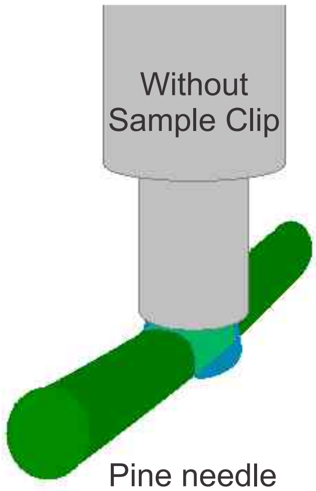
Measuring immature rice

Measuring Arabidopsis thalia
The same day as germination.

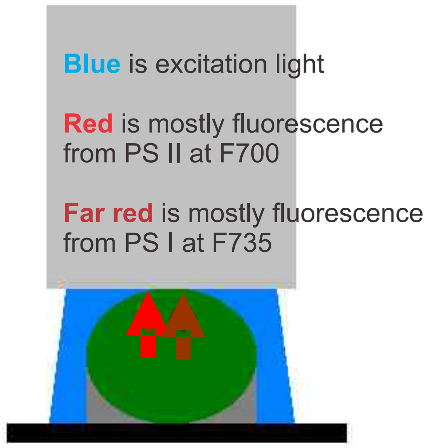
Fruit

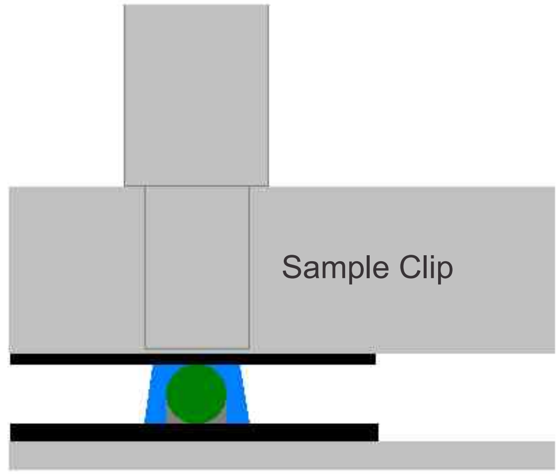
Pineapple

How does it work?



Pine needle

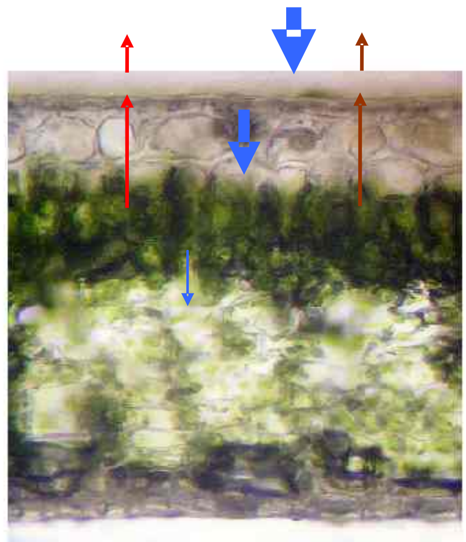




Sample clip on single White Pine needle

F735 / F700 Fluorescence Ratio -

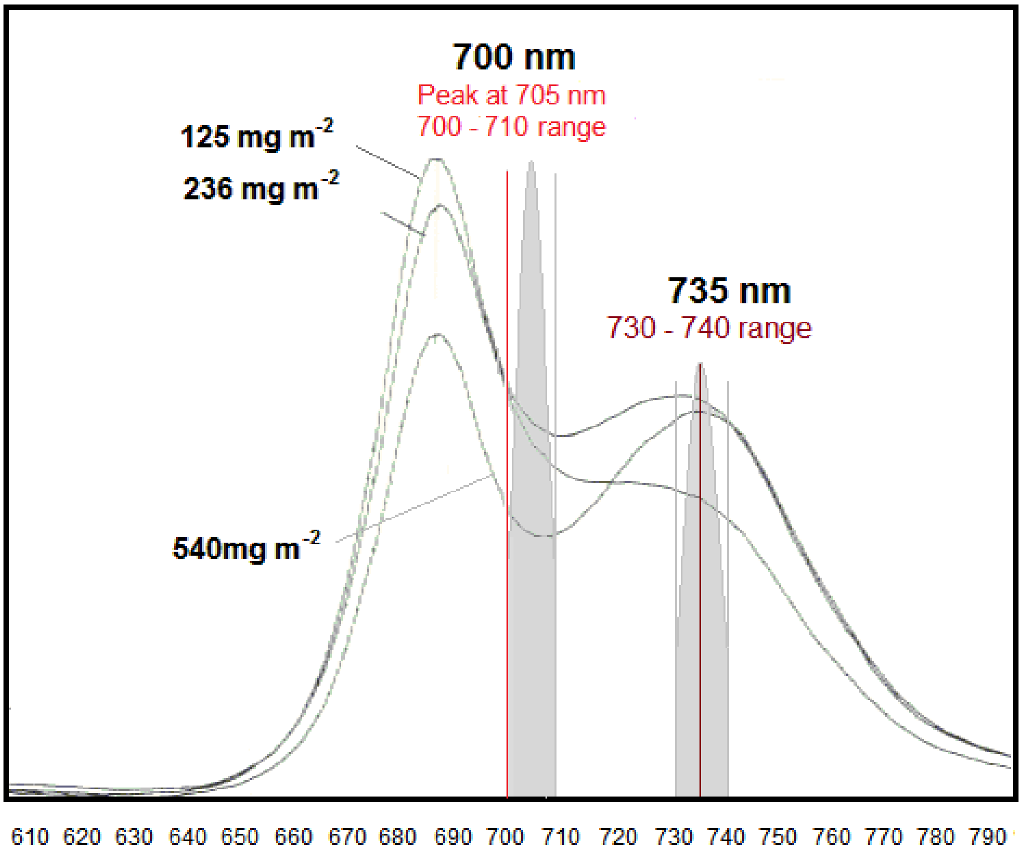
Most of the F 700 fluorescence comes form PS II and most of the F735 fluorescence comes from PS I



Leaf cross section

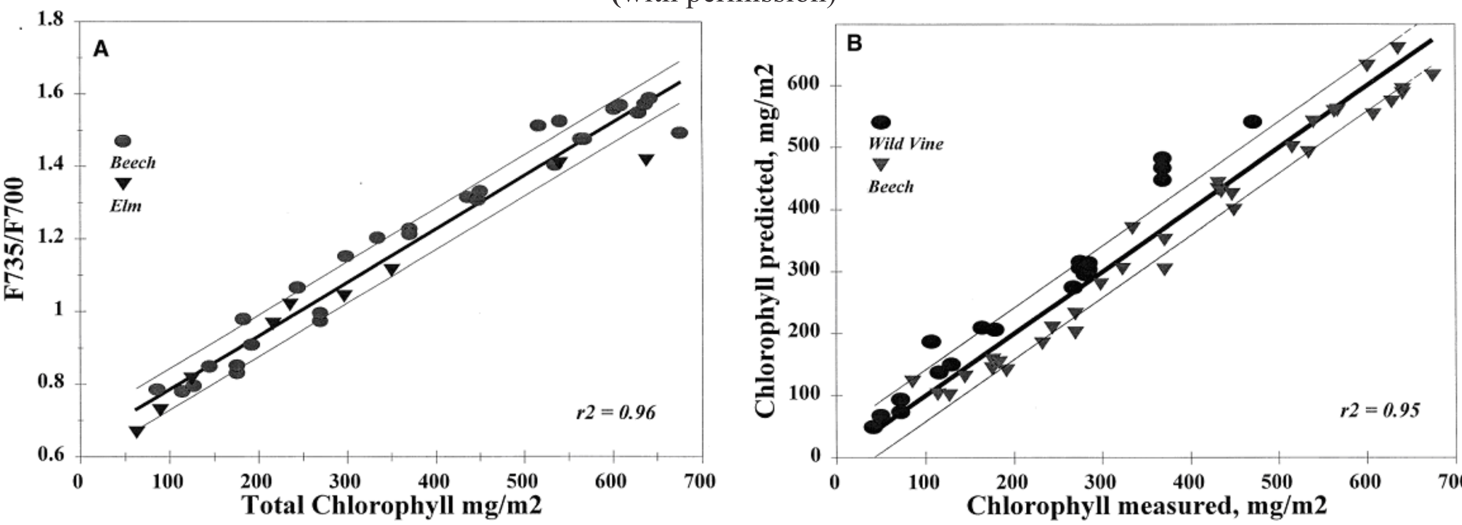
Most of the blue excitation light only penetrates down to the green mesophyll later. For this reason, along with the use of the F700 wavelength, reabsorbed fluorescence is less of problem, and the linear range of measurement is extended beyond absorption techniques

How does it work?



The graph above shows the fluorescence emission spectra for three different chlorophyll content measurement values.

Graphs from Gitelson 1999
(with permission)



The graph on the left shows the F735/F700 ratio measurement vs. total chlorophyll content by chemical test. The center line is a best fit line that shows the linear relationship between the ratio and chemical measurement. The lighter paralell secondary lines represent a single standard deviation.

CCM-300 Chlorophyll Content Meter - for very small leaves and difficult samples

The science for measuring chlorophyll content using chlorophyll fluorescence has been well established. The cost for such systems, however, has been much higher than for the more popular light absorption instruments available. As a result, the ability to measure very small samples, curved samples and very thick samples has been out of reach for most budgets.

With the CCM 300, Opti-Sciences has engineered a fluorescence solution that is much closer to the cost of absorption techniques.

While it is still more cost effective to use the CCM 200plus for medium size and larger leaves found on most wheat or corn plants, the CCM 300 is now in an affordable price range to allow cost effective measurement of chlorophyll content in *very* small leaves, fruit, conifer needles, moss, cactus, lichens, filamentous algae on rocks, and other difficult to measure samples.

Unlike absorption techniques that require full coverage of the measuring aperture, and a relatively flat surface for reliable measurement, this fluorescence technique does not. Instead, light is absorbed by the sample at one wavelength, and it is re-emitted as fluorescence at longer wavelengths.

This allows measurement of curved samples like individual conifer needles, leaves that are too thick for absorption techniques found in CAM plants, and samples that are too small for reliable absorption technique measurements such as moss, turf grasses, Arabidopsis, and immature rice.

Furthermore, the correlation with chemical measuring techniques is excellent, even at higher chlorophyll content levels.

The design of this instrument is based on the science from Gitelson A. A., Buschmann C., Lichtenthaler H. K. (1999)

Samples may be light adapter or dark adapted. It does not significantly change the result. For samples with lower signal strength, measurement reliability is improved by averaging multiple measurements. The measuring aperture does not have to be fully filled.

The fluorescence emission and excitation wavelengths used in this test were designed to provide the maximum chlorophyl measuring range, and minimize possible measuring errors.

Reference for using the technique:

Gitelson A. A., Buschmann C., Lichtenthaler H. K. (1999) “The Chlorophyll Fluorescence Ratio F735/F700 as an Accurate Measure of Chlorophyll Content in Plants” Remote Sens. Enviro. 69:296-302 (1999)

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Technical Specifications

Measured Parameters: CFR or Chlorophyll Fluorescence Ratio - fluorescence emission ratio of intensity at 735nm / 700nm, or readout or relative chlorophyll content in mg/m^{-2}.

Measurement Area: 3 mm diameter circle, external diameter of 4 mm. However, the instrument will reliably measure samples that are much smaller than 3 mm.

Resolution: Ratio 0.01 or 1 mg/m^{-2}.

Repeatability: is dependent on signal strength. For samples with low signal strength, averaging of multiple measurements is recommended. for samples with good signal strength, ratio values of +- 0.03 or better, are common.

Noise: <+/- 2%

Source: (1) LED 460 nm blue diode half band width 15 nm.

Detector: Two solid state, high sensitivity detectors. Band limiting filter sets provided. Dual wavelength detection at the same time. 700nn to 710nm, and 730 nm to 740 nm.

Detection: Modulated light digitally controlled to minimize background detection. Temperature compensation included for light source and detector

Storage Capacity: Up to 2 gigabytes of non-volatile flash memory

Modes: Single point measurement, measurement averaging for 2- 30 samples, averaging with 2 sigma outlier removal, or median determination.

Sample interface: fiberoptic probe 4mm in diameter,

User Interface: 240 x 320 pixel Color touch screen

Output: USB 1.1

Temperature Range: 0-50 Deg C

Power Source: 2 Rechargeable AA batteries

Auto Off Interval: (no key press or download) programable from 0 to 20 minutes.

Size: 12cm x 9cm x 3 cm

Weigh: 0.6 lbs 275g

Measuring time: 5 seconds

Components included: CCM 300 Fluorometer, fiberoptic, sample clip, battery charger, 4 AA NiMH rechargeable batteries, USB cable, carrying case, and manual.

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