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Plant Stress Kit - two measuring systems in one kit

Light adapted protocol: Y(II) meter with *leaf absorptance*
Dark adapted protocol: F_V/F_M meter *with affordable dark clips*

Fv/Fm meter

Y(II) meter

The Plant Stress Kit- By *eliminating the fiber optic*, and using LED technology, both the *light adapted Y(II) meter* and the *dark adapted F_V/F_M meter* provide reliable plant stress measuring capability at a more affordable price.

Capability:

F_V/F_M Meter:

- Measures F_V/F_M & F_V/F_O
- ***Affordable dark adaption clips make measurements of large plant populations in the field much more fun!***
- Graphic display of measurement
- *2 Gigabyte memory*
- *USB port data transfer into Excel*
- *Automated modulated light set up*
- *Screen visible in bright sun light*

Y(II) Meter:

- Measures Y(II) or $\Delta F'/F_M'$ & ETR
- Measures PAR
- Measures leaf area over large area
- ***F_M' correction option included***
- Works in ambient actinic lighting
- *Option to estimate leaf absorptance*
- *Monitor fluorescence mode useful in growth chambers or lab conditions*
- *USB port data transfer into Excel*
- *Automated modulated light set up*
- *2 Gigabytes of memory*
- *Screen visible in bright sun light*

Attention to Detail
Y(II) meter

Measurement of leaf absorptance and leaf transmittance. ETR = Y(II) x 0.84 x 0.5 The average value for leaf absorptance, 0.84, and the ratio of PSII reaction centers to PSI reaction centers, 0.5, are shown as the default values normally used to determine Electron Transport Rate. **The actual leaf absorptance varies for 0.7 to 0.9 in healthy plants (This value varies with species, plant type, growth light conditions, light quality, growth plant stress conditions, current plant stress conditions (Baker 2008), and light intensity (Cazzaniga 2013, Dall'Osta 2014).** While the most accepted way to measure leaf aborptance involves using and integrating sphere, the YII meter very closely approximates these measurements. The Y(II) meter uses RGB sensors to measure the PAR visible spectrum above and below the leaf. Calibration standards are included.

More reliable leaf temperature measurement. By using an ***infrared, non contact sensor***, the Y(II) meter measures leaf temperature over a much larger area including most of the measuring aperture. It provides an average value over that area. The method is completely non-destructive, extremely durable, and provides more reliable measurements (Pons 2009).

Humidity measurement - A solid state sensor that has been used in gas exchange measurement has been included in the Y(II) meter. Relative humidity is shown as a percent.

Automated modulated light intensity adjustment –
The Y(II) meter provides an automated method to set the modulated light intensity correctly. It starts low and adjusts the detector gain control first, until the fluorescence signal is high enough for detection, but low enough so that there it is not driving photosynthesis. While one can still adjust the modulated light intensity manually, the automated method saves time and helps prevent mistakes. The modulated light intensity is less than 0.1 μmols.

Algorithm that prevents saturation pulse NPQ issue. The instrument measures the highest 20 ms. 8 point rolling average to determine the highest F_M and F_M '. This prevents saturation pulse NPQ from being a problem for all samples, even if the Flash width is set too wide. It also eliminates any electronic noise from being a factor.

F_V/F_M meter

The PSK system also includes an inexpensive modulated light F_V/F_M meter for dark adapted measurement.

The meter (shown below) follows proven methods to make reliable measurements. It offers the use of ***affordable dark adaption clips*** for measuring large sample populations quickly at any time of day.

F_V/F_M allows the comparing of samples using a normalized ratio at the same common dark adapted state. While optimal values vary by species between 0.79 to 0.84, lower F_V/F_M values indicate that plant stress is affecting the F_V/F_M measurement and photosystem II.

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Affordable with the latest technology

The Y(II) meter allows the option to use *F_M' correction according to Loriaux & Genty 2013*.

Research shows that under light adaption conditions, *near leaf saturation intensities*, it is impossible to completely close or chemically reduce all Photosystem II reaction centers, even with the most intense saturation flash. Since closing all PSII reaction centers is a requirement for reliable measurement, this method is an ingenious solution. One of the authors, Bernard Genty, was the person that developed the Y(II) measurement protocol back in 1969. The method uses different saturation pulse intensities over the period of one second and uses linear regression analysis to estimate the F_M', maximum variable chlorophyll fluorescence signal, if an infinitely intense saturation pulse is in use.

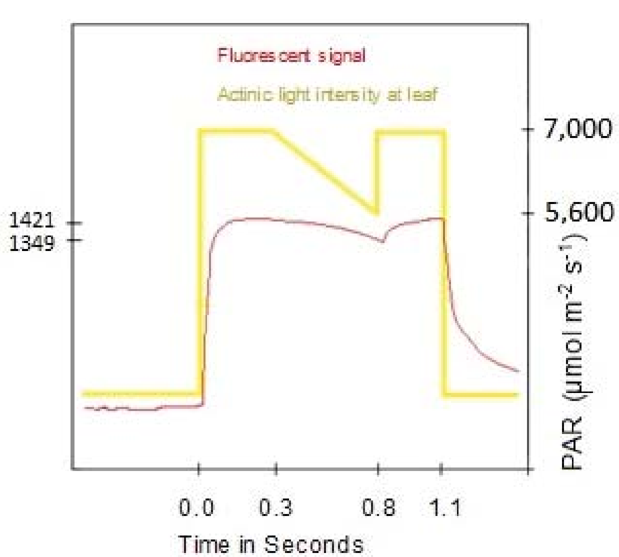
Studies by Earl (2004), and Loriaux (2006), have compared chlorophyll fluorescence measurement results with gas exchange measurements and found that by using the multiple saturation flash method, and regression analysis, an infinite fluorescent saturation light flash intensity could be estimated and used to correct ϕPSII or (Y(II)) and J (ETR) measurements. The research has shown that Y(II) measurements, taken under high actinic light conditions, could be underestimated with up to a 22% error with a square topped saturation flash, and there could be up to a 41% error in ETR values if this method is not used. Square topped flash is also available.

LORIAUX S.D, AVENSON T.J., WELLES J.M., MCDERMITT D.K., ECKLES R. D., RIENSCHE B. & GENTY B. (2013) Closing in on maximum yield of chlorophyll fluorescence using a single multiphase flash of subsaturating intensity Plant, Cell and Environment (2013) 36, 1755–1770 doi: 10.1111/pce.12115

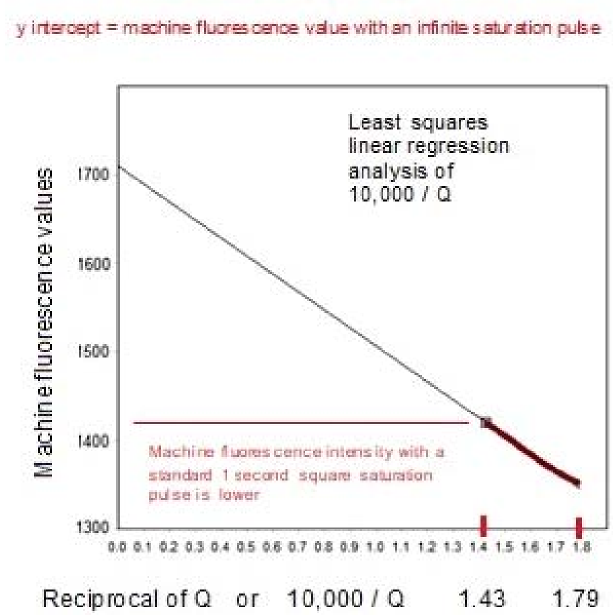
Earl H., Said Ennahli S., (2004) Estimating photosynthetic electron transport via chlorophyll fluorometry without Photosystem II light saturation. Photosynthesis Research 82: 177186, 2004.

Q = PAR a light intensity at the leaf called photosynthetically active radiation.

Representation of how the flash works



Regression Analysis Graph



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Y(II) meter: Parameters Measured and Protocols included:

Y(II): Quantum Yield of PSII (or) $\Delta F/F_M$ ' or Y)
ETR: Electron transport rate
PAR: Photosynthetically Active Radiation value
T: Leaf temperature
F_{MS} (or F_M'): Maximal fluorescence with actinic illumination at steady state fluorescence.
F_S (or F): Fluorescence under steady state conditions s (prior to saturation pulse)
Loriaux 2013 correction of ETR, and F_M ' option included for Y(II) mode and monitor mode.
α, or alpha: - leaf absorptance.
Monitor mode: allows long term measurement day, and night. Allows F_V/F_M, YII, ETR, leaf absorptance, PAR, leaf temperature, relative humidity, and calculation of NPQ.
(Mode is designed for growth chamber & lab work only not for field use)
Relative Humidity: 5% to 95% to +- 2% over the range.
Will work with any USB power supply or AC. Has tripod mount (tripod not included).

With F_V/F_M meter:

F_V/F_M: Maximum Photochemical efficiency of PSII
F_V/F_O: A more sensitive detector of stress than F_V/F_M but it does not measure plant efficiency.
Fo: Minimum fluorescence
FM: Maximal fluorescence
Fv: Variable fluorescence

Automated modulated light set-up option included.

Will work with any USB power supply or AC.

USB data file output in a comma delineated format can be opened directly in Excel or other spread sheet products without additional software.

The size of the battery supplied allows easy insertion into clothing pockets.

Opti-Sciences Inc.

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Light Sources:
Saturation pulse Y(II) meterWhite LED with 7,000 µmols with PAR clip
Saturation pulse - F_V/F_M meter - Red LED up to 6,000 µmols
Modulated light Red:660 nm LED with 690 nm short pass filter.
Actinic light source: - Ambient light only Detection method: Pulse modulation method.
Detector & Filters: A PIN photodiode with a 700 ~ 750 nm bandpass filter.
Sampling Rate: Auto-switching from 1 to 10,000 points per sec., depending on test & on phase of test
Automated routine to optimally set the modulated light intensity. The modulated light may also be set manually
Test Duration: About 3 seconds for fast tests and may be run for several months in monitor mode.
Storage Capacity: 2 gigabyte of non-volatile flash memory, supporting almost unlimited data sets and traces.
Special Algorithms: 8 point rolling 25 ms average to determine highest F_M , & F_M ' , eliminates saturation pulse NPQ & any electronic noise as an issue.
Output: USB comma delineated files may be opened in Excel.® No special software is required.
User Interface: Display: Graphic black and white display Menu driven with arrows. 132 x 32 pixels.
Power Supply: 8 hour USB lithium ion battery is standard, but any USB battery can be used. mains current may also be used. Mains plug is also supplied. 2 batteries are supplied if both the Y(II) & the F_V /F_M meter are purchased. USB chargers included.
Dimensions: Both the Y(II) meter and the F_V/F_M meter are 9 inches long with a USB cable that is 65 inches long. A case that is 14”x 11”x 6” - (included).
Weight:
Y(II) meter w/battery & USB cable- 1 lbs. or 0.45 kg. F_V/F_M meter w/bat. & USB cable- 0.8 lbs. or 0.36 kg. Complete w/case & accessories- 4.3 lbs. or 1.95 kg.
Operating temperature range $0^{o}C$ to $50^{o}C$
Dark adaptation clips - 10 supplied with case
Absorptance measuring standard - 2 included.

PSK System - Journal reference:

Boris LAZAREVIĆ, Tomáš LOŠÁK, Ahmad M. MANSCHADI (2018) Arbuscular mycorrhizae modify winter wheat root morphology and alleviate phosphorus deficit stress, Plant Soil Environ., Vol. 64, 2018, No. 1: 47–52, doi: 10.17221/678/2016-PSE