

ForceA

DUALEX[®]

Optical leafclip meter

Measuring the **chlorophyll**
and **polyphenols**
contents in plants.



Non-destructive



Real time results



Any plant leaves

GPS and data logger





SENSOR

DUALEX® is a **leafclip meter** that can accurately determine the **chlorophyll**, **flavonols** and **anthocyanins** contents in leaves.

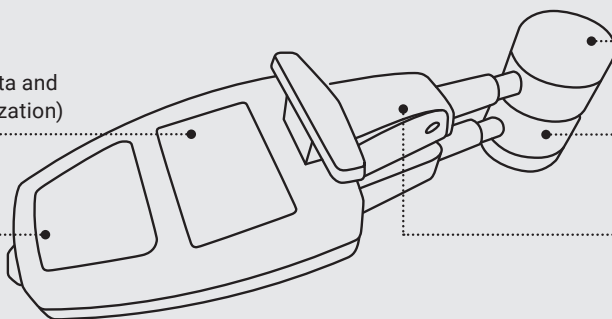
DUALEX® also provides the NBI® (Nitrogen Balanced Index), a **good indicator of plant nitrogen status**.

DUALEX® is mainly used in Plant Sciences for **abiotic stress studies** (physiology, agronomy, ecology, ...).

Zoom on the product

LCD screen (data and settings visualization)

Keyboard



Light sources

Light detection

Opening handle

FEATURES



Non-destructive measurement

Clipping the leaf **doesn't cause any damage**. With DUALEX® it's possible to measure the same leaf multiple times.



Adapted to experimentation

DUALEX® offers the **possibilities to:**

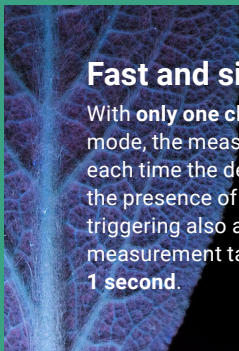
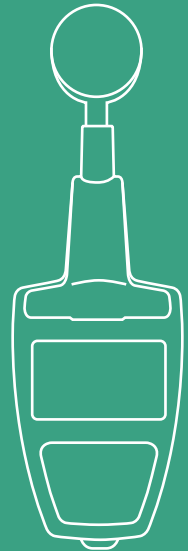
- Remove the last measurement.
- Manage measurement groups (two levels of classification).
- Record more than 10,000 multiparametric data.



Lightweight and compact

DUALEX® is **easily portable and can be used frequently**.

Not sensitive to ambient light, DUALEX® **can be used in labs, greenhouses or fields**.



Fast and simple

With **only one clip**, in automatic mode, the measurement is recorded each time the device detects the presence of a leaf (manual triggering also available). One measurement takes **less than 1 second**.

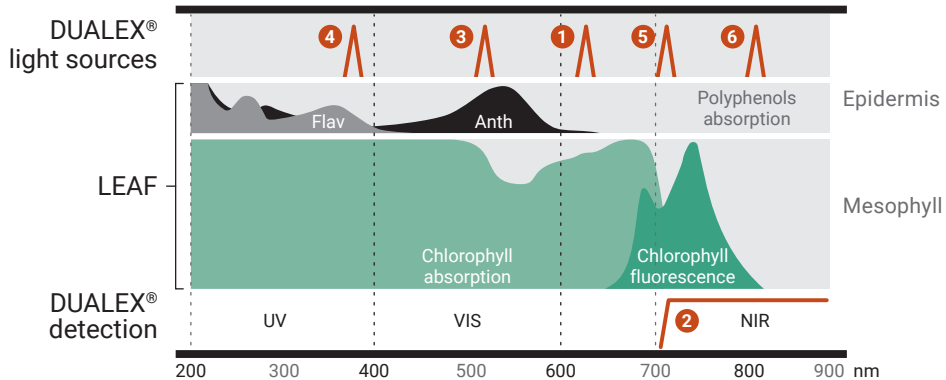
Reliable and practical

With a measurement area of 19,6 mm², DUALEX® has a good sampling area. Thanks to a 8 cm long clip it's **possible to measure the middle of the leaf** where chlorophyll is less variable and more representative.

PRINCIPLES

Accurate measurement of chlorophyll

DUALEX® measures the chlorophyll content of leaf thanks to a transmittance ratio at two different wavelengths. One in the far-red **5** absorbed by chlorophyll and one in the near-infrared **6** as reference.



The only leafclip sensor to measure flavonols and anthocyanins contents

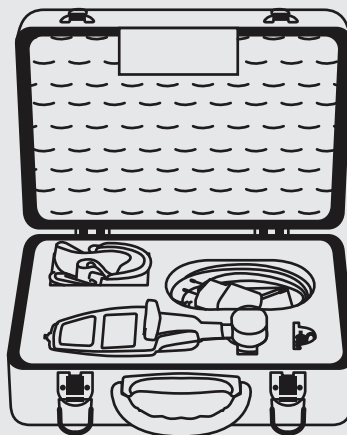
DUALEX® measures flavonols and anthocyanins content of the leaves epidermis thanks to a differential ratio of chlorophyll fluorescence.

Near-infrared chlorophyll fluorescence is measured under a first reference excitation light not absorbed by polyphenols **1**. It is compared to a second sampling specific light absorbed by polyphenols (e.g. green **3** for anthocyanins or UV **4** for flavonols).

Only a fraction of this light reaches the chlorophyll in the mesophyll and can generate near-infrared chlorophyll fluorescence **2**. This principle of measurement is called the screening effect of polyphenols on chlorophyll fluorescence.

TECHNICAL SPECIFICATIONS

Measuring material	Plant leaves
Measuring system	Transmittance and screening effect on chlorophyll fluorescence
Index measured	Chlorophyll (CHL), Flavonols (FLAV), anthocyanins (ANTH), NBI
Accuracy	5%
Reproducibility	4,5% for CHL, 3,5% for FLAV and ANTH
Repeatability	1,3% for CHL, 2% for FLAV and ANTH
Area measured	19,6 mm ²
Leaf thickness	1.5 mm maximum
Measurement time	< 1 s
User interface	LCD screen Sound warning
Positioning	Internal GPS
Relative accuracy	< 2,5 m (CEP, 50%, 24 h static)
Storage capacity	10 000 multiparametric data
Data output	.csv file
Data transfer	USB
Operating temperature	From 5 to 45 °C
Battery	Li-ion rechargeable
Autonomy	6 hours
Total weight	220 g
Size	205 x 65 x 55 mm



DUALEX® case contains:

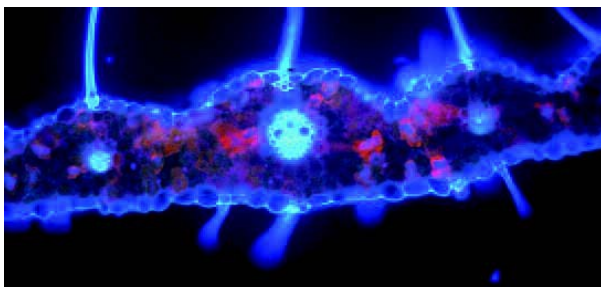
- Dualex leafclip sensor.
- USB cable and charger.
- Hand wrist strap.
- Cleaning swab.



Dualex® - zur optischen Messung von Flavonolen und Chlorophyll-Gehalt in der Epidermis von Blättern.

Dank einer mehr als 15-jährigen Forschung ist Dualex® ein tragbarer, optischer Sensor, der den Flavonol- und Chlorophyll-Gehalt der Blattepidermis in Echtzeit und auf nicht destruktive Weise misst. Dies ermöglicht der speziell ausgeführte Blattclip und lässt somit Rückschlüsse auf die Pflanzen-/Blattgesundheit zu.

Die im Dualex® verwendete patentierte Technologie basiert auf der Fluoreszenz des Chlorophylls und des Screening-Effekts durch Flavonole aus der Blattepidermis. Er ist unempfindlich gegenüber einer variablen Fluoreszenz des Chlorophylls und unabhängig vom Chlorophyllgehalt des Blattes. Die Messungen sind nicht destruktiv, sehr schnell und einfach. Sie erfordern keinerlei Einstellung und können unter Lichtbedingungen im Außenbereich durchgeführt werden. Es ist keine Vorbereitung erforderlich.



Dualex® misst rasch und quantitativ den Flavonolgehalt von Obst und Gemüse (Blätter und Haut) für die folgenden Themen:

Agroindustrielle Anwendungen:

Polyphenol-Antioxidantien
Nutrazeutika und medizinische Lebensmittel
Farbstoffe



Landwirtschaftliche Anwendungen:

- Überwachung der Düngung
- Qualitätsbewertung der Ernte (Proteine, Entwicklung des Öko-Produkts, etc.)
- Lichtschutz, niedrige Temperaturen
- Verhinderung von Verbrennungen
- Farbe (Flavonole)
- Sortenauswahl

Diese Technologie erlaubt den Erhalt von:

- Messungen des Chlorophylls und des Flavonols
- Schnelle Messungen (<1 Sek.)
- Nicht destruktive Messungen
- Eine Diagnose in Echtzeit und in situ

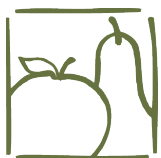


Das **Dualex®** ist ein Produkt und Markenzeichen der Force-A, Orsay, Frankreich.



Technische Daten:

Gemessenes Objekt	Pflanzenblätter
Gemessener Parameter:	Optische Absorption bei 375nm (bei Flavonolen) Optische Übertragung bei 2 Wellenlängen im nahen IR- Bereich
Messung	Druck auf Start-Taste oder Schließung der Blattclips (zu wählen)
Messbereich	5mm Durchmesser
Akquisitionszeit	< 500ms
Speicherkapazität	Rund 10.000 Multiparameter- Messungen
Klassifizierung	2 Niveaus
Flavonol- Gehalt	Von 0,00 bis 3,00 (Dualex® Einheit, problemlos in µg/cm ² konvertierbar) 1) Absorptionsgenauigkeit (1s) 5% 2) Wiederholbarkeit (1s) 2.5% 3) Reproduzierbarkeit (1s) 3.5%
Chlorophyll-Gehalt	Von 0 bis 150 (Dualex® Einheit, problemlos in µg/cm ² konvertierbar) 1) Wiederholbarkeit (1s) 1.3% 2) Reproduzierbarkeit (1s) 4.5%
Temperaturbereich	Von 5°C bis 40°C (bei einer Absorptionsabweichung von unter 2%)
Lichtquellen	4 LED: 1 UV-A, 1 Rot und 2 NIR
Detektor	1 Silizium-Fotodiode
Benutzerschnittstelle	LCD-Bildschirm, Alarmton
Datenschnittstelle	USB-Anschluss - Mit Excel-Arbeitsblättern kompatible Datenorganisation
Batterie	Wieder aufladbare Li- Ionenakku (eigene) Autonomie 10 Stunden Aufladezeit 4 Stunden
Gesamtgewicht	220g (mit den Akkus)
Größe des Blattclips	205mm x 65mm x 55mm
Geolokalisierung	Internes GPS
Präzision	> 1m
Sprachen	Englisch und Französisch
Sicherheit	Schlaufe
Update	Internet Online-Update



Obstqualität – Inhaltsstoffe

Dualex®



Umweltanalytische
Produkte GmbH

Was unsere Kunden sagen:



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In our research group (Horticultural Sciences, University of Bonn, Germany) we use both the MULTIPLEX® and DUALEX® units to sense the physiological response of plants to biotic and abiotic stresses. Of particular interest is the physiological adaptation of field crops (e.g., barley and sugar beet) and horticultural crops (e.g., tomato, sweet pepper, apple trees, medicinal plants) to water shortage. In addition, we look at the relevance of other factors such as mineral nutrition as well as light intensity and light quality for the plant physiology and product quality. In this frame, our overall aim is to estimate the impact of environmental constraints on the fitness of the plants and their adaptation to the stressful situations (e.g., degradation of chlorophyll, accumulation of secondary metabolites) leading to changes in plant performance and product quality. The big number of parameters provided by the MULTIPLEX®/DUALEX® enables a huge flexibility for their use in basic and applied research in a broad range of experimental situations. Further, the compactness and robustness of the equipments open promising perspectives for many in-field applications e.g., in the scope of stress physiology studies, field-phenotyping and precision agriculture. Finally, the fast and professional technical support provided by the FORCE-A team is exemplar; we know the company and use their instruments since 2009, and we only made positive experiences. In our group, the MULTIPLEX® and DUALEX® units assumed a central role for the fast and in situ evaluation of the physiological status of plants, leaves and fruits.

[Close](#)

PD Dr. Maurício Hunsche, Horticultural Science Group (chair: Prof. Dr. Georg Noga), Faculty of Agriculture, University of Bonn

Morales, L.O., Tegelberg, R., Brosche, M., Lindfors, A., Siipola, S., Aphalo, P.J. (2011) Temporal variation in epidermal flavonoids due to altered solar UV radiation is moderated by the leaf position in *Betula pendula*. *Physiologia Plantarum*, 143: 261-270. **(Dx)**

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Veröffentlichungen:

Cerovic, Z.G., Masdoumier, G., Ben Ghazlen, N., Latouche, G. (2012) A new optical leaf-clip meter for simultaneous non-destructive assessment of leaf chlorophyll and epidermal flavonoids. *Physiologia Plantarum*, ISSN 0031-9317. **(Dx)**

Coelho, F.S., Rezende Fontes, P.C., Finger, F.L. & Cecon, P.R. (2012) Evaluation of potato nitrogen status based on polyphenol and chlorophyll leaf content *Pesquisa Agropecuaria Brasileira*, 47(4): 584-592 **(Dx)**

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