PLANT BASED IRRIGATION SCHEDULING

PMS INSTRUMENT COMPANY

AGRICULTURAL PRODUCT CATALOG

WWW.PMSINSTRUMENT.COM

How It Works

Simply put, the pressure chamber is just a device for applying pressure to a leaf or small shoot. Most of the leaf is inside the chamber, but the cut end of the stem (the petiole) is exposed outside the chamber *(see illustration below)*. The amount of pressure it takes to cause water to appear at the cut surface of the petiole tells you how much tension the leaf is experiencing on its water supply. A high value of pressure means a high value of tension and a high degree of water stress. These stress levels vary within different species. The unit of pressure most commonly used is Bar (1 Bar = 14.5 PSI).

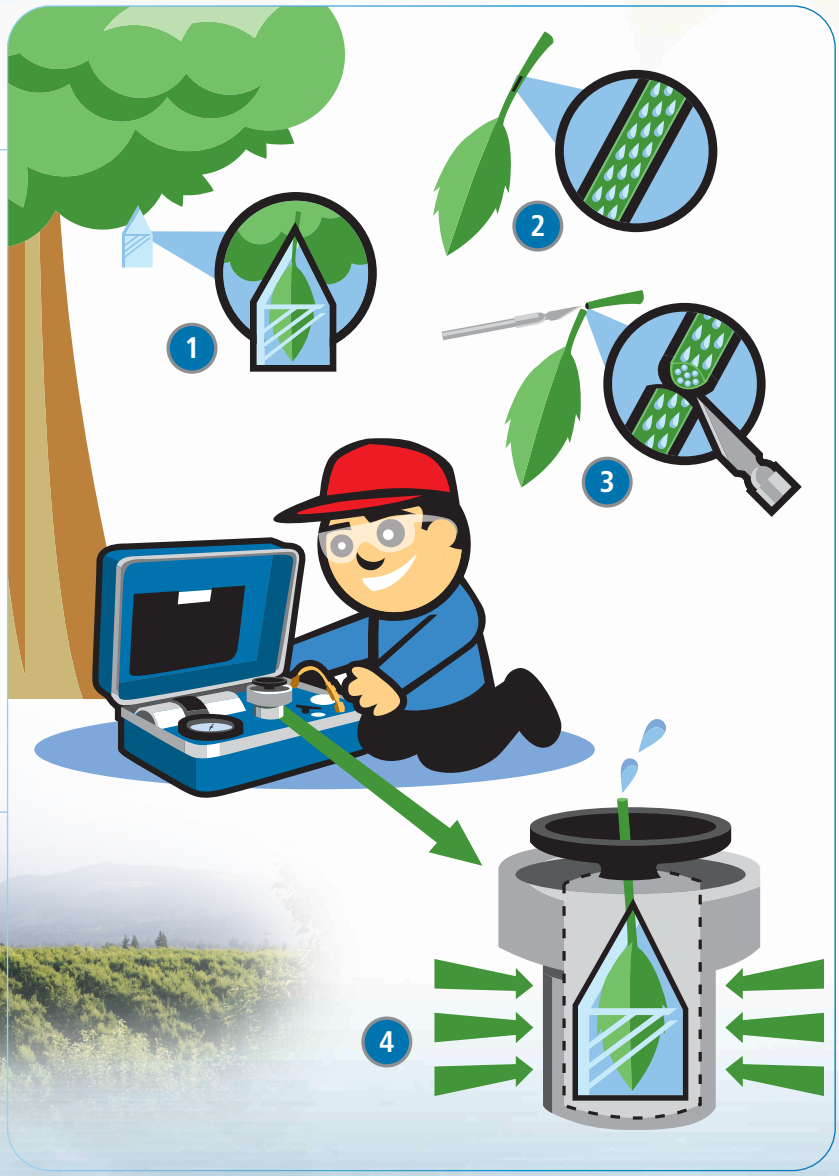
4 SIMPLE STEPS

1 A shaded, lower canopy leaf is covered with foillaminate bag.

2 The water in the stem is under tension.

3 The stem is cut and the leaf with bag is sealed inside chamber.

4 Pressure is applied to the leaf until water appears at the cut surface.



What is Plant Moisture Stress?

The water status of plants, and how to measure it, has received much attention in recent years and for good reason. Plant moisture stress (PMS), or plant water potential, indicates the demand for water within a plant. A PMS measurement indicates the water status of a plant from the "plant's point of view." PMS also tells how the environment affects the plant. High PMS levels cause many physiological processes, such as slowing or stopping photosynthesis. Conditions producing high PMS reduce plant growth and may eventually result in the death of the plant. PMS readings can be used to evaluate the plants need for water or how well it is adapted to its environment.

Why Measure Plant Moisture Stress?

Measuring PMS gives an indication of a plants ability to grow and function and can be used as a guide for managing the plants moisture environment so as to improve growth and crop yield. Air temperature, wind speed, humidity, and soil moisture are all integrated by the plant into one single value — PMS. A measure of PMS thus gives an evaluation of the moisture status of a plant from the plants point of view. It is an excellent tool for aiding in irrigation scheduling for crop plants such as almonds, walnuts, prunes, cotton, and wine grapes or for any application where plant growth is managed such as in nurseries, greenhouses, seedlings or reforestation.

PMS - Meaning and Importance

The pressure chamber can be thought of as measuring the "blood pressure" of the plant — except that for plants it is water rather than blood. Additionally, the water is not pumped by a heart using pressure, but rather pulled with a suction force as water evaporates from the leaves. Water within the plant mainly moves through very small inter-connected cells, collectively called xylem, which are essentially a network of pipes carrying water from the roots to the leaves. The water in the xylem is under tension. As the soil dries or humidity, wind or heat load increases, it becomes increasingly difficult for the roots to keep pace with evaporation from the leaves. This causes the tension to increase. Under these conditions you could say that the plant begins to experience "high blood pressure."

Since tension is measured, negative values are typically reported. An easy way to remember this is to think of water stress as a "deficit." The more the stress the more the plant is experiencing a deficit of water. The scientific name given to this deficit is the "water potential" of the plant. The actual physics of how the water moves from the leaf is more complex than just "squeezing" water out of a leaf, or just bringing water back to where it was when the leaf was cut. However, in practice, the only important factor is for the operator to recognize when water just begins to appear at the cut endof the petiole.

The Plant Moisture Stress (PMS) reading at any given time reflects the plant's interaction with the water supply and the demand for water placed upon the plant by its environment *(see diagram on back cover).* Since these factors are almost always changing, PMS is nearly always changing. The time of measurement therefore requires careful consideration — PMS is most at midday and least just before sunrise. Pre-sunrise PMS values will usually reflect average soil moisture tension, if the soil is uniformly irrigated. Midday PMS values reflect the tension experienced by the plant as it pulls water from the soil to satisfy the water demand of the atmosphere.

Model 615

PRESSURE CHAMBER INSTRUMENT

Max Operating Pressure:	40 bar (4 Mpa)
Chamber Construction:	Anodized Aluminum
Chamber Size:	2.5" Diameter x 5.0" Deep
Read-out:	Bourdon Tube Gauge
Size (L x W x H):	22 x 15 x 10 (inches) 56 x 38 x 26 (centimeters)
Weight:	32 lbs - 14 kg
Gauge:	4 1/2" Dia. Gauge, 1/2 of 1% accuracy
Aluminum Tank:	207 Bar/3000 PSI Max Pressure 20 Cubic Foot

INSTRUMENT INCLUDES:

- 1/4 inch Compression Gland Sealing System
- 5 Extra 1/4 Compression Gland Gaskets
- 6 foot Filling Hose
- 1 Solid Lab Stopper for instrument testing
- O-Ring Lubricant and Lithium Grease
- 1 1/32 inch Wrench and 3/32 inch Allen Key for Control Valve Adjustment
- Color Operating Instructions Manual
- Safety Glasses

RECOMMENDED ACCESSORIES:

- Various Sizes of Compression Gland Gaskets
- Volume Reducer - *(depending on plant type)*
- Stem Water Potential Bags for Orchard Crops.

- Necessary accessories will depend upon users application.

Model 600

PRESSURE CHAMBER INSTRUMENT

Max Operating Pressure:	40 bar (4 Mpa)
Chamber Construction:	Anodized Aluminum
Chamber Size:	2.5″ Diameter x 5.0″ Deep
Read-out:	Bourdon Tube Gauge
Size (L x W x H):	13 x 11 x 10 inches 33 x 28 x 24 centimeters
Weight:	14 lbs - 6 kg
Gauge:	4 1/2″ Diameter Gauge, 1/2 of 1% accuracy

INSTRUMENT INCLUDES:

- 1/4 inch Compression Gland Sealing System
- 5 Extra 1/4 Compression Gland Gaskets
- 6 foot Filling Hose
- 1 Solid Lab Stopper for instrument testing
- O-Ring Lubricant and Lithium Grease
- 11/32 inch Wrench and 3/32 inch Allen Key for Control Valve Adjustment
- Color Operating Instructions Manual
- Safety Glasses

RECOMMENDED ACCESSORIES:

- Portable Tank
- 1/2 or full height Volume Reducer - *(depending on plant type)*
- Lighted Hand Lens or Instrument Mounted Eye Lens
- Extra sealing gaskets
- Stem water potential bags for orchard crops.

PUMP-UP PRESURE CHAMBER

The Pump-Up Pressure Chamber is different from the conventional gas chamber in that it does not require a source of compressed gas such as nitrogen. The instrument produces pressure in the chamber by pumping it. The relatively small chamber allows the user to achieve about 1/2 bar (7.25 psi) pressure per stroke.

Max Operating Pressure:	20 bar (2 Mpa)
Chamber Construction:	Aluminum (5"Vert. Depth x 2.75" Wide x 5/8" Breadth)
Read-out:	Bourdon Tube Gauge
Size (L x W x H):	38 x 14 x 6 inches 97 x 36 x 17 centimeters
Weight:	7.5 lbs (3.5 kg)
Gauge:	2 1/2" Diameter Gauge; 1% accuracy

INSTRUMENT INCLUDES:

- Small, or Large Grass sealing lid
- O-ring lubricant
- Lithium grease to grease piston
- Extra rubber piston cup
- Color Operating Instructions Manual.
- 7 power eye lens that mounts to instrument
- 5 extra gaskets
- Safety Glasses

THE SMALL LID accepts samples up to .140 inches or just slightly larger than 1/8 inch in diameter. The stem must be at least 3/4 inch in length to pass through the lid. This system was designed for use with orchard tree leaves like prunes. The samples are sealed into a compression gland mounted in the chamber lid, which uses various sizes of the O-rings.

THE LARGE LID accepts samples up to 1/4 inch. The stem must be at least 11/8 inch in length to pass through the lid. This system was designed to fit leaves with larger diameter stem. The samples are sealed into a compression gland mounted in the chamber lid. This system uses Compression Gland Gaskets to seal the sample.

THE GRASS LID is designed for making measurements on bladed grasses. The gasket allows for samples up to 3/4" wide and 1/8" thick. This system uses Grass Compression Gland Gasket.

STEP 1

INTAKE STROKE

Lift up instrument to take up air.

STEP 2

COMPRESSION STROKE

Push down instrument to compress air into chamber

STEP 3

CHECK

Look to see if water has come to surface of cut stem

ACCESSORIES

COMPRESSION GLAND SEALING GASKETS

Available in: 1/8", 1/4", 3/8", 1/2" and
Special "Almond Gasket" for short petioles like almond.

COMPRESSION GLAND INSERT

Available in: 1/8", 1/4", 3/8", 1/2"and
Special "Almond Insert"

NOTE: Insert should be matched with appropriate sized gasket.

PORTABLE TANK

Lightweight high pressure (207 Bar) 20 cu ft aluminum tank. Comes with a nurse tank adapter and connects easily to instrument with hose supplied from the instrument. 8.6 lbs (3.9 kg)

VOLUME REDUCERS

Conserves gas and allows for more measurements per tank. The volume reducer is slipped into the chamber prior to sample. Available in either full or half height. May be drilled out to accommodate different plant materials.

LENS ACCESSORIES

EYE LENS WITH LANYARD

7 Power (7X) foldable eye lens on a 36 inch lanyard. Eye lens has a swing-away nickel plated case that protects it and serves as a handle.
Lens is a high quality Hastings Triplet Magnifier.
Lanyard slips easily over the neck of the user to keep from loosing magnifier in the field.

3.5 Power Lens

MOUNTED EYE LENS

The instrument mounted eye lens is mounted directly to the instrument and has a 6 inch flex-arm (gooseneck) that allows it to be held at focal point for a hands free operation. The eye lens can then be quickly swiveled away to change samples in the chamber.

LIGHTED HAND LENS

5 power illuminated LED

Top View *Bottom View*

GRASS COMPRESSION GLAND

Works just like our normal round stem compression gland system but is designed for sealing bladed grasses or corn. The sealing "slit" is 3/4" long and 1/8" wide at the widest place - it has an eliptical opening.

MEASURING LEAF WATER POTENTIAL IN WINE GRAPES

To see this tutorial in more detail and in video format go to: www.pmsinstrument.com
All reading should be taken within 2 hours of solar noon.

1: Select a leaf from a good representative vine. Ensure it is at least 5 plants from the end of the row and a leaf that is in full sun. Place a plastic sandwich bag over the leaf and cut from vine with a razor.

2: Take the bagged leaf and insert the petiole through the bottom of the chamber lid. The petiole should barely protrude through the lid. Turn the Compression Gland Screw clockwise to lock the sample into the chamber lid.

3: Place the bagged leaf into the chamber. Press down and turn clockwise to lock the lid. The instrument Rate Valve should be set to 1/2 bar per second or slower.

4: Turn the Control Valve to the "ON" position to pressurize the chamber. The end of the petiole should be dry at first. The end point can be observed when water comes to the cut surface of the petiole. A slight color change will happen as the water appears. Immediately turn the Control Valve to the "OFF" position and record the pressure indicated on the gauge.

ADDITIONAL TIPS FOR TAKING MEASUREMENTS IN THE VINEYARD:

1. Three readings per irrigation block.
2. Re-cutting petioles is not recommended nor necessary.
3. Extending readings past the two hour window of solar noon creates inaccurate readings.
4. Recording air temp, humidity, wind speed, cloud cover, and other relevant weather conditions will help correlate variations in readings from day to day.
5. Ensure you pay close attention to the end-point. Not stopping the pressure right when the water appears will create an inaccurate reading.
6. Testing without a plastic bag can create differences as great as 2 bar.

MEASURING STEM WATER POTENTIAL IN WALNUT TREES

To see this tutorial in more detail and in video format go to: www.pmsinstrument.com

1: Select a leaf from an established limb in the lower canopy and on the shaded side of the tree. Place the foil SWP bag on the leaf. Leave the bag on the leaf for a minimum of 15 minutes.

2: Cut the sample leaf from the tree. Insert the petiole into the hole on the bottom of the lid and turn compression gland screw clockwise to secure the sample into the lid.

3: Immediately place the sample leaf still inside the bag into the pressure chamber. Lock the lid in place by pressing down and turning clockwise. The instrument rate valve should be set to ½ bar per second or slower.

4: Turn the Control Valve to the "ON" position to pressurize the chamber. The end of the petiole should be dry at first. The end point can be observed when water comes to the cut surface of the petiole. A slight color change will happen as the water appears. Immediately turn the Control Valve to the "OFF" position and record the pressure indicated on the gauge.

ADDITIONAL TIPS FOR TAKING MEASUREMENTS IN THE ORCHARD:

1. Choose a sample tree that is 3-5 rows from the edge of the orchard to avoid the additional stress in these areas.
2. Re-cutting petioles is not recommended nor necessary.
3. Extending readings past the two hour window of solar noon creates inaccurate readings.
4. Recording air temp, humidity, wind speed, cloud cover, and other relevant weather conditions will help correlate variations in readings from day to day.
5. Ensure you pay close attention to the end-point. Not stopping the pressure right when the water appears will create an inaccurate reading.
6. Testing without a stem water potential bag can create an inaccurate reading.

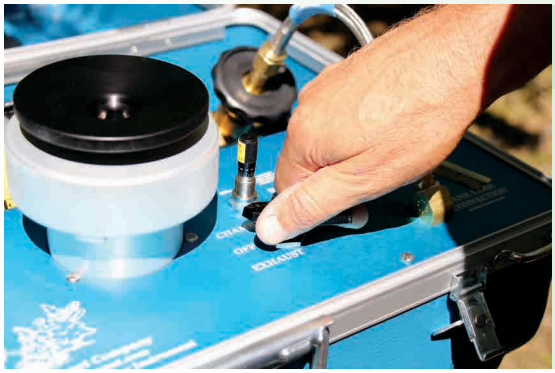
MEASURING STEM WATER POTENTIAL IN ALMOND TREES

To see this tutorial in more detail and in video format go to: www.pmsinstrument.com

1: Select a leaf from an established limb in the lower canopy and on the shaded side of the tree. Place the foil SWP bag on the leaf. Leave the bag on the leaf for a minimum of 15 minutes.

2: Cut the sample leaf from the tree. Insert the petiole into the hole on the bottom of the lid and turn compression gland screw clockwise to secure the sample into the lid.

3: Immediately place the sample leaf still inside the bag into the pressure chamber. Lock the lid in place by pressing down and turning clockwise. The instrument rate valve should be set to ½ bar per second or slower.



4: Turn the Control Valve to the "ON" position to pressurize the chamber. The end of the petiole should be dry at first. The end point can be observed when water comes to the cut surface of the petiole. A slight color change will happen as the water appears. Immediately turn the Control Valve to the "OFF" position and record the pressure indicated on the gauge.

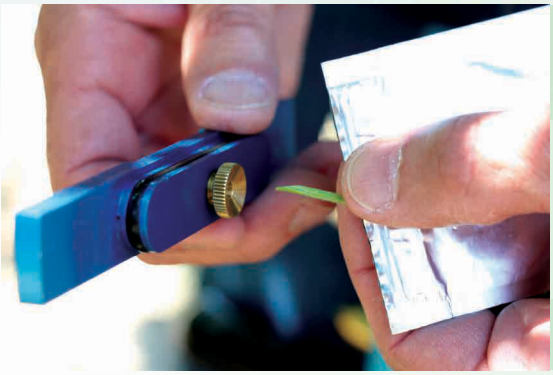
ADDITIONAL TIPS FOR TAKING MEASUREMENTS IN THE ORCHARD:

1. Choose a sample tree that is 3-5 rows from the edge of the orchard to avoid the additional stress in these areas.
2. Re-cutting petioles is not recommended nor necessary.
3. Extending readings past the two hour window of solar noon creates inaccurate readings.
4. Recording air temp, humidity, wind speed, cloud cover, and other relevant weather conditions will help correlate variations in readings from day to day.
5. Ensure you pay close attention to the end-point. Not stopping the pressure right when the water appears will create an inaccurate reading.
6. Testing without a stem water potential bag can create an inaccurate reading.

MEASURING STEM WATER POTENTIAL IN PRUNE TREES

To see this tutorial in more detail and in video format go to: www.pmsinstrument.com

1: Select a leaf from an established limb on the lower canopy and on the shaded side of the tree. Place the foil SWP bag on the leaf. Leave the bag on the leaf for a minimum of 15 minutes.



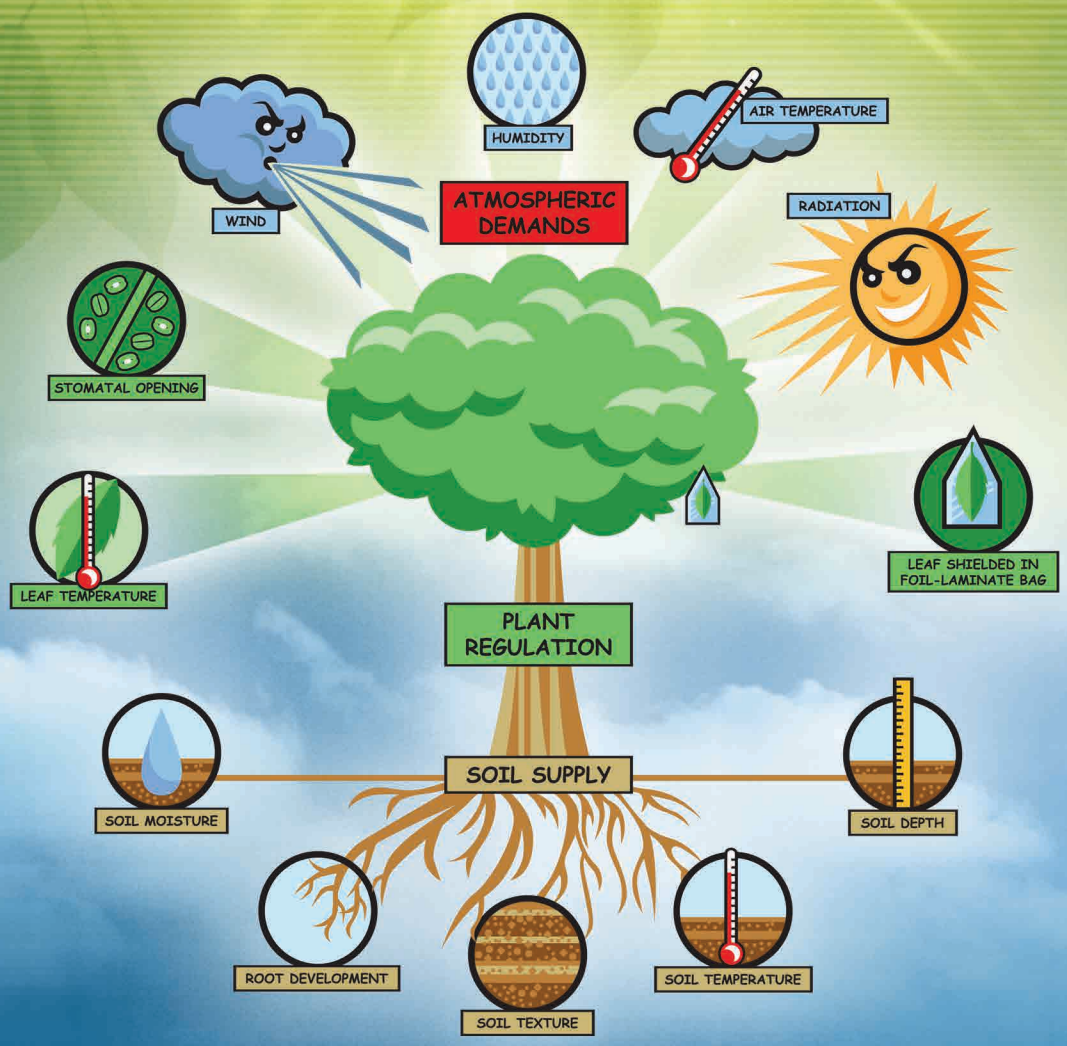
2: Cut the sample leaf from the tree. Insert the petiole into the hole on the bottom of the lid and turn compression gland clockwise to secure the sample into the lid.

3: Immediately place the sample leaf still inside the bag into the pressure chamber. Lock the lid by securing the two push pins in place. Swing the mounted eye lens into position and focus as needed.

4: Lift the instrument up to take in air. Push the instrument down to compress air into the chamber. Check to see if water has come to the cut surface of the petiole. Repeat until end point has occurred.

ADDITIONAL TIPS FOR TAKING MEASUREMENTS IN THE ORCHARD:

1. Choose a sample tree that is 3-5 rows from the edge of the orchard to avoid the additional stress in these areas.
2. Re-cutting petioles is not recommended nor necessary.
3. Extending readings past the two hour window of solar noon creates inaccurate readings.
4. Recording air temp, humidity, wind speed, cloud cover, and other relevant weather conditions will help correlate variations in readings from day to day.
5. Ensure you pay close attention to the end-point. Not stopping the pressure right when the water appears will create an inaccurate reading.
6. Testing without a stem water potential bag can create an inaccurate reading.



ATMOSPHERIC DEMANDS

The atmosphere of the plant puts four different demands on the plant: wind, humidity, air temperature, and radiation.

PLANT REGULATION

The plant regulates water stress by opening and closing the stomata *(small holes)* on the backside of the leaf. Other regulators used are leaf flagging, rolling and leaf loss. Good root development is also key in regulating water stress.

SOIL SUPPLY

Soil composition is critical for the plant. Moisture content is a key factor in PMS. In addition, the temperature of the soil and depth will influence PMS. Depending upon the texture of the soil and how it holds moisture is another important aspect of the soil. Loose sandy soil will drain out moisture quickly while heavy clay will hold moisture longer.

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