MODEL 600
PRESSURE CHAMBER INSTRUMENT

Effective Date: January 2019

OPERATING INSTRUCTIONS

Read Operating Instructions before using this instrument. Failure to do so can result in serious injury or death.

Instrument Specifications:

Maximum Instrument Operating Pressure:
40 BAR/ 600 PSI

Chambers Construction:
Anodized Solid Stock Aluminum

Maximum Supply Tank Pressure:
207 BAR / 2000 PSI

Weight:
14 Pounds / 6 Kg

FOR A COMPLETE LIST OF PICTURE TUTORIALS AND VIDEOS VISIT US ONLINE AT:

WWW.PMSINSTRUMENT.COM

IMPORTANT SAFETY INFORMATION

Read all instructions contained in these Operating Instructi
Keep these instructions with the Pressure Chamber Instrum

General Warnings

- Safety Glasses must be worn at all times when preparing the Pressure Chamber Instrument for use, using the Pressure Chamber Instrument, and trans-filling gas.
- Working with high and low-pressure nitrogen gas requires safe handling, precaution and safety measures must be followed.
- Nitrogen gas fittings, hoses and valves can fail. Safety measures must be followed to ensure that in the event of an accidental failure of any equipment the user will not be injured. Possible consequences of failure include but are not limited to:

a. Dangerous whipping hose. Could cause injury to body or even death.

b. Couplings or parts thrown off at high speed. Could cause bodily injury or even death.

c. High pressure discharge of gas. Could penetrate skin and cause bodily injury.

d. Catastrophic failure of fittings, hoses or valves could cause overwhelming discharge of Nitrogen Gas (N2). Risk of asphyxiation or oxygen deprivation in enclosed environment. Clear all persons from the area and ventilate in this event.

Appropriate and Intended Use

- The Pressure Chamber Instrument must only be used for the purpose it was intended; that intended purpose is to pressurize plant samples in order to measure xylem water potential, extract xylem water or induce cavitation into plant samples. Any other process or use is not recommended and user could be injured or even killed.

Working Environment

- Whenever operating the Pressure Chamber Instrument, be sure to operate in a safe environment. Lay the instrument on a flat surface when operating.
- The Pressure Chamber Instrument should be operated and stored in temperatures no lower than 20 degrees Fahrenheit / -7 Celsius and maximum temperature of 120 degrees Fahrenheit / 49 Celsius. Outside of this range could cause damage to instrument.

Testing a Leaf
(Pressurization of a Sample)

- Instrument should be prepared properly to work with the samples being tested.
- Always fit the appropriate sized insert with appropriate sized gasket to ensure the sample does not extrude or shoot out of the lid. ½ inch Com-

ons before use to avoid serious injury or death.
ent at all times.

pression Gland Base should be used only with 3/8 and ½ inch sealing systems. ¼ inch Compression Gland Base should be used with 1/8 and ¼ inch and Almond sealing systems. Grass Compression Gland System should be used only with Grass Compression Gland Base.

- Safety Glasses must be put on prior to pressurizing the instrument; they should be worn for the duration of the test until the instrument is fully depressurized and put away.
- When viewing a sample, ensure your eyes are not directly over the sample. View from a slight angle. This will ensure your eyes are not over the sample if it accidentally extrudes or shoots out of the chamber lid.
- If sample appears to move during pressurization, stop the process and ensure it is properly sealed and that you are using the best possible gasket, insert and Compression Gland Base for this sample.
- If you cannot get a good seal on the sample, discontinue testing.

Transporting Instrument

- Never transport the Pressure Chamber Instrument while connected to the portable tank. Whenever transporting the instrument, the instrument needs to be disconnected from the tank and hose, and it should be completely depressurized.

Damaged Instrument

- In the event the instrument is dropped, struck or damaged it should be returned to PMS Instrument Company for evaluation prior to further use. Using damaged equipment could result in physical injury or death!
- Each instrument should be inspected on regular intervals depending upon usage but at least annually. High Pressure Hose, High Pressure Fittings and instrument should be inspected for ware, cracks, leaks or any other damage that might cause danger to the user. Instrument should be in good working order prior to use! Failure to correct these problems can lead to injury or death!

Other Warnings and Considerations

- These are basic guidelines and safety recommendations. User must consult and comply with local laws that might further govern the use of the instrument or use of compressed gases.

Disposal or Decommission of the Instrument

- While the instrument should provide years of use, it is possible that at sometime it will be disposed of. Local recycling guidelines should be followed for disposal.

How The Pressure Chamber 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).

1
A lower canopy, shaded leaf is covered with foil laminate 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.

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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 information 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 almond, walnut, prunes, cotton, and wine grapes or for any application where plant growth is managed such as in nurseries, greenhouses, seedlings or reforestation.

Principle of Operation

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. And 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 end of 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.

SECTION I: Connecting Instrument to Tank

The Model 600 Pressure Chamber requires an external source of pressure. The instrument has been designed to connect directly to a tank with a maximum pressure of 207 bar/3000 PSI. The instrument requires a 6-foot filling hose that is also certified to this pressure.

STEP 1:

Setting up the Instrument

1. You need the Model 600 Pressure Chamber, a 6-Foot Filling Hose, and a Portable Tank.
2. Lay the tank & instrument on a flat, level surface before connecting the hose.
3. Ensure the hose connection is approved for use with the tank you have selected.
4. Put on approved safety glasses before operating the pressure chamber instrument.

STEP 2:

Connect the Tank to the Filling Hose

5. Make sure the tank valve is closed.
6. Connect the end of the hose into the portable tank by threading it firmly in place and securing the connection into the tank. Maximum tank pressure should not exceed 207 bar/3000 PSI.

STEP 3:

Connect the Filling Hose to the Pressure Chamber

7. Ensure the hose is not pressurized. If the hose is pressurized, exhaust the pressure by opening the relief valve on the hose. (The check valve inside the quick connect does not operate like a pneumatic air compressor fitting. It must be completely exhausted.)

STEP 3 - Continued:

8. Vertically align the male quick-connector on the hose end to the female quick-connector on the pressure chamber instrument.

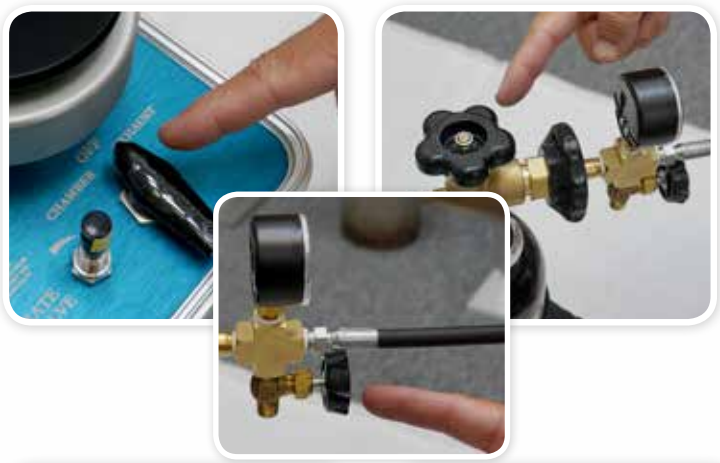
9. Press down firmly to connect the hose to the instrument. When it locks in place, you should hear a "click". These two connectors have an internal check valve for safety and will not properly connect if either side is pressurized.

10. Firmly pull on the hose to ensure proper connection to the instrument. Although the quick connectors contain a check valve, if instrument and hose are not properly connected, severe injury could possibly occur.

STEP 4: .....

Close Valves Before Pressurizing

11. Ensure the following three valves are closed before pressurizing
    a. Control Valve (on the pressure chamber)
    b. Purge Valve (on the hose)
    c. Tank Valve (on the portable tank)



STEP 5: .....

Pressurize the Hose

12 Hold the hose with one hand and the tank valve in the other.

13. Slowly open the tank valve to pressurize the hose. Keep hold of hose until pressure stabilizes. This step will help prevent any injury if the hose is not properly connected.

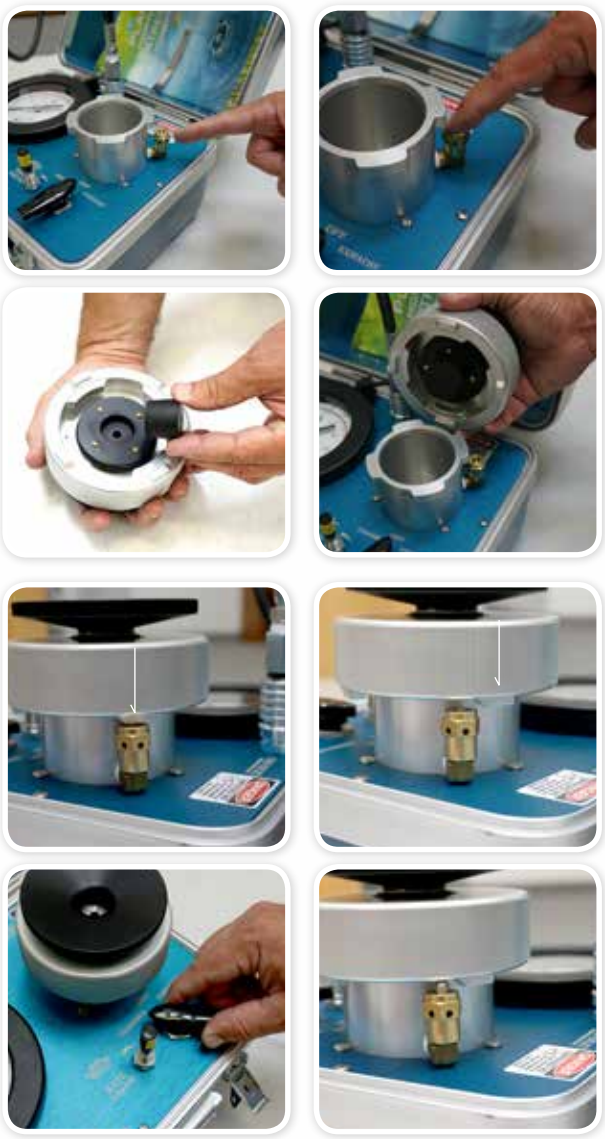
14. The instrument is now ready for use.

SECTION 2: Testing Safety Features

STEP 1: Test the Safety Valve

The safety valve ensures the lid is properly installed when the chamber is pressurized. If the lid is not properly installed, pressure will escape through the safety valve. The safety valve should be tested prior to each daily session. The instrument should be properly connected to a pressure source to test this feature.

1. Remove the chamber lid and locate the safety valve.
2. Using your finger, push the piston down inside the safety valve.
3. Firmly fix the lab stopper into the base of the lid.
4. Place the lid on the top of the chamber. Push down on lid and turn clockwise to the stop.
5. Ensure one of the four cams on the lid is directly over the piston.
6. Rotate the lid slightly counterclockwise, so that the cam is no longer over the piston.
7. Slowly turn the control valve to "chamber," which will begin to pressurize the chamber.
8. The piston should pop up and begin to exhaust pressure before pressure in chamber exceeds 2 bar.



If the piston successfully cycles, the safety valve is working properly. If the piston does not cycle, refer to the maintenance section to clean the safety valve. Dirt and debris are the most common problems that result in a faulty safety valve function. Do not operate the instrument unless the safety valve is functioning properly.

STEP 2: Set the Rate Valve

The rate valve controls the flow of pressure into the chamber. If the rate valve is loosened (turn black knob counterclockwise), the chamber will pressurize quickly. Tightening of the rate valve (turn black knob clockwise) restricts pressurization, slowing the rate that the chamber pressurizes. If the rate valve is overtightened, it could severely damage the valve. As such, it is important to set the rate valve at the beginning to a desired flow rate. For most applications, a good rate of increase is ½ bar per second. ***NEVER USE THE RATE VALVE TO COMPLETELY RESTRICT THE FLOW OF PRESSURE.***

1. Firmly fix the lab stopper into the base of the lid.
2. Place the lid on the top of the chamber. Push down on lid and turn clockwise to the stop.
3. Slowly turn the control valve to "chamber," which will begin to pressurize the chamber.
4. Turn the rate valve clockwise to tighten (restrict flow) or counterclockwise to loosen (increase flow). DO NOT use the rate valve to completely restrict the flow of pressure.




SECTION 3: Making the Measurement

STEP 1: Secure the Sample

While there are several different methods to measure water potential and various gasket sealing sizes to choose from, the following is a basic tutorial to seal the leaf sample inside the chamber lid.

1. Insert the cut end of the petiole (stem) through the hole from the bottom side of the chamber lid.
2. Twist the compression screw (on the top of the lid) clockwise to squeeze the gasket around the petiole to seal it.




STEP 2:
Pressurize the Sample and Take a Reading

1. After sealing the sample in the lid, place the lid on the top of the chamber. Push down on lid and turn clockwise to the stop to lock it on the chamber.
2. Slowly turn the control valve to "chamber," which will begin to pressurize the chamber.
3. Adjust the rate valve if necessary to control the rate of pressurization. Do not use the rate valve to completely shut off the flow into the chamber.
4. Observe the end of the petiole as the pressure increases in the chamber.
5. When you observe xylem water exuding from the cut end of the petiole, you have observed the end point. Immediately turn the control valve to "off".
6. Check the pressure reading on the gauge and record the data. This is the plant moisture stress reading.

STEP 3:
Exhaust Chamber & Remove Sample

1 Turn the control valve to "exhaust" to depressurize the chamber.

2 Check the gauge to ensure the chamber is depressurized.

3 Turn the lid counterclockwise then lift to remove from the chamber.

4. Twist the compression screw counterclockwise to loosen the sample from the lid.
5. Remove the sample from the lid. After removing the sample, secure the lid back on the chamber.

SECTION 4: Depressurizing & Disconnecting the Instrument

When finished using the pressure chamber, follow the following guidelines to ensure that the equipment is safely disconnected and properly stored for later use. Exhausting all residual pressure from the instrument and hoses ensures safe storage and allows the next user to easily reconnect the instrument. Leaving residual pressure in the chamber or hoses can make reconnection unsafe and difficult during subsequent uses.

STEP 1:
Close Tank and Depressurize Hose

1. Ensure the chamber is completely exhausted by turning the control valve to "exhaust".
2. Turn the tank valve clockwise to close.
3. Turn the purge valve counterclockwise on the hose to exhaust the hose.
4. Verify the gauge on the hose to ensure depressurization.
5. Make sure the gauge is at zero before disconnecting the hose from the instrument.




STEP 2:
Disconnect the Hose from the Instrument

1. After the hose has been completely depressurized, hold the hose with one hand and the female quick-connector on the instrument with the other.
2. Pull down on the coupler sleeve to release the hose. The hose should easily disconnect. If the hose does not disconnect, check to ensure you have released all the pressure from the system.

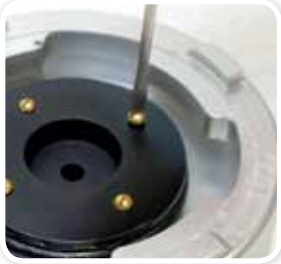

SECTION 5: Maintenance

Maintaining the Compression Gland Lid is simple. The O-ring around the Compression Gland Base should be kept clean and lubricated with petroleum jelly. Occasionally unscrew the Compression Gland Screw and take out the Compression Gland Insert and Compression Gland Gasket inside for cleaning. We recommend lubricating the compression screw threads with a basic lubricant like Lithium Grease to maintain the threads and ensure easy operation. Clean the Compression Gland Gasket with ARMOR ALL or some other type of rubber conditioner for optimal use. Over time the compression gland gasket will become worn and should be replaced. If additional gaskets are needed, you may purchase them directly from PMS Instrument Company. If you need any of these additional parts or would like to purchase a rebuild kit for the lid, please contact PMS Instrument Company directly.

***These are the parts pictured on the right** (listed from left to right):*

- Chamber Lid
- 330 O-Ring
- Compression Gland Base
  (with 006 O-Rings and screws)
- Compression Gland Gasket
- Compression Gland Insert
- Friction Washer
- Compression Gland Screw

1. Lubricate each small (size 006) O-Ring lightly with petroleum jelly and place into recessed screw hole.
2. Next, lubricate the large (size 330) O-Ring and place over the Compression Gland Base.
3. Slide the Compression Gland Base into the lid, align the screws and tighten down screws into place.
4. Flip over the lid and install the Compression Gland Gasket into the Compression Gland Base.
5. Next, place the Compression Gland Insert over the Compression Gland Gasket (put the flat side of the insert facing up)



6. Put the Friction Washer on top of the Compression Gland Insert.
7. Lastly, install the Compression Gland Screw into the Compression Gland Base. Be careful to not cross-thread the two pieces. Be careful not to crush the Friction Washer.

Stainless-Steel Control Valve – Maintenance

The Control Valve is the valve that directs the flow of nitrogen from CHAMBER / OFF / EXHAUST. This valve will require periodic adjustment. If a leak is in the control valve, the symptoms are generally a continual flow of gas into the chamber even while the instrument is in the "OFF" position. To correct this, follow the instructions below.

With the Stainless Steel valve you will need two tools to make the adjustment. These tools were provided originally with your instrument. The top is a 11/32 inch Combination Wrench and the bottom is a 3/32 inch Allen Key.

1. Connect instrument to a supply tank. Remove lid of chamber and turn valve to the "OFF" or "EXHAUST" position. Listen for gas leak. (Make sure that you are in a quiet environment that allows you to detect when the gas hiss stops).
2. Use the Allen key to loosen the set screw in black handle of the control valve. Lift the handle straight up to remove.
3. Using the box end of the combination wrench, slowly tighten the packing gland nut.
4. Rotate wrench clockwise until the gas leak can no longer be heard. Remove wrench and reinstall the black handle.

Stainless-Steel Control Valve – Maintenance *Continued*

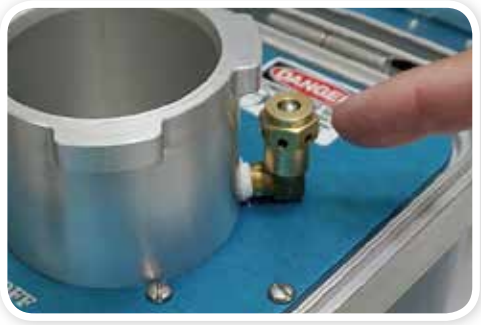
Note: If the instrument is used over a wide range of temperatures, some adjustment may be needed due to thermal expansion within the valve; this is normal.

Caution: Do not over-tighten the valve packing, as permanent damage will result. Over-tightening can additionally make the valve too tight to function normally.

Safety Valve – Maintenance

The safety valve is one of the most important safety features on the pressure chamber instrument; it ensures that the chamber lid is securely fastened onto the pressure chamber. As such, the safety valve should be tested each time the instrument is used. If the safety valve leaks or if it does not operate at pressures below 2 bar, it should be cleaned.

Consult the "Test the Safety Valve" section to learn how the safety valve properly functions. If the safety valve does not function properly, then follow the following cleaning instructions.



1. Identify the Safety Valve on the pressure chamber instrument. Make sure the chamber is depressurized completely before operating on the valve.
2. Take a wrench and slowly twist the safety valve cap counterclockwise to loosen. Remove the brass cap.
3. Remove the steel piston from inside the safety valve. Carefully remove the 006 O-Ring from around the piston.
4. Clean out the the cap, inside of the valve, and piston with a gentle cloth or Q-Tip.
5. Lubricate a fresh 006 O-Ring and place it on the piston.
6. Place the piston back in the valve and twist the cap back over the piston. Tighten the cap finger tight and then use a wrench to tighten 1/6 of a turn. DO NOT over-tighten the cap, as it will severely damage the valve.

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EU
Declaration of Conformity

We,

PMS Instrument Company
1725 Geary Street SE
Albany, OR 97322 USA

Declare under our sole responsibility that the following products:

Pump-Up Chamber, 600 Pressure Chamber, 600D Pressure Chamber,
615 Pressure Chamber, 615D Pressure Chamber, 1000 Pressure Chamber,
1505D Pressure Chamber, 1515D Pressure Chamber, 1505D-EXP Pressure Chamber,

In addition, the following accessories are included:

Digital Cavitation Chamber

To which this declaration relates is in conformity with the following Standards or other normative documents:
EN ISO 12100-1:2003, EN ISO 12100-2:2003, 97/37/EC Annex I

Following the provisions of Directives;
98/37/EC, 97/37/EC (Equipment is below class I limits per the PED)

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Tél. 01 30 50 34 50

Responsible party in the European Union: _____

Place: Trappes, France
Date: October 2, 2018

Officer: Alexis AVERLAN, CEO
Sols Mesures

President, PMS Instrument Company: _____

Place: Albany, Oregon, USA
Date: October 2, 2018

Officer: Jeff Hamel, President
PMS Instrument Company

PMS INSTRUMENT COMPANY

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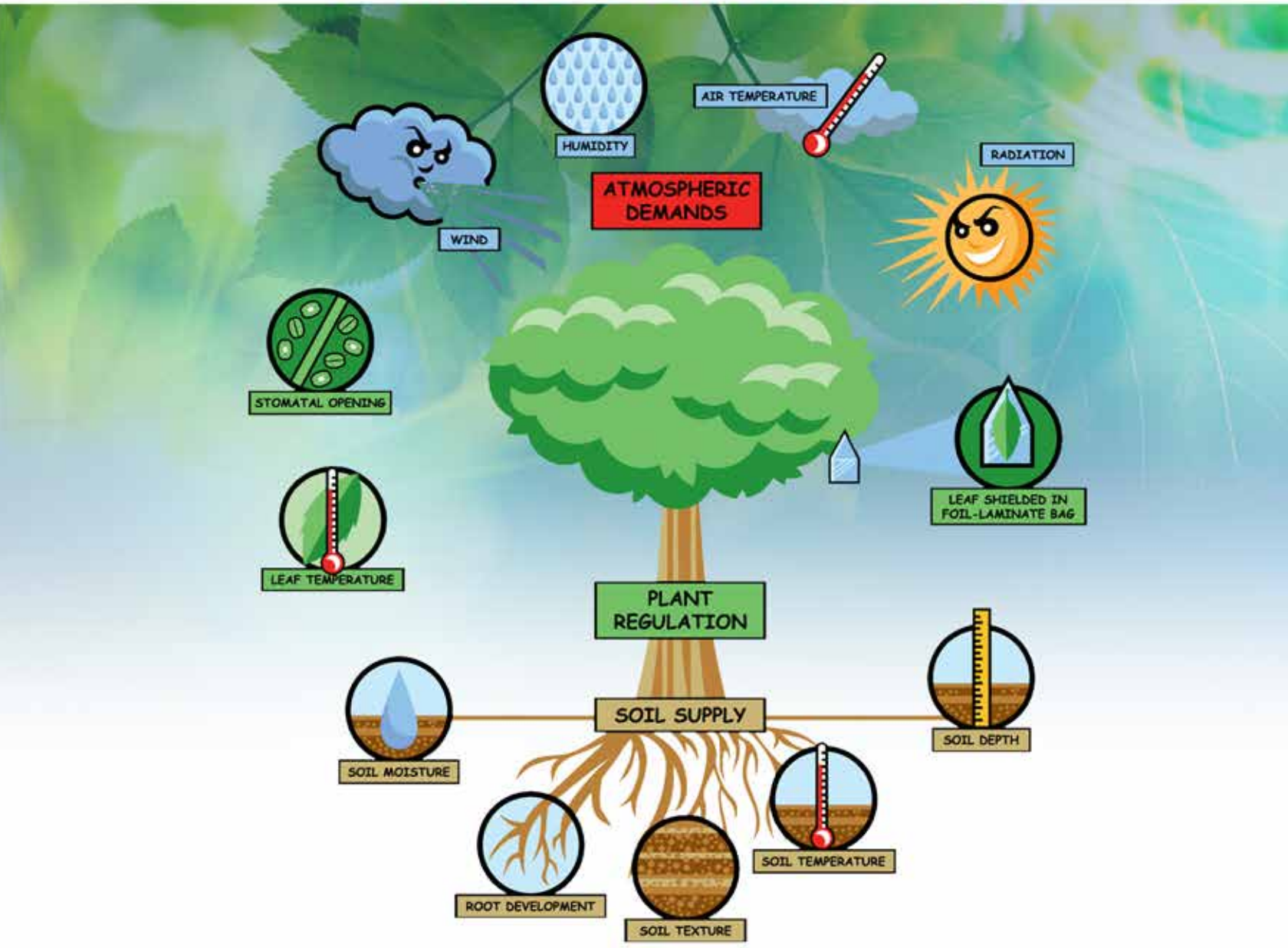
PLANT REGULATION CYCLE:



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.