NIEUWKOOP

METEN.NL

USER MANUAL

GV1600

TENSIOMETER DIGITAL




TO MEASURE = TO KNOW

Preface

Congratulations with your **Nieuwkoop** Tensiometer.
The principal of Tensiometers has been used in soil scientific research since 1930. From that moment the Tensiometer is successfully used in agriculture and horticulture. Nieuwkoop is manufacturer of Tensiometers in this sector for more than 45 years.

Using Tensiometers will give you a better opinion about soil conditions. This makes it possible to tune irrigation schedules better to the requirements of the plants. This will result in a saving of water and nutrients and will give a bigger production. The Tensiometer is a good help to minimalize the drain. This will result in a better environment.

Thanks to the new line of Tensiometers with a digital readout, it is possible to have a continuous control of the soil conditions. This will help you to protect the plants against diseases caused by too much water or less production because of water stress.
From now on guesswork in scheduling irrigation belongs to the past. Good luck with your Tensiometer.

Summary

Soil particles, water and air are the main elements of the soil around the roots of the plant. Water cannot move freely in the soil but will be hold between the soil particles. How easy water can move in soil depends on the soil type, the capillary attraction and the amount of water.
These values determine how easy a plant can extract water from the soil (see figure 1 and 2).

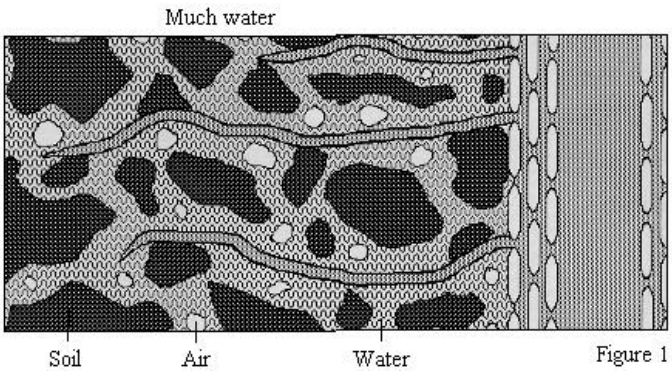


Figure 1

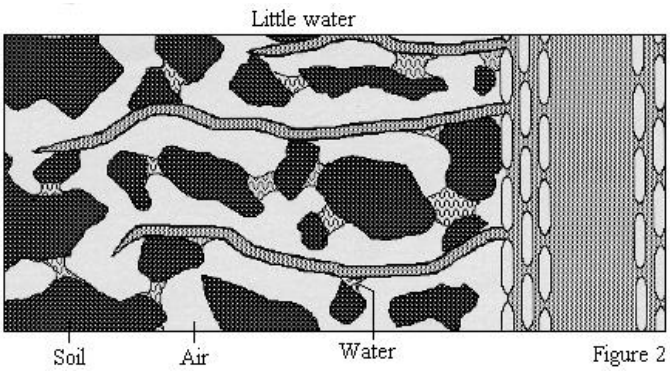


Figure 2

When the soil contains much water and even the big spaces between soil particles are filled with water, the plant roots can extract the water quite easy from the soil. If the soil contains less water and only the small spaces between soil particles are filled, the plant has to suck more to extract water from the soil.

When there is too much water in the soil, soil particles cannot hold all the water, so water will drain away (the soil is saturated). If the water content decrease, at a certain point the plant cannot extract water from the soil anymore (this is the wilting point).

Measuring principal

Tensiometers are the only instruments that measure directly the suction a plant needs to extract water from the soil.

A Tensiometer consists of a hollow tube with a ceramic tip at the bottom. A rubber stopper closes the tube at the upper side. The tube has to be filled with boiled or distilled water. After this the tube has to be placed into the soil. When the soil gets dry it will extract water from the tube through the ceramic tip. This will cause a vacuum in the tube. When the vacuum is equal to the suction of the soil, the water flow through the ceramic tip will stop. When the soil gets wet through rain or irrigation, the Tensiometer will extract water from the soil through the ceramic tip caused by the vacuum into the tube. The vacuum will decrease until it is equal to the soil suction. When the soil is saturated, water can freely flow in and out the tube, so there will be no vacuum into the tube.

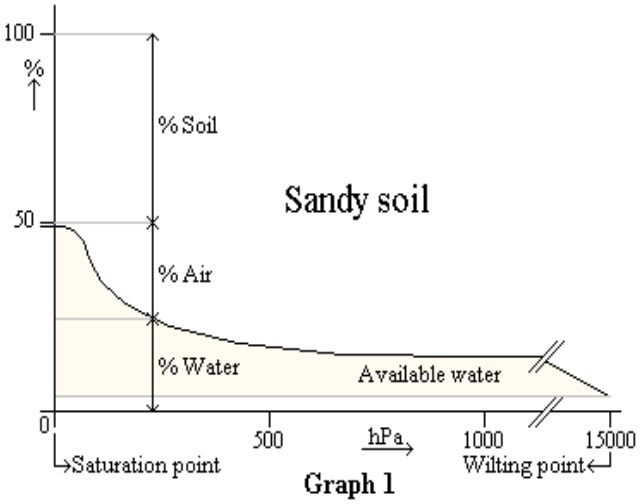
In this way we can see the Tensiometer as a synthetic root of a plant where the vacuum is always in balance with the soil suction.
We can use this as a standard for the suction a plant needs to extract water from the soil.

Measuring vacuum

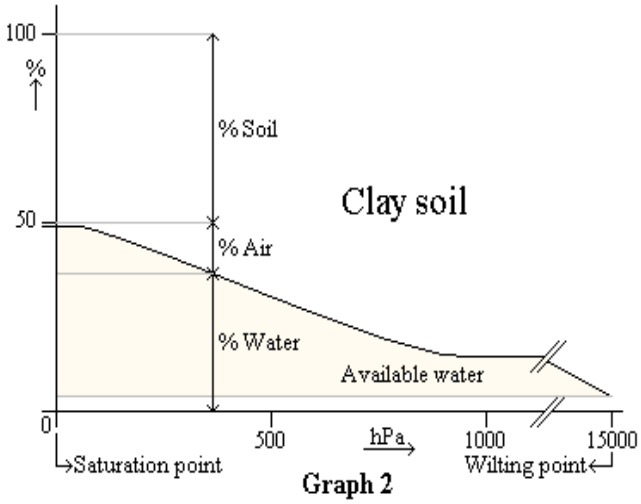
The measuring principle of Tensiometers has been used in soil scientific research since 1930. These Tensiometers used Mercury or water columns to measure the vacuum. Later this was replaced by a Bourdon pressure gauge. Nowadays electronic sensors can measure vacuum. With these sensors it is possible to measure the pressure more accurate. The sensors have an electronic output that can be connected to a controller a computer or readout. The GV1600 of Nieuwkoop BV is a Tensiometer of this type.

The international standard for measuring pressure is Pascal (Pa). Other standards for measuring the pressure are hPa, cm H_2O column or pF. We use the international standard and measure in hectopascal (1hPa = 100Pa). The conversion to the other units is 1hPa=1mBar = 1cm H_2O column. The pF is the logarithmic value of the pressure in hPa.
The pressure in the Tensio tube is measured compared to the barometric pressure. The GV1600 is calibrated in this way the pressure will be zero when the meter is separated from the tube (in open air). When water will be extracted to the tube, this will cause a vacuum, so this will be a negative value on the GV1600 (for example readout of -100hPa on the GV1600 means 100hPa vacuum or soil suction).

In the graphs below you will find the soil moisture (in percentage) compared to the soil suction (in hPa) of sandy soil (graph 1) and clay soil (graph 2)



Graph 1



Graph 2

Measuring values in the root zone

Every soil type has a saturation point and a wilting point. At saturation the suction is 0hPa and at the wilting point the suction is about 15.000hPa. Between these values a plant can extract water from the soil. However, in practice the soil suction will stay between 0 and 800hPa and irrigation should take place between these points. The condition of the soil between these points is mainly as follows:

0hPa
Soil suction of 0hPa means the soil is completely saturated. This can be expected after heavy rainfall or long irrigation. When soil suction is 0 for a longer period, there can be oxygen starvation of the roots and diseases can develop. A persistent zero reading after irrigation indicates poor drainage conditions.

0-50hPa
When the soil suction is between 0-50hPa there is enough water for the plants.
This suction is normal after rainfall or irrigation. In this measuring range water will drain quickly. When the soil suction will be in this range for a long period (more than two days) this indicates poor drainage conditions. (This can damage the plants)

50-200hPa
A soil suction of 50-200hPa means there is enough water and enough air for an optimum growth and production of plants. Soil suction in this range is called field capacity of the soil. This means soil can not held more water for the plants. All the water what will be irrigated extra will drain after a while.

200-400hPa
The soil suction is good for plant growth in normal soil and soil with fine texture, but in sandy soil the suction can increase quickly. This will cause water stress.

400-600hPa
Soil suction is good for fine texture soils. But in other soils the suction can increase quickly, this will cause water stress.

600-800hPa
Available water for the plant is scarce. Even in heavy clay soil the suction can increase quickly. This will cause water stress.

This is a coarse indication of the soil condition for plants.
In practice soil conditions are dependent on soil type and structure, even on one field some areas can differ.

Beside this some plant types are more sensitive for water stress as others are.
Because of this, irrigation scheduling will differ for every user.

Installing the tubes.

For a representative measurement the tubes have to be placed properly. Because of this there are a few things important:

1. Right filling of the Tensiometer with distilled water.
2. The ceramic tip has to make good contact with the soil.
3. The Tensio tubes have to be placed in a representative area.

1. Before placement the Tensiometer has to be filled with distilled water.
Remove the rubber stopper from the Tensio tube. Fill the tube only with **distilled or boiled water**. Avoid air bubbles in the tube (this will delay the measurement).
Make the rubber stopper wet and plush it **carefully** back into the tube, **the tube may not have a leak**.
Place the ceramic tip of the tube during a few hours into distilled water until the ceramic tip is completely wet.

2. For a representative measurement the ceramic tip has to make good contact with the surrounding soil.
In soft soil the tube can be pushed directly into the soil. In hard soil firstly we have to drill a hole with the same diameter as the Tensio tube.
The ceramic tip of the Tensiometer is breakable **so be careful when placing the tube.**
Press the soil around the tube firmly and make the soil wet. This will give the soil it's old structure back and irrigation water flowing along the tube will be avoided.
It will take some time before the Tensio tube has adjusted to the soil (±1 day).

3. The Tensio tube has to be placed in a representative area.
Place the Tensiometer between the plants. How deep the Tensio tube has to be inserted into the soil depends on which purpose the Tensio tube is used for. When the Tensio tube is used for scheduling irrigation, it has to be placed in the active root zone with the ceramic tip between the roots. This is the place where plants extract water from the soil. For deeply rooting plants we advise to use two Tensiometers; one at ¼ of the rootzone and one at ¾ of the rootzone. Because of this you get a better view of the soil suction over the complete depth of the rootzone.

Place these two Tensio tubes close together to avoid different readings because of difference in soil structure etc. When the Tensio tube is used for controlling the drain, place the ceramic tip of the tube deeper than the active root zone, in the middle between the rootzone and the groundwater, until max. 80cm deep.
Place the Tensio tube in an area that is representative for the whole field.
When some places in a field differs in moisture because of soil structure, soil type or difference in height; it is necessary to place in both areas a Tensiometer to get a complete view in soil suction over the whole field for a good scheduling of irrigation. Place the Tensio tubes always in the shadow, to avoid deviation caused by temperature fluctuation.
Mark the length of the tube on the PVC (for example with a colour). This to avoid mistakes.

N.B. The soil suction is measured through the water into the tube. Because of this the Tensiometer will not work when it is freezing. So do not use the Tensiometer below temperatures of 1°C.

Measuring

When the tubes are properly placed over the area, you are ready to measure.
To get representative measurements it is very important to handle every step with care, knowing exactly what you are doing. Take notice of the following points:

1. Monitor readings should be done regularly.
2. Taking a measurement.
3. Registering the data

1. Monitor readings should be done every day at the same time.
In order to have a good comparison; the measurements have to be done in the same way every time:

- Take the samples every day at the same time, preferably in the morning between 7-8am.
- Passing the tubes, always follow the same route.
- Mark the tube length on the tube. Once placed you cannot see the depth anymore.
- The best is when the same person always takes samples. This in order to make sure always the same procedure has been followed. Only in this way results are comparable.
-

2. For making a measurement the next steps have to be followed:

- Place the sensor carefully over the Tensio tube. The needle has to go through the rubber stopper.
- While sticking the needle through the stopper, the Tensio tube will loose a little bit vacuum. This vacuum has to be building up again.
- Switch on the meter and wait until the value becomes stable.
- While waiting do not move the sensor. This will cause a pressure onto the rubber stopper what will lead to a change in vacuum inside the Tensio tube.
- When the readout is stable it will give the value of the soil suction in hPa (this will be a negative value because it is a vacuum).
- Remove the sensor carefully from the Tensio tube.

IMPORTANT. While the pressure sensor measures in the top of the tube, there will be a water column connected to the sensor. This will cause a shift of the 0-point (in hPa) equal to the length of the water column in cm (for example a tube of 30cm will cause a shift of ± 35hPa).

For finding the exact shift of the 0-point, place the filled tube until half of the porcelain into water. When stabilised, the readout on the GV1600 is equal to the zero shift in hPa. In future this value has to be substracted from the measured value.

3.The best way to register the data is as follows:

- Make a schematic drawing of the location of the tubes with specification concerning soil type, tube length etc.
- Make a graph of the measured values. The graph paper on the last page can be used as original for copies.
- Do also note information into this graph like growth of the plant, rainfall/sun, irrigation times etc.

By registering results in this way, your GV1600 can be of help understanding the soil. This makes it possible to schedule irrigation to the requirements of the plants.

Maintenance

1. The tube
2. The meter

1. The tube

- When the Tensiometer is placed, water will drip out of the tube very slowly. (In practice this happens when the soil suction becomes more than ±600hPa) This will give an air column into the tube. The air delays the reaction time. Therefor we advise to refill the tube when the air column gets bigger than 1cm. Removing the rubber stopper can do this, refilling the tube with distilled water and pushing the stopper **carefully** back into the tube). Because of this, the Tensiometer will loose its vacuum, so it will take a few hours before you can read out values again.
- The pores of the ceramic tip could choke-up after a while. To prevent this, clean the ceramic tip every half-year with a household cleaner.
- Replace the rubber stopper every year. Do only use the original rubber stoppers.

2. The meter

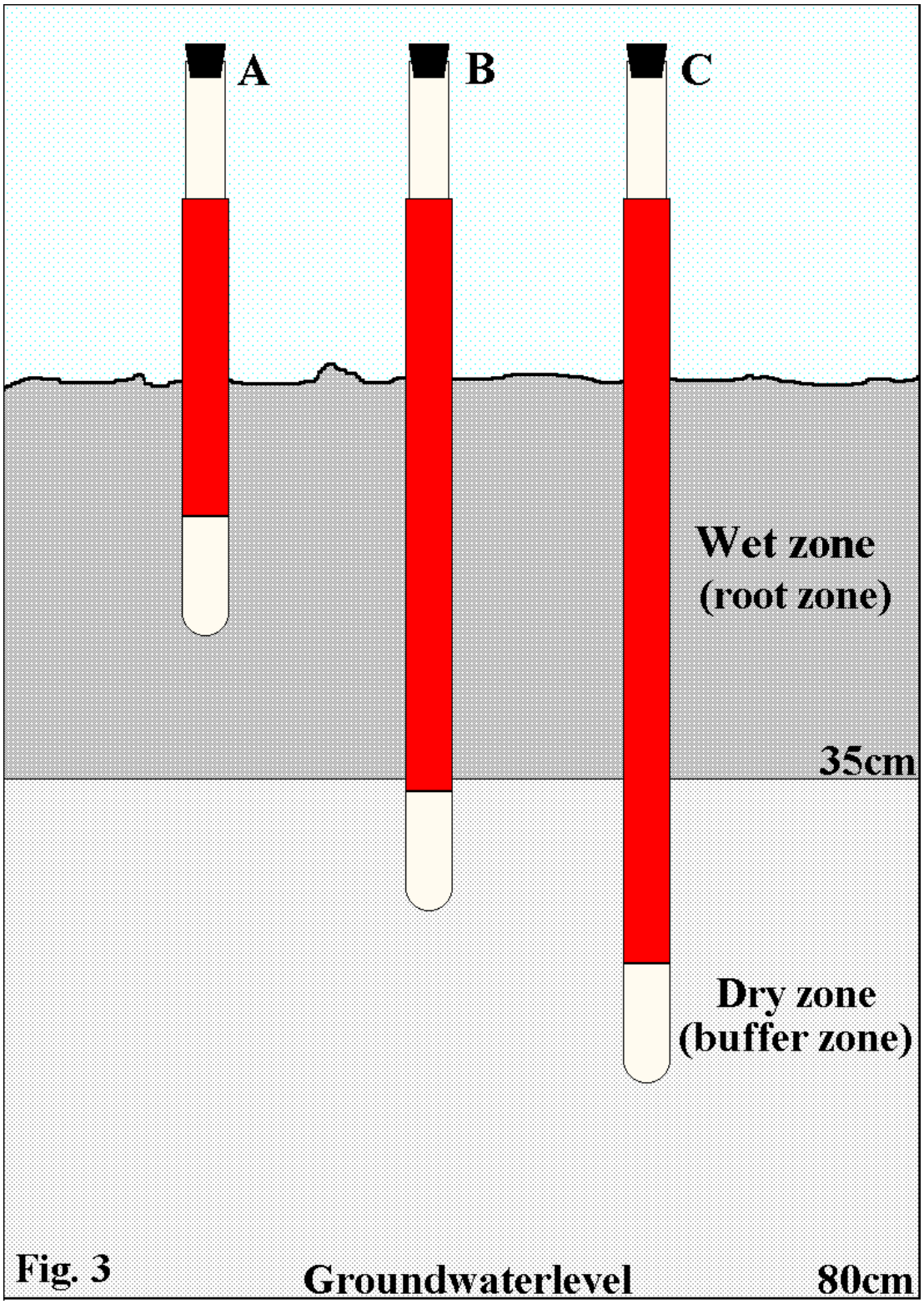
- Store the meter always on a dry place, condensation is electronics biggest enemy.
- Replace the 9V battery as soon as the meter indicates an arrow to the left (🡐) in the left upper corner of the display. The arrow also occurs when you shut of the instrument.
- The needle has to be replaced when it gets blunt. This has to be done as follows:

1. 1 Unscrewing guide tube (on the sensor).
2. 2 Unscrewing needle from the needle holder using needle-protection cover.
3. 3 Screwing new needle into the needle holder, Vaseline can be used to improve the seal. Take care the needle will not leak. This will cause unreliable readings.

- Do not pull digital meter from the Tensio tube by it's cord (this will cause errors after a while).
- Some drift with temperature in zero setting of the monitor can be expected. Zero setting can be adjusted by regulating the screw at the left side of the instrument.

Tensiostations

To have a good view over the soil suction we advise to use more Tensiometers at different depths, close together. We call this a Tensiostation (see figure 3).



Tensiometer "A" is placed with the ceramic cup in the middle of the rootzone of the plants (in this case: 20cm).

Tensiometer "B" is placed with the ceramic cup just under the rootzone (in this case: 35cm).
The ceramic tip of Tensiometer "C" is placed in the middle between Tensiometer "B" and the Groundwaterlevel (in this case: 60cm).

The depths mentioned in the drawing are examples. These will differ for everyone. The depth of the rootzone depends on plant type (use for deeply rooted plants two Tensiometers as mentioned in point 3 at page 4). The depth of Tensiometer "C" depends on the Groundwaterlevel. Do not placed Tensiometer "C" deeper than 80cm.

In this way we will get a good view over the soil suction until 60cm deep into the soil. This makes it possible to create a wet zone of soil where roots can grow, with under this zone a dry zone until the groundwater. In this way drain will be minimised, which saves a huge amount of water per year.

Tensiometer "A" is used to schedule irrigation. With Tensiometer "B" the water flow from the wet to the dry zone will be measured. Tensiometer "C" is to control if the dry zone stays dry enough. This to avoid drain to the groundwater (the Tensiometer value may not change after irrigation).

In this way we can find the ideal frequency and duration of irrigation. There has to be irrigated in this way the wet zone stays at field capacity (then there will be enough water for the plants but no drain). The irrigation time may not be too long.

It is very important to use an irrigation system, which irrigates uniform, and the irrigation water has to be very clean (because of salt increasing).

We advise to make graphs of the soil suction over a few weeks or even a complete cultivation period. This will give an overview of the soil suction over a longer period.

With this information we can schedule irrigation in a way the soil suction gets as equal as possible. So it is not only important to control the actual value of the soil suction, but also the variations over a longer period.

Fine-tune your irrigation by using a GV1600 in combination with your own experience.
Keep in mind that all crops require different water quantities during their growth depending on the amount of water they evaporate and need for their own development.

Do not forget that evaporation is highly influenced by temperature and humidity (the climate).

TO MEASURE = TO KNOW

Nieuwkoop BV
Aalsmeerderweg 249 -S
1432 CM AALSMEER

0297 325836
info@nieuwkoopbv.nl
www.meten.nl

NIEUWKOOP