



## **Research report on PlantCare soil moisture sensor technology**

Please find in the following a research report from the University of Applied Sciences Weihenstephan in Germany about the Gardena soil moisture sensor, which is based on PlantCare's sensor technology, licensed by Gardena.

## Weihenstephan information service April 2008 issue

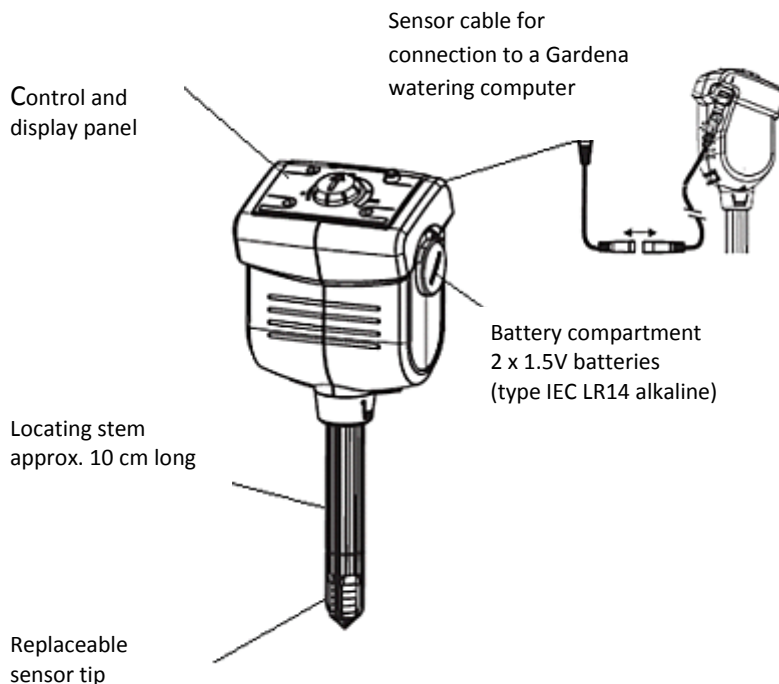
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### Low-maintenance soil moisture sensor



III.1: Gardena's soil moisture sensor

Gardena is particularly innovative especially when it comes to watering technology for the domestic garden and hobby sector. As a replacement for their previously marketed tensiometer, the company has had a new soil moisture sensor in its range for around a year. In comparison to the previous moisture sensor that worked on the tensiometer principle, this sensor is largely maintenance-free and can continue to be used particularly for longer periods of soil dryness. While tensiometers slowly drain during long periods of soil dryness with water tensions above 800 hPa and finally stop working, the 1188 moisture sensor works according to an electro-thermal measuring principle that does not require filling with water. In combination with a Gardena watering computer, this sensor is recommended for use in small (outdoor) gardens to provide an automatic watering system.



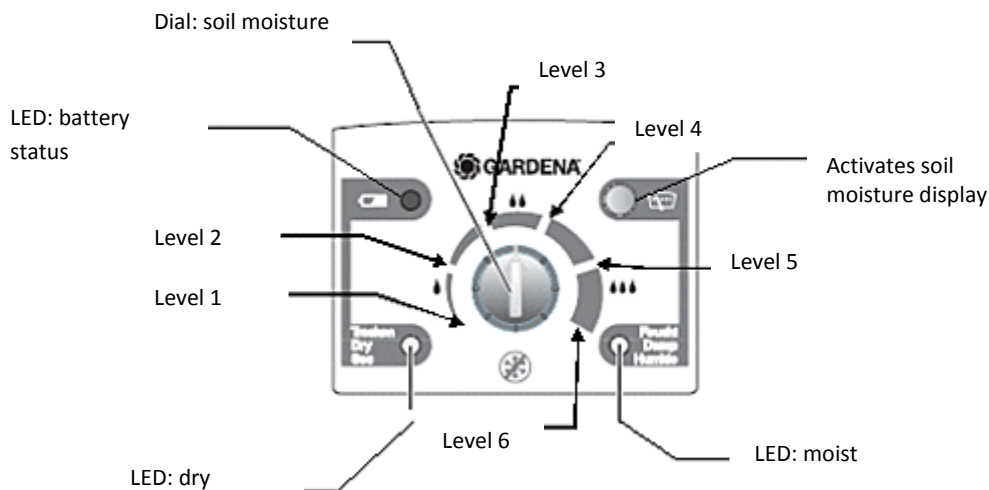
### III. 2: Working principle of Gardena's new soil moisture sensor

The sensor is battery-operated and passes on the measurements to the watering computer every 10 minutes. Using the adapter cable supplied, this moisture sensor can also be connected to an existing Gardena watering computer fitted with a connection for "soil moisture sensors". Alongside the battery status display, the operating panel has an LED for "dry" and one for "moist". These "dry" and "moist" LEDs are activated for approx. 60 seconds by pressing the activation button. Using a dial, the switching point at which watering is to take place can be infinitely adjusted. In the "dry" state, the contact point through the cable is closed, in the "moist" state, the contact point is opened. Just as with the tensiometer, it is important to ensure that the sensor tip is in good contact with the substrate and that irrigation water or rainwater can also seep into this area.

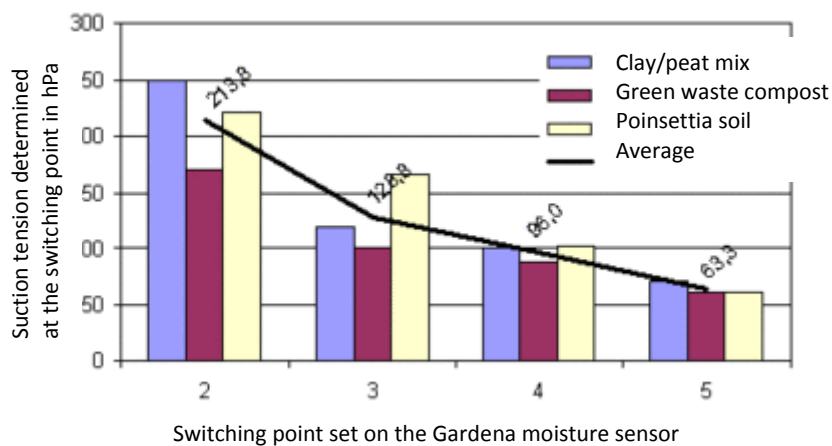
The water content or water retention (soil moisture tension) can be used to specify the soil water or to control the watering. Water availability, in other words water retention, is decisive for plants or plant growth. As already described in the introduction, tensiometers are mainly used to determine soil moisture tension, which, however, can no longer operate with long-term soil dryness. Other measuring processes for soil moisture are costly to some extent and cannot be used in the hobby sector. Numerous trials were conducted under laboratory conditions and in practical test cultivation in order to demonstrate the correlation between the switching points set on the new moisture sensor, water retention in the soil and plant growths.

A scale of 1-6 was defined on the moisture sensor's operating panel to quantify the switching point set, with setting 1 meaning very dry cultivation and setting 6 very moist. After setting the switching point, the moisture sensor was put in a plant pot (terracotta) filled with substrate, with an analogue tensiometer in parallel. The switching status of the moisture sensor was monitored by digital input cards, which was recorded in a file together with the tensiometer data.

As soon as the “dry” switching point was reached due to natural evaporation, the substrate was watered again – repeated a total of 3-4 times for all switching points. The suction tension determined at the time of switching point change (“moist”-“dry”) is shown in III. 3. The substrate varieties used were a clay-peat mix, a green waste compost as well as “poinsettia soil”, which was enriched with mineral components (perlite).



III. 3: Operating panel of the moisture sensor



III. 4: Correlation between the switching point set and suction tension to reach the switching point with various substrates (2= dry cultivation, 5= moist cultivation).



III. 5: Lettuce trials

At a switching point of “2”, an average soil-moisture tension of 214 hPa was attained for all substrates, at a setting of “3” 129 hPa and 63 hPa at “5”. However, substrates react differently and this must be taken into account by users.

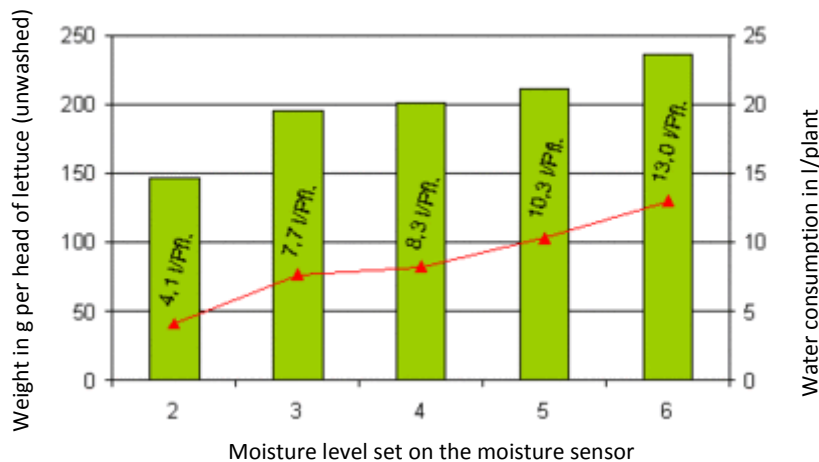
In another test bed in the greenhouse, 5 moisture sensors were investigated in combination with the 1020 watering computer and a drip watering system for lettuce. One moisture sensor with watering computer was installed per bed. After planting, the moisture levels were set at “2”, “3”, “4”, “5” and “6” in the various beds. “Daytime watering” and the maximum watering time of 10 min were programmed into the watering computer.



III. 6: Lettuce trials

The watering system used was an above-ground drip tube with a drip spacing of 30 cm and a drip rate set at 4l/h. Sixty-four plants were planted per bed, spaced at intervals of 32 x 33 cm – with a drip hose between each 2 rows of plants. Alongside water usage, the yield was determined at the end of the growing period. It was noted that the higher the moisture level, the greater the increase in yield. However, “6” was considered to be an excessively wet setting from a horticultural standpoint and thus the effect of economical irrigation was lost.

At a moisture level setting of 2, very compact plants were obtained with a water consumption of approx. 4 litres per plant. Moisture level 5 resulted in the highest yield and also the highest water consumption of 13 litres per plant.



III. 7: Influence of the moisture setting on fresh weight production and water consumption of lettuce (2 = dry growing conditions, 6 = damp growing conditions)

## Summary

The moisture sensor investigated proved its worth both under laboratory conditions and in the open. In laboratory tests, the moisture levels set at 5 (damp growing conditions) had a switching point of 60 hPa, in setting 2 (dry growing conditions) the switching point was at a soil-moisture tension of 200 hPa. With this spread, users can adapt the moisture conditions in the ground to their own requirements and plant growth. It is recommended that beginners start with a medium setting and then adjust in the direction of “dry” or “moist” after observing plant growth. When using the sensors, it should be noted that only brand-name batteries should be used. Cheap, “no-name” batteries were dead after a few weeks. One small point of criticism is that the sensor becomes somewhat weighty and top-heavy because of the batteries. Supports must therefore be provided for use in small pots.

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