3 ways to measure medium EC

Direct soil probes, PourThru and saturated media extract are methods to effectively measure growing medium electrical conductivity.

By Bodie V. Pennisi and Marc van Iersel

Managing nutrients in growing media can be challenging even for experienced growers. Excess or insufficient nutrients or nutrient imbalances can develop very rapidly, which often seriously compromises the quality of a crop. Regular measurement of a medium's electrical conductivity (EC) and pH should be done throughout a crop's growing cycle.

Most land grant universities as well as several private labs offer testing services. Labs generally use two different methods: a 1:2 dilution and a saturated medium extract (SME).

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Another, more cost-effective measurement is for growers to perform their own media analyses. The PourThru method is an easy, inexpensive technique to check media EC and pH. For more information on PourThru, see www2.ncsu.edu/unity/lockers/project/hortsublab/pourthru/index.html.

Several companies offer analytical equipment that can measure substrate EC by inserting a metal probe directly into the media. The measuring probes eliminate the step of collecting media leachate as in the PourThru technique. Probes could become a technique of choice among growers seeking to perform regular EC tests.

Soil salinity probes

Researchers at the University of Georgia compared two soil EC probes with the

PourThru and SME methods. The Hanna Instruments soil conductivity meter (model HI 76305), which costs about $400, is designed specifically for soils and soilless substrates. This meter displays soil salinity in units of grams per liter (g/L), which is not commonly used in the greenhouse industry. It is necessary to convert these values to milliSiemens per centimeter (mS/cm). We found that by multiplying the values by 6.4 (1 g/L = 6.4 mS/cm), the Hanna conductivity meter gave results similar to those of the PourThru method. The results presented are the data after they were converted to units of mS/cm (multiplied by 6.4).

The SigmaProbe is designed specifically for use with greenhouse substrates and can also measure the EC of solutions. It can display EC in different units, including mS/cm. The SigmaProbe costs $2,420 and has a handheld computer to automatically store data. Without the computer, the probe costs $1,350.

Both the SigmaProbe and the Hanna conductivity meter work better in moist growing media. They should be used one to two hours after the medium has been irrigated. Both can take measurements in a few seconds.

Hanna Instruments soil conductivity meter, model HI 76305 (left), and SigmaProbe.

We measured leachate samples from the PourThru method with different EC equipment, a Hanna Instruments EC probe (model HI 76304), the SigmaProbe and a Corning EC probe. For the SME method, growing media samples were sent to MicroMacro International, a commercial testing lab in Athens, Ga. The same media samples used to measure EC were also used for the SME analysis.

Comparison of testing methods

Lab results. Four-inch pots were filled with a soilless medium and saturated with a 20-10-20 fertilizer solution with an EC range of 0.15 (tap water) to 4.5 mS/cm. The medium, which was divided into two groups, was tested with the Hanna conductivity meter and the PourThru method. The leachate was analyzed with the Hanna EC probe and the Corning EC probe. The medium measured with the Hanna conductivity meter was then analyzed using the SME method.

As expected, the EC of the medium and the leachate increased as the EC of the fertilizer increased (see Table 1). The Hanna conductivity meter and the two EC probes used for the PourThru method gave very similar results. Because the SME method involves adding water to the medium, the salts in the medium are diluted. Therefore, the SME EC values are lower than those from the PourThru method. However, our analyses showed that SME closely correlated to the PourThru method and the Hanna conductivity meter, and consistently gave an EC value that was half of the other methods.

Although our first experiment showed that the Hanna conductivity meter gives results similar to the PourThru method, the conversion factor of 1 g/L = 6.4 mS/cm is a concern. The standard method of converting g/L to mS/cm is to multiply by 1.6 (1 g/L = 1.6 mS/cm). The reason for the conversion difference is not clear, but it is possible that a mathematical error was involved.

Greenhouse testing

In a second experiment, 4-inch pots were placed on ebb-and-flow benches and subirrigated for six days with fertilizer solutions with an EC range of 0.5 to 2.5 mS/cm. After the six days, the medium EC was measured with the SigmaProbe.

We also used the PourThru method to collect leachate, which was then measured with the SigmaProbe and a Corning EC probe. Measurements of the leachate EC were very similar for the two meters, which indicates that the SigmaProbe is reliable as an EC solutions meter. The direct measurements of the medium with

TABLE 1

Comparison of electrical conductivity readings

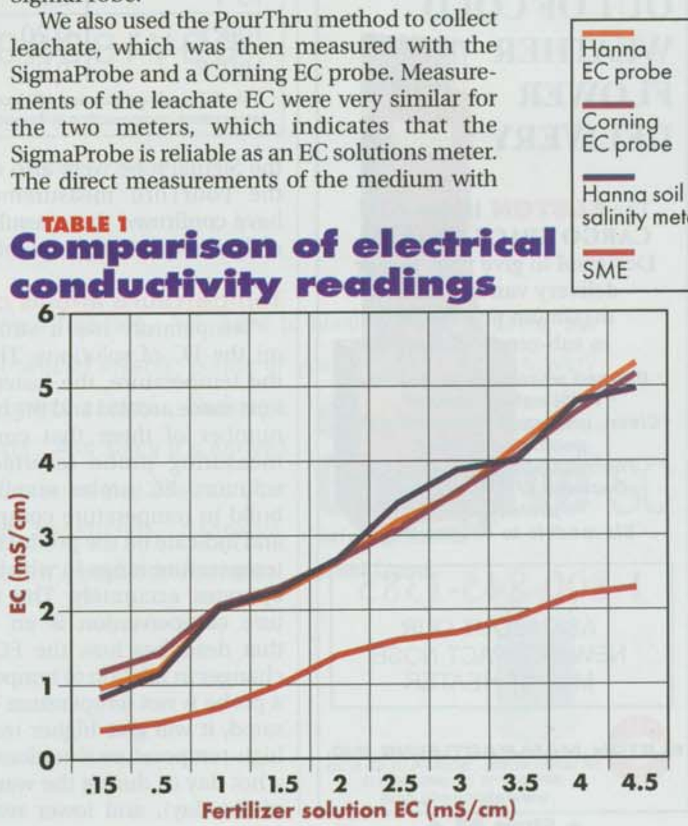

TABLE 2

Comparison of electrical conductivity (mS/cm) measured with different testing methods

1:2	SME	PourThru	Test results
0 to 0.3	0 to 0.8	0 to 1	Very low
0.3 to 0.8	0.8 to 2	1 to 2.6	Low
0.8 to 1.3	**2.0 to 3.5**	**2.6 to 4.6**	**Normal**
1.3 to 1.8	3.5 to 5.0	4.6 to 6.5	High
1.8 to 2.3	5.0 to 6.0	6.5 to 7.8	Very high
> 2.3	> 6	> 7.8	Extreme

TABLE 3

Hanna soil conductivity meter electrical conductivity readings at different temperatures*

Temperature	EC reading (growing medium irrigated with tap water, EC of 0.15 mS/cm)	Temperature	EC reading (growing medium irrigated with fertilizer solution, EC of 2 mS/cm)
50°F	0.12	52°F	0.37
55°F	0.13	56°F	0.39
60°F	0.13	61°F	0.40
65°F	0.14	66°F	0.41
71°F	0.15	73°F	0.43
78°F	0.16	78°F	0.48
86°F	0.17	85°F	0.51
93°F	0.19	93°F	0.55
100°F	0.20	100°F	0.57
109°F	0.22	107°F	0.59

* The EC readings increase with increasing temperature because of the lack of temperature compensation in this probe.

the SigmaProbe were also similar to the PourThru measurements. We have confirmed these results in several subsequent experiments.

Temperature effects on EC

Temperature has a strong effect on the EC of solutions. The higher the temperature, the faster the salt ions move around and the higher the number of them that contact the measuring probe inserted into a solution. EC probe manufacturers build in temperature compensation and indicate on the product label the temperature range in which a probe operates accurately. The temperature compensation is an equation that describes how the EC reading changes in relation to temperature. If a probe is not temperature compensated, it will give higher readings in high-temperature situations (e.g., on a hot day or during the warmer part of the day), and lower readings in low-temperature situations (e.g., on a cool day or during the morning.)

We tested the Hanna conductivity meter's response to temperature by placing its probe in the middle of a pot filled with moist medium. The pot, medium and probe were placed in a watertight plastic bag, which was then put into a beaker filled with cold water. The water was heated gradually and EC measurements were taken every few minutes. The temperature of the medium was also measured each time EC readings were taken.

The medium in the pots was saturated with either plain tap water (EC of 0.15 mS/cm) or with a fertilizer solution (EC of 2.0 mS/cm). As the temperature increased from 50°F to 100°F, the EC readings increased rapidly, whether in media irrigated with plain water or with fertilizer solution (see Table 3).

Our analysis suggests that the Hanna conductivity meter is not temperature-compensated, although its manual suggests that it is. Because of the lack of temperature compensation, readings from the Hanna conductivity meter are not as dependable unless the temperature of the medium is between 70°F-80°F. To obtain reliable data with the Hanna conductivity meter, it is important to minimize temperature effects. This can be achieved by taking measurements early in the morning before the greenhouse and growing media start to warm up. We are working with Hanna to develop a conductivity meter that has improved temperature compensation.

In similar tests with the SigmaProbe, we found that it is temperature compensated and works well over a wide range of temperatures.

Soil testing labs

Soil analyses performed by commercial testing labs include levels of individual nutrients in growing media. Some labs also provide recommended concentrations of individual nutrients. Growers can use this information to adjust their fertilizer programs.

The PourThru method determines pH and electrical conductivity of all nutrients present in the growing media, but does not provide information about individual nutrients. Therefore, lab analyses may be able to detect potential problems that won't be detected with in-house grower tests.

Testing labs generally use the 1:2 dilution method or saturated medium extract (SME) method. Both methods involve the dilution of media samples. Because of this, the EC results from soil-testing labs are always lower than the EC measured with the PourThru method, and the results should be interpreted accordingly.

When preparing growing medium samples for a soil testing lab, remove the upper ½ to 1 inch of the medium and then collect a core of the medium extending to the bottom of the pot.

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