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Measuring Electrical Conductivity with an Inexpensive, Digital, Pocket-size Meter

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Electrical conductivity (EC) measurement is widely used in horticulture to estimate salinity and fertilizer levels in irrigation waters, nutrient solutions, soils, and growing media (1–4). EC often is referred to as specific conductance (5), conductivity (1), or soluble salts; however, the term EC has been used widely in scientific literature (2–4).

EC meters for horticultural use range in price from about \$100 to \$400. Recently, an inexpensive (\$39.50) EC meter was introduced. The DiST 4 (Cole-Palmer, 7425 North Oak Park Ave., Chicago, IL 60648) weighs 90 g, is 144 × 28 × 15 mm, and is powered by four batteries with a 200-hr life. The unit has a liquid crystal display (LCD), a 100 to 19,900 $\mu mho \cdot cm^{-1}$ range and a stated accuracy of ±2% of full scale. The two stainless steel electrodes are recessed in the base of the meter. The LCD reading must be multiplied by 100 to obtain $\mu mho \cdot cm^{-1}$ units. The suitability of the DiST 4 for horticultural use was evaluated by measuring the EC of standard KCl solutions.

KCl solutions of known EC (Table 1) were heated to 25°C, the standard temperature for EC measurement. The DiST 4 was calibrated with either 10 or 20 mM KCl by immersing the meter ≈2 cm into the solution and adjusting the "offset trimmer", a recessed screw in the back of the unit, until the LCD read 1.4 or 2.8 (Table 1). The electrodes in the base of the meter were rinsed with deionized water and blotted dry between readings. The meter was calibrated with a KCl solution, the EC of each of the solutions in Table 1 measured, and then the meter was "decalibrated" by turning the offset trimmer. This process was repeated five times for each of the two KCl solutions used for calibration.

EC values of 0 to 20 mM KCl were within the stated accuracy of ±2% full scale or 0.4 $mmho \cdot cm^{-1}$ (Table 1). The EC at 25°C ranged from 0 to 2.8 $mmho \cdot cm^{-1}$, which covers most of the usual range encountered in horticulture. EC of saturated growing media >4 $mmho \cdot cm^{-1}$ is usually considered too saline for optimal plant growth (2). For 100 mM KCl, the measured EC underestimated the actual value by ≈2 $mmho \cdot cm^{-1}$, indicating that the DiST 4 may underestimate solutions of high EC. For increased accuracy at high EC, a standard curve could be used. As with any analytical instrument, at least two standards that bracket the ECs of the samples should be used.

Table 1. Electrical conductivity (EC) of standard KCl solutions measured with the DiST 4 meter.

KCl (mM)	EC at 25°C ($mmho \cdot cm^{-1}$): Absolute[y]	DiST 4[z] mM KCl standard: 10	DiST 4[z] mM KCl standard: 20
0	0	0.0	0.0
5	0.717	0.7 ± 0.0	0.7 ± 0.0
10	1.413	1.4 ± 0.0	1.44 ± 0.05
20	2.767	2.74 ± 0.05	2.8 ± 0.0
50	6.668	6.20 ± 0.10	6.32 ± 0.04
100	12.900	11.02 ± 0.18	11.16 ± 0.09

[z]Data are mean ± SD, n = 5. Linear regressions of each column of data with absolute EC gave r^2 = 0.997 (n = 30), with significance level <1%.
[y]Data from Table 205:I of ref. 1.

Since the DiST 4 does not have temperature compensation, the effect of temperature on EC readings and use of temperature correction factors was investigated. A 20-mM KCl solution was heated from 5° to 42°C while EC was measured with the DiST 4 and temperature with a mercury thermometer (Table 2). EC increased from 1.7 $mmho \cdot cm^{-1}$ at 5° to 3.7 $mmho \cdot cm^{-1}$ at 42°, but, when standard temperature correction factors were used, the temperature-corrected EC values were all about 2.7 $mmho \cdot cm^{-1}$, the actual value measured at 25° (Table 2).

The DiST 4 has several advantages over other meters commonly used for EC measurements in horticulture, including lower price, smaller size, and digital readout. The major disadvantage, lack of automatic temperature compensation, can be overcome by using temperature correction factors.

Table 2. Electrical conductivity (EC) of 20 mM KCl at 5° to 42° as measured with a DiST 4 meter, temperature correction factors, and temperature-corrected EC values.

20 mM KCl temp (°C)	EC reading of DiST 4 meter ($mmho \cdot cm^{-1}$)	EC temp correction factor[z]	EC at 25°C[y] ($mmho \cdot cm^{-1}$)
5	1.7	1.613	2.74
7	1.8	1.528	2.75
9	1.9	1.448	2.75
11	2.0	1.375	2.75
13	2.1	1.309	2.75
15	2.2	1.247	2.74
17	2.3	1.189	2.73
19	2.4	1.136	2.73
21	2.5	1.087	2.72
23	2.6	1.043	2.71
25	2.7	1.000	2.70
26	2.8	0.979	2.74
28	2.9	0.943	2.73
30	3.0	0.907	2.72
32	3.1	0.873	2.71
34	3.2	0.843	2.70
35	3.3	0.829	2.74
37	3.4	0.801	2.72
39	3.5	0.775	2.71
41	3.6	0.750	2.70
42	3.7	0.739	2.73

[z]Temperature correction factors from Table 2 of ref. 3.
[y]Product of columns 2 and 3.

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