From Forest Nursery Notes, Summer 2008

153. Interpret soil and tissue tests correctly. Fisher, P. R., Douglas, A. C., and Argo, W. R. Greenhouse Management and Production 27(11):47-49. 2007.

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Interpret soil and tissue tests correctly

IF THE CALCIUM LEVEL is high in your soil test, is that a problem?

What is the acceptable pH range for petunias or for geraniums?

Should you be worried about a low pH for calibrachoa?

What about a high pH on marigolds?

Here's your chance to learn what test results are really important.

Check for errors

Soil tests are just a tool and should be checked for errors. When pH or electrical conductivity tests look very different from the week before (there is a sudden jump or drop in results), check the testing meter and the sampling method before concluding that there is something wrong with the crop. If the test numbers have suddenly changed across all crops, the meter may be broken or poorly calibrated, or it could be a real problem, for example, with the fertilizer injector.

If soil samples are taken from the top part of the growing medium in containers of at least a 4-inch diameter, then salt levels will be artificially high and not represent the lower electrical conductivity in the root zone. Check your bio-indicator crops to confirm you have a problem. If in doubt or the results don't make sense, test again.

Soil tests are inexact, so don't overreact. Based on our trials, a reasonable estimate of precision for correctly-taken soil tests on five pots is ±0.25 pH units and ± 0.5 milliSiemens per centimeter electrical conductivity units. In other words, if a electrical conductivity test indicates 2.0 mS/cm, the true average electrical conductivity for the crop is probably between 1.5 and 2.5 mS/cm. Smaller changes than these levels simply can't be measured without taking more samples and averaging results.

Interpretation of growing media pH levels for container-grown crops

	Acceptable pH range	Examples
Iron-inefficient or petunia group	5.4 to 6.2	Azalea, bacopa, calibrachoa, dianthus, nemesia, pansy, petunia, rhododendron, snapdragons, verbena, vinca and other plants prone to micro-nutrient deficiency (particularly iron) when grown at high media pH.
General group	5.8 to 6.4	Chrysanthemum, impatiens, ivy geranium, osteospermum, poinsettia and other plants not generally affected by micronutrient deficiencies or toxicities.
Iron-efficient or geranium group	6 to 6.6	Lisianthus, marigolds, New Guinea impatiens, seed geraniums, zonal geraniums and other plants prone to micro-nutrient toxicity (particularly iron and manganese) when grown at low media pH.

*Values are the same for all testing methods, although subtle differences in soil testing methods can vary results (by up to 0.5 pH units). Adapted from "Understanding pH management of container-grown crops." W. Argo and P. Fisher, 2002, Meister Media, Willoughby, Ohio.

Optimum electrical conductivity

Values vary depending on soil test method. Some methods dilute the test samples more than others resulting in a lower electrical conductivity.

Interpretation of media electrical conductivity or soluble salt levels	1:2 Method	Saturated media extract method	Pour-through method	Plug squeeze method
Low fertility	0 to 0.5	0 to 1.0	0 to 2.4	0 to 2.4
Acceptable range	0.6 to 1.50	1.1 to 3.0	2.5 to 5.0	2.5 to 4.0
High fertility	>1.50	>3.0	>5.0	>4.0

*Values are reported in milliSiemens per centimeter (mS/cm).

Test limits

An electrical conductivity test only measures total salt concentration of the extracted solution. It does

Species and their nutrient concentrations

Situation	Examples	Symptoms
Sensitive to high nutrient concentrations (high media electrical conductivity).	New Guinea impatiens, heliotrope, ferns and pentas.	Susceptible to leaf or root burn, and under extreme conditions will show toxicity symptoms on older leaves.
Sensitive to low nutrition concentrations (low electrical conductivity).	Petunia and chrysanthemum.	Plants appear pale green to yellow and are slow growers.
Sensitive to iron deficiency caused by high pH (above 6.4).	The petunia group, including calibrachoa, nemesia, pansy and petunia.	Chlorosis on new growth.
Sensitive to iron toxicity caused by low pH (below 6).	The geranium group includes seed or zonal geraniums, New Guinea impatiens, pentas and marigold.	Toxicity symptoms on old leaves. They can be good bio-indicators of pH and electrical conductivity problems.

not give an indication of the concentration of plant nutrients. The only way to determine exactly what ions make up the electrical conductivity is to use a more extensive commercial laboratory analysis.

A soil test is a snapshot in time — one solid leaching with clear water may totally change the electrical conductivity level and not be representative of the conditions under which the crop was growing. Soil tests can be out of sync with how the crop is looking, because current crop growth is the accumulation of growing conditions over the past weeks. In contrast, tissue tests represent nutrient accumulation over the

How to interpret popular tests

Here are several of the most popular soil and tissue tests that growers perform.

• pH and electrical conductivity. Analytical testing labs use a different soil test protocol (probably saturated medium extract) from the one most growers use in-house. Therefore, use the lab's electrical conductivity (EC) range, rather than an in-house target range. Some labs vacuum-extract the samples, which can consistently result in pH levels about 0.5 units higher than the in-house measured pH.

If you have a consistent testing protocol and good meters, you can do a better job of measuring pH and electrical conductivity than a commercial lab because you can use more samples. If the electrical conductivity is high, check whether salts are primarily nutrients (nitrogen, potassium and phosphorus, i.e., fertilizer) or junk ions (sodium, chlorine and aluminum from probably irrigation water or growing medium).

• Nitrate and ammonium. Together with urea (normally not included in lab reports), nitrate and ammonium are the main nitrogen sources. Ammonium levels above 30 parts per million indicate potential for toxicity — and sometimes causes rolled-down leaf margins — especially in cool, damp conditions.

A high ammonium level can occur with ammonium-based fertilizers (e.g., 20-20-20) and with unseasoned compost or manure. A low nitrogen level is the most common deficiency indicating inadequate fertilizer supply (pale or purple growth). High nitrogen levels increase electrical conductivity and can cause lush growth.

• Phosphorus. Deficiency is common (usually purple coloration in lower leaves), especially with a low- or no-phosphorus fertilizer (e.g., 15-0-15) on a long-term crop. Toxicity is unlikely, but high levels can cause excess stem elongation. Low solubility occurs at pH 7.5 or above.

• Potassium. Deficiency is rare with variable symptoms (usually marginal necrosis), resulting from inadequate potassium in fertilizer (such as fertilizing only with calcium nitrate). High potassium levels increase electrical conductivity and can reduce uptake of calcium and magnesium. Not affected by pH.

• Calcium. Deficiency (distorted new leaves) can occur even though the calcium level in the soil is adequate because calcium uptake is greatly affected by climate. High levels are often the result of overliming, high calcium in the irrigation water or in the fertilizer. High calcium levels increase electrical conductivity and reduce magnesium uptake. The calcium level should be two to four times the magnesium level. A low calcium level occurs at low pH because of inadequate lime application.

• Magnesium. Deficiency (usually interveinal chlorosis on medium-aged leaves) is fairly common on crops that have excess calcium (e.g., from calcitic lime) and inadequate magnesium in the fertilizer. High magnesium levels increase electrical conductivity and reduce the uptake of calcium. The magnesium level should be one-fourth to one-half of the calcium level.

• Sulfur. Deficiency (overall chlorosis) and toxicity are rare.

• Iron, manganese, zinc and copper. Deficiency symptoms can be similar between nutrients (interveinal chlorosis on new leaves). Deficiencies (especially iron) usually occur at a media pH above 6.5 in the iron-inefficient petunia group of plants. Toxicity is common (necrosis on old leaves) at low pH (below 6) in iron-efficient geranium group plants.

Zinc source may be galvanized pipes and copper from fungicides. Bark in the growing mix can provide excess manganese at low pH.

Low levels of these micronutrients in the soil test do not necessarily represent a problem because the saturated medium extract method does not extract micronutrients effectively. Check media pH to evaluate problems.

• Boron. Deficiencies (distorted, thickened new growth) are common at high pH and in high humidity. Toxicity (necrosis of old leaves) usually occurs from high boron levels in the irrigation water.

• Molybdenum. Low levels occasionally cause deficiency in poinsettia (yellowing of leaf margin). It is often not measured effectively by saturated medium extract. High levels may occur at high pH but toxicity is not likely.

• Sodium and chloride. Main "junk" ions are not needed for plant growth. A tiny amount of chlorine is used by plants, but deficiencies don't occur in horticultural crops. Usual sources are irrigation water, growing media components and fertilizer. High levels increase electrical conductivity.

• Aluminum. This is not needed for plant growth, so deficiencies do not occur. A high aluminum level usually occurs at low pH, sometimes with gravel or soil media components. Toxicity symptoms often appear as calcium deficiency because the aluminum ion binds to the roots and inhibits calcium uptake. The toxic level is not well-defined.

• Silicon. Silicon is used by plants primarily in stress responses, but deficiencies or toxicities do not occur in normal horticulture. No upper limit. 0.1 percent silicon has been reported as typical in plants.

entire growth period of the leaves being sampled.

Electrical conductivity tests of plugs and liners are less reliable compared to larger pots because vigorously growing seedlings or cuttings can quickly take up nutrients. A low electrical conductivity may not indicate a problem.

Species that are sensitive to iron toxicity caused by a pH below 6, like geranium, can be good bio-indicators of pH and EC problems.

For plugs and cuttings, it can be most important to pick an appropriate water-soluble fertilizer concentration, determine if the injector is working properly and make adjustments based on observed plant growth.

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Young Plant Research Center

The authors thank University of New Hampshire Agricultural Experiment Station and the Young Plant Research Center partners: Blackmore Co., Center Greenhouses, Costa Nursery, D.S. Cole Growers, Ellegaard, Farfard, Four Star Greenhouses, Glass Corner Greenhouses, Greencare Fertilizers, Knox Nursery, Kube-Pak Corp., Lucas Greenhouses, Pleasant View Gardens, Pindstrup, Premier Horticulture, Quality Analytical Laboratories, SunGro Horticulture and Welby Gardens for their research support.

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