Figure 2. Formulas for calculating dry or liquid fertilizer rates

Dry fertilizer

$$\frac{\text{rate of nutrient needed}}{\text{\% nutrient in fertilizer}} = \text{rate of fertilizer to apply}$$

For example, *if* the soil report recommends 6.0 lb /1,000 ft^2 K_2O and you have a 13-0-44 fertilizer (13% N, 0% P_2O_5 and 44% K_2O), *then* you should apply 13.6 lb fertilizer per 1,000 ft^2.

$$6.0 \text{ lb } K_2O / 1{,}000 \text{ ft}^2 \div 0.44\ K_2O = 13.6 \text{ lb} / 1{,}000 \text{ ft}^2$$

Liquid fertilizer

$$\frac{\text{ppm nutrient needed}}{(\text{\% nutrient in fertilizer} \times 75)} = \frac{\text{oz}}{100 \text{ gal.}}$$

For example, 6.7 oz of Epsom salts (10% Mg) in 100 gallons of water will supply 50 ppm Mg.

$$50 \text{ ppm Mg} \div (0.10 \text{ Mg} \times 75) = 6.7 \text{ oz } / 100 \text{ gallons}$$

Phosphorus (P) & potassium (K). Soil test recommendations for P and K are provided in units of lb/1,000 ft^2 of P_2O_5 and K_2O, respectively. To convert these rates to lb/yd^3, divide by 24. Take into account the amount of P_2O_5 and/or K_2O that will be applied if a complete fertilizer such as 20-10-20 is used as the nitrogen source.

Magnesium (Mg). If a *$* symbol appears in the Mg column of the *Recommendations* section on the soil test report, levels of Mg are low. When *$* is present and the pH is low, apply dolomitic lime. However, if lime is not needed, supply Mg by adding 5 lb Epsom salts (0.5 lb Mg) per 1,000 ft^2. For established plants, apply Mg along with other fertilizer treatments. In a constant feed program, inject 35–50 ppm Mg using a source such as Epsom salts.

Sulfur (S). Plant tissue analysis is the most reliable test for determining sulfur status in the crop. When the S-I is less than or equal to 25 for soil-based substrate, an application of 0.5 lb S per 1,000 ft^2 may be beneficial to the crop. For a continuous-feed program in soilless substrates, 35–50 ppm S is recommended.

Micronutrients. A *$* symbol in the Mn, Zn or Cu column of the *Recommendations* section of the soil test report indicates low levels of these nutrients. Application may or may not be necessary. It is best to monitor status of micronutrients with plant tissue analysis.

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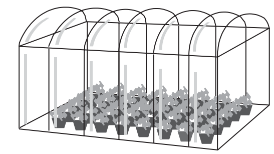
January 2006

NOTE 9: Soil Analysis of Growth Substrates for Greenhouse Crops



In addition to soil testing, best management practices for any greenhouse crop include having irrigation source water tested (solution analysis) well in advance of production. This approach allows time to make any necessary adjustments to substrate or source water before it comes into contact with plants.

During production, plant tissue analysis and solution analysis of pour-thru leachate are the appropriate tests for diagnosis of nutrient-related problems. NCSU Horticulture Information Leaflet 590 describes the pour-thru sampling procedure and is available online at www.ces.ncsu.edu/depts/hort/floriculture/cfr/index.htm.

The primary purpose of soil testing in a greenhouse situation is to evaluate the quality of bulk growth media prior to production. Soil testing is geared toward providing reliable information about nutrient levels and properties of mineral soil, but it does have some limited usefulness with regard to soilless media (perlite, vermiculite, peat, bark, compost, sand and/or mixtures of these). The key items that are always important in a "soil" analysis of a greenhouse substrate are pH and soluble salt levels. These values must be within acceptable ranges before a crop is planted.

Greenhouse crops can include houseplants, bedding plants, seasonal flowers, perennial flowers, vegetables and herbs. Fertilizer and pH requirements vary greatly, depending on crop, type of substrate and production method. For this reason, the soil test report does not provide lime and fertilizer recommendations for specific crops. Each grower must decide when adjustments need to be made based on a comparison of soil test report values and the optimum fertility requirements given in crop production manuals.

pH/Lime

Most plants grow best in a substrate with a pH of 5.5–6.5. For these, a target pH of 6.0 is usually recommended. However, some plants are more suited to acid soils with a pH of 5.0–5.5. Refer to production manuals for a crop's optimum pH, then use the formula in **Figure 1** to calculate the lime requirement, if necessary.

Figure 1. Formula for calculation of lime requirement

$$\frac{\text{desired pH} - \text{soil pH}}{6.6 - \text{soil pH}} \times Ac \times cf = \text{rate of lime to apply}$$

where

Ac is the soil test report acidity value and *cf* is the appropriate conversion factor for the desired rate of application: use $cf = 1.9$ to obtain lb per yd^3 and $cf = 46$ for lb per 1,000 ft^2.

For example, *if* *soil test pH* = 5.0, *Ac* = 1.5 and *desired pH* = 6.0, *then* you should apply

$$\frac{6.0 - 5.0}{6.6 - 5.0} \times 1.5 \times 1.9 = 1.8 \text{ lb per yd}^3$$

or

$$\frac{6.0 - 5.0}{6.6 - 5.0} \times 1.5 \times 46 = 43 \text{ lb per 1,000 ft}^2$$

Soluble salt index (SS-I)

Since most plant nutrients in fertilizers are formulated as salts, the SS-I is an indication of the fertility level of the substrate. When fertility is too high, salts can cause injury to plant roots. Composition of the substrate, moisture level, texture, temperature and other factors determine the potential for SS-I problems. As a general rule, plants growing in substrates with high cation exchange (CEC) and water-holding capacities can tolerate higher fertility and soluble salt levels.

Table 1 indicates the relative salt hazard to a crop based on substrate type and SS-I value. Find the hazard level indicated by the SS-I value on your soil test report, and take the action indicated in **Table 2**.

Table 1. Salt hazard by substrate type

	Soluble-Salt Index (SS-I) Ranges*			
Media	**Low**	**Medium**	**High**	**V. High**
peat-lite mixes	0–40	41–100	101–180	180+
silt-clay loam	0–30	31–75	76–135	135+
sandy loam	0–23	24–51	52–95	95+
pine bark	0–12	13–26	27–50	50+

* SS-I is in units of 10^{-5} mhos/cm. SS-I ÷ 100 = dS/m.

Table 2. Soluble-salt guidelines

Salt Level	Action Required
Low/Medium	The effect of salt on plants is negligible.
High	Germination and seedling injury may occur if the SS-I is at the high end of the range. Otherwise, levels are satisfactory.
Very High	Do not add fertilizer or let the media become dry. Water enough to cause leaching if the SS-I is well over this range.

Nutrient level values & recommendations for soil-based media

Soil test nutrient analyses are not generally meaningful for soilless substrates. Nutrient level measurements can be misleading for these types of media. Assume all nutrients are to be supplied by the fertilizer solution.

For soil-based substrates, nutrient level values and recommendations are relevant. Refer to **Figure 2** for formulas to calculate application rates for dry or liquid fertilizers.

The nutrient concentrations for phosphorus (P), potassium (K), sulfur (S), manganese (Mn), zinc (Zn) and copper (Cu) are reported as indices (P-I, K-I, S-I, Mn-I, Zn-I, Cu-I). In general, an index value less than or equal to 10 indicates a very low nutrient level; 11–25, low; 26–50, medium; 51–100, high; and 100+, very high. For the micronutrients Mn, Zn and Cu, index values greater than 25 indicate sufficient levels for plant growth. Because availability indices (Mn-AI, Zn-AI) take into account the effect of soil pH, these values are better indicators of sufficiency than Mn-I and Zn-I.

Nitrogen (N). NCDA&CS soil tests do not measure N concentration, and the report does not recommend a rate for N. Most greenhouse crops need 3–6 lb N per 1,000 ft^2 or 0.125–0.250 lb N per yd^3 for the production cycle. Growers should refer to a reliable production manual for the specific crop.