Nutrition and Fertility of Substrates

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Sixteen elements have traditionally been considered essential for growth of nursery crops. Recently, nickel has also been shown to be an essential element for at least some nursery crops (river birch and pecan). The nickel requirement has been mask due to impurities in minor element products and use of superphosphate as a nutrient amendment. In the past, minor element products also contained trace amounts of nickel which supplied adequate nickel nutrition for growth. Today minor element products contain few impurities and superphosphate is no longer recommended as a potting substrate amendment due to excessive leaching of phosphorus. Nickel supplements are now being developed for nursery crops and will likely be included in most minor element packages sold for nursery production. One new product is Advance Ni^{TM}, developed as an outcome of research by Dr. John Ruter, Univ. of GA. In North Carolina, nickel is not on the list of approved micronutrients. Apparently a special legislative bill is required before sale of the product in North Carolina is approved. Nickel has received federal approval through the American Association of Plant Food Control Officials, therefore allowing individual states approval for registration of nickel as a fertilizer product. The Advance Ni product will then be available through distributors such as Coor Farm Supply from NIPAN LLC, Valdosta, GA.

Regarding other plant nutrients, nurseries do not need to supply carbon, hydrogen and oxygen since they are free from the environment, however the other thirteen elements in soil-less organic potting mixes must be applied by the grower. A distinction is necessary between soil and soil-less potting mixes. Commercial growers rarely use potting mixes containing soils, however as late as the 1960's potting mixes did frequently include some soil. Cultural changes to better drained organic potting mixes required nutritional changes, particularly addition of minor elements. Today several commercial minor nutrient packages are sold as additives to potting mixes. Many controlled release fertilizers with minors packages added as an all in one amendment are also widely available from Controlled Release Fertilizer companies. In addition, several soluble trace element packages applied several times during a growing season as a drench or spray can be used to meet minor element requirements, however most nurseries prefer to use minor element packages incorporated during potting mix preparation, or as part of the NPK controlled release product package with minors as a top-dressed or incorporated into the potting mix. Addition of dolomitic limestone to potting mixes is also traditional, but research from several Southeastern Land Grant Universities appear to question rate of application or the need for addition of lime. However, from the focus of plant nutrition, addition of dolomitic limestone provides the essential elements, calcium and magnesium and it also raises pH of potting mixes as it dissolves. If adequate calcium and magnesium are available from components in the potting mix or from the irrigation water, no further

calcium or magnesium supplement would be required. If adequate levels are not available, products other than dolomitic limestone could be utilized. $CaSo_4$ (gypsum) can be substituted as a calcium supplement if dolomitic limestone can not be used due to high pH levels. However, monitoring EC is necessary as gypsum does increase EC levels in substrate solution. $MgSo_4$ (Epsom Salts) can be substituted for dolomitic limestone to provide Mg but Epsom salts is very soluble so may require liquid drench applications during the growing season. An alternative Mg amendment incorporated for longer activity is a product called CropMag. Irrigation supplies should be tested to determine strategies to provide Ca or Mg.

Most nurserymen provide, nitrogen, phosphorus and potassium using Controlled Release Fertilizers (CRF's). Like many other corporate sectors of business, considerable consolidation has occurred in recent years in the commercial fertilizer industry. Today, most nurserymen have many choices of fertilizer longevity and analysis but only about six company product lines. Controlled release fertilizers have labels similar to pesticide products. Recommended rates usually include low, medium and high rates depending on the type of crop, age, and container size. However, the amount of nitrogen applied generally determines the rate used. Best Management guidelines indicate that adequate growth of most container ornamentals can be produced with an equivalent of 3 grams of nitrogen per 1 gallon container. Fertilizer rates are reduced for larger containers using rates included on product labels. Nutrient content of irrigation water must be considered as fertilizer programs are developed. Irrigation water samples should be analyzed to determine how to design nutritional applications. Most lab reports will provide a recommendations and suggestions regarding the use of the water sample as an irrigation supply. Container leachates can be analyzed by soil and plant testing labs to determine current nutrient levels. Foliar tissue analysis is useful to solve nutritional problems when they are observed.

A grower can trouble shoot fertilizer levels and problems by monitoring soluble salts and pH of container leachates. Nutrient concentrations, pH and conductivity levels can be monitored by pouring a 0.5 cup of irrigation water per gallon size of container over the surface of the substrate about 30 minutes to 2 hours after irrigation and collecting water that comes out of the bottom of the container. Actually, collecting the solution that drips out of the container 30 minutes to 2 hours after irrigating provides information regarding the exact levels experienced by roots. To test the leachate solution, a grower needs to purchase a pH and conductivity meter. Prices range from about $49 to $1000's but inexpensive glass electrode pH meters and pens and conductivity meters and pens provide accurate results and can save $1000's in nursery stock losses. Sending the leachate solution for laboratory analysis at least once during the growing season is a good idea, so that actual nutrient levels in the container are known and corrected if needed. For more information on doing PourThru leacahate collection see the following website:http://www.ces.ncsu.edu/depts/hort/hil/pdf/hil-450.pdf

Table 1 below provides suggested nutrient guidelines for irrigation supplies, container leachate nutrient levels and foliar analysis.

Table 1. Nutrient and Chemical Ranges for Water, Substrates and Plant Tissue Parameters in Woody Ornamental Crop Production

Quality Factor	Irrigation Water[1] (BMP's)	Substrate Leachate[2] (PourThru)	Plant Tissue[3]
pH	5.4-6.8	5.2-6.3	-
Conductivity	0.2-2.0 mmhos/cm (dS/m)	0.5-2.0 mmhos/cm (dS/m)	-
Total dissolved salts	<1000 ppm	<1400 ppm	-
Bicarbonate	<100 ppm or <2 meq/l	-	-
Alkalinity	<2 meq/l	-	-
(carb. + bicarb.) [1 meq = 50 ppm]	<100 ppm$CaCO_3$	-	-
TC	<2 meq/l	-	-
Hardness	150 ppm or <3 meq/l (Ca + Mg)	-	-
SAR	<10 meq/l		
Na	<3 meq/l or <50 ppm	<50 ppm	0.01-0.1%
Chlorides	<70 ppm	<70 ppm	50-200ppm
N		25-150 ppm	2.0-3.5%
NO_3-N	<10 ppm	50 ppm	-
NH_4-N	1-2 ppm	50 ppm	-
P	<1 ppm	1-5 ppm	0.2-0.5%
K	<10 ppm	<100 ppm	1.1-2.0%
Ca	<60 ppm	40-200 ppm	1.0-2.0%
Mg	<6-24 ppm	10-50 ppm	0.3-0.8%
S	<24 ppm	75-125 ppm	0.2-0.7%
Fe	0.2-4.0 ppm	0.3-3.0 ppm	35-250 ppm
Mn	<0.5-2.0 ppm	0.02-3.0 ppm	50-200 ppm
Zn	<0.3 ppm	0.3-3.0 ppm	20-200 ppm
Cu	<0.2 ppm	0.01-0.5 ppm	6-25 ppm
B	<0.5 ppm	0.5-3.0 ppm	6-75 ppm
Mo	<0.1 ppm	0.0-1.0 ppm	0.1-2.0 ppm
Al	0.05-0.5 ppm	0.0-3.0 ppm	<300.0 ppb
Fl	<1.0 ppm		

1. Ranges that generally do not require water treatment.
2. Recommended concentration in leachate collected from substrate
3. Desired concentration in leaf tissue samples