Editors' Note: This is the first in a six-part series of articles highlighting the research being performed at the University of Florida in Gainesville.

Nutrient Supply in Propagation

New research from the University of Florida highlights the most effective strategies for applying fertilizer to produce more consistent results with less environmental impact.

By Kate Santos, Paul Fisher and Bill Argo

We surveyed several leading liner producers on how they applied water-soluble fertilizer during a four-week cropping cycle with vegetative annuals (Figure 1). While there are many ways to deliver nutrients during cutting propagation, some strategies for applying fertilizer produce more consistent results with less environmental impact than others.

This range in the application of water and fertilizer raised several research questions that have driven Kate Santos' Ph.D. project on cutting nutrition. In this article, we describe a few of our findings from university trials and grower experience as part of the Young Plant Research Center program.

Nutrition Requirements of Unrooted Cuttings

Unrooted cuttings (URCs) require higher tissue nutrient levels than finished plant material because tissue nutrient concentrations often drop from just after sticking until roots begin to form. If the cuttings contain a high level of nutrients (relative to finished plant material), then this drop will not cause a problem because the tissue levels never reach a minimum critical level that affects growth, if fertilizer is supplied throughout the rooting cycle (Figure 2). However, if the nutrient levels in the URC are low to begin with, then this drop can cause nutrient levels to drop below the critical level, often causing the appearance of nutrient deficiencies, slow or non-uniform rooting, or greater susceptibility to diseases.

One of the biggest problems we found was the lack of information on tissue nutrient levels in URCs and how they related to published levels in finished plant material. We therefore asked cuttings suppliers and rooting stations to send in tissue samples from healthy URCs for nutrient analysis. We collected more than 4,000 tissue samples between 2004 and 2008, and we now have information on 89 plant species. We have included the survey results for petunia (Figure 3), and other results will be published later this year. Overall, we have found that stock plant producers are doing a good job providing rooting stations with cuttings that are high in initial nutrient levels relative to finished plant material (Figure 4).

In your own operation, if you consistently see deficiencies in cuttings during propagation (Figure 5), check nutrient levels of the URCs using a tissue analysis, and increase stock plant fertilizer levels. It is common to see deficiencies in tip cuttings taken off a tray, because those tip cuttings are likely to have low initial nutrient levels unless you have adequately fertilized mother plants in the tray.

Maintain Steady Supply

Once root initials emerge, cuttings need a constant supply of nutrients. There are several ways to do this at the stage when roots emerge.

Include a pre-plant charge, and minimize leaching. Most pre-plant nutrient charges are

Concentration of Water-Soluble Fertilizer

Grower	Week			
	1	2	3	4
A	200	200	200	200
B	0	200	170	200
C	150	200	200	150
D	0	300	300	300
E	0	0	150	150
F	0	0	1x150; 2x300	1x150; 2x300
G	0	0	200	200
H	100	100	100	100

Figure 1. *Concentration of water-soluble fertilizer in parts per million (ppm) of nitrogen during a four-week liner production cycle for petunia or calibrachoa. During week 1, plants were under mist, and from weeks 2 to 4 irrigation was applied by hand or with a boom.*

Nutrient Percentages During Propagation

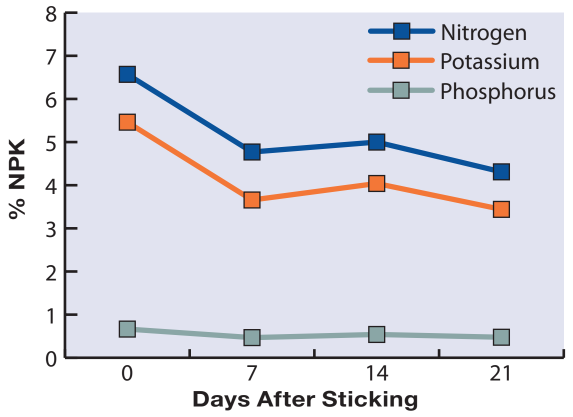

Figure 2. *Percent of nitrogen (N), phosphorus (P) or potassium (K) during three weeks of propagating petunia 'Supertunia Royal Velvet' cuttings supplied from InnovaPlant Costa Rica. A complete NPK fertilizer (17-4-17) was applied at 100-ppm N in both mist during week 1 and subsequent hand irrigation.*

Petunia Tissue Nutrient Levels

Nutrient	Low	High	Mean
N (%)	4.5	6.9	5.7
P (%)	0.4	0.7	0.6
K (%)	4.1	6.0	5.0
Ca (%)	0.7	1.8	1.1
Mg (%)	0.3	0.8	0.5
S (%)	0.4	1.1	0.8
Fe (ppm)	61	183	110
Mn (ppm)	50	124	81
Zn (ppm)	29	81	50
Cu (ppm)	4	16	10
B (ppm)	25	64	41
Mo (ppm)	1.8	11.5	5.8
Al (ppm)	0	185	82

Figure 3. *Petunia tissue nutrient levels from a survey of URC from 10 locations and 291 samples over three years. Tissue levels that are above or below the "low" or "high" levels do not necessarily indicate a problem. Ten percent of samples were below the "low" level, and 10 percent of samples were above the "high" level. For aluminum (Al), the "low" level is 0 because this is not an essential nutrient.*

Initial Tissue Nitrogen Content in Unrooted Cuttings

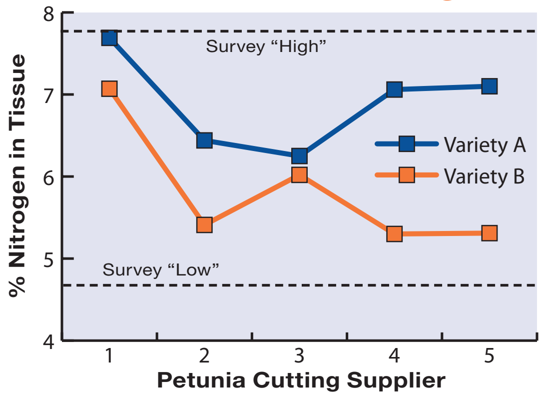

Figure 4. *Initial tissue nitrogen content in URC for two cultivars from five offshore cuttings suppliers during spring 2008.*

highly soluble. Our research has shown that once a complete container volume of water is leached through a plug tray, that pre-plant charge is gone. We developed a simple collection tray method to measure leaching, which growers use to refine their mist practices (Figure 6a). When we used this method in several grower locations, we found that some growers leached a container volume very quickly, within a week of sticking, whereas other growers used much less water.

Apply a fertilizer drench as soon as mist is reduced. Growers typically apply 200- to 250-ppm nitrogen from a complete fertilizer as a one-time drench.

Figure 5. Nutrient deficiency symptoms on a petunia cutting during mist propagation

Figure 6. To minimize leaching, check under trays to see how much moisture is pooling around the drain holes (left) or use a collection tray (right) to quantify the amount of leachate.

Apply fertilizer in the mist system from sticking on. Mist fertigation is most effective for crops that show nutrient deficiencies early during propagation at your location, if URCs arrive looking nutrient deficient, or if you are taking tip cuttings from liners that were grown lean. Most growers only apply 50- to 100-ppm nitrogen during mist fertigation to avoid salt burn.

As with any change in your management, trial the fertilizer method you use on a small group of plants before applying to the entire crop. Once plants are off mist, most growers apply 150- to 200-ppm nitrogen. Higher fertilizer concentrations tend to increase shoot growth and decrease root growth.

In Conclusion

Research emphasizes that nutrient deficiency during propagation is less likely if URCs have adequate nutrient levels prior to sticking. Even with a URC high in nitrogen, phosphorus, calcium, magnesium, iron and boron (the most common deficiencies in cuttings), it is easy to run into deficiency issues during propagation. Nutrients need to be supplied to cuttings by the time roots begin to grow, either through a pre-plant charge, corrective fertilizer drench or mist fertigation. A moderate fertilizer level (100- to 200-ppm nitrogen) with minimal leaching will provide the best combination of root and shoot growth without excess runoff.

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