Nutrient Analysis for the Nursery Industry©

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INTRODUCTION

A limiting factor in the production of container-grown plants is the inability of nursery production managers to regularly, and accurately, monitor plant nutrient levels. To obtain the most competitive production rates all components of the production system need to be optimised. One of the most significant components is the level, and balance, of nutrients. Throughout the nursery industry electrical conductivity (EC) is used as a guide to the salt concentration within the growing medium. In normal circumstances the source of most of the salt in the medium will be from the added fertilizers. The EC then provides the production manager with an indication of the need for supplementary fertilizer application or, conversely, the need to leach excess salts from the medium. The EC does not, however, identify individual fertilizer salts nor does it provide any indication of the relative proportions of the various salts present. By using EC as a guide for the need to add supplementary fertilizer we are effectively assuming that all the nutrient components that constitute fertilizer salts are consumed by the plant, or lost from the medium, at an identical rate. Clearly this does not happen.

There are at least 16 nutrient elements required by plants. Carbon, hydrogen, and oxygen are sourced from the atmosphere, including the growing medium atmosphere, or water. The rest are primarily obtained from the growing medium. Some, the macro-nutrients, are required in larger amounts than others – the trace, or micro-nutrients. We know that plants use some nutrients at a faster rate than others and that some will be more mobile than others and consequently more readily leached. This is particularly the case with anions, the negatively charged component of a fertilizer salt such as nitrate (NO_3^-), and less so with the positively charged component, or cation, such as ammonium (NH_4^+). Not only are anions usually more mobile than cations, and therefore lost from the container medium more readily, but the cation components will vary in their tenacity on exchange sites within the medium.

As well as having various degrees of mobility it is also worth remembering that plants will require different proportions of the different nutrients at various stages in their growth cycles. Nutrients are taken up by plants in the form of ions, both cations and anions, removed from the water surrounding the roots. In a typical container production system we rely on these nutrient ions being replaced in the medium solution from exchange sites on colloids or decomposition of organic material but mainly from fertilizers.

For optimal growth plants not only need an optimal concentration of each nutrient but they also require those nutrients to be present in the correct proportion to each other. Whitcomb (1984) outlined some of the key nutrient relationships. Given the variable mobility of nutrients and their varying use by plants, it is inconceivable that when we take a measurement of total salts (EC) and use it to add a fertil-

izer that we will consequently have all nutrients in the "correct" concentrations and in the "correct" proportions. Quite simply we do not know if we are adding a surplus of some nutrients or creating a deficiency of others. A further complication is that when we create a surplus of one nutrient we can induce a deficiency of another.

This indiscriminate use of nutrients can also create environmental problems as nutrient rich leachate can, potentially, pollute waterways and ground water systems.

At the present time the only way of determining individual nutrient levels is to forward a sample of the growing medium to a laboratory for analysis using the Australian Standard (1996) technique. This can be moderately costly and there is inevitably some delay in the return of the results. A "user friendly", inexpensive, accurate, and quick method of determining the status of individual nutrients in a potting medium would be a significant tool for production nurseries. Ideally an interpretative guide for each nutrient and major nutrient relationships, based on a correlation of the results with those of the Australian Standards (1996), would be a key component of any new nutrient monitoring tool.

METHODS

In this preliminary trial a comparison was made between the results of media nutrient analysis using the Australian Standards (1996) technique and an RQflex[©] 2 a product of the Merck Pharmaceutical Company.

The RQflex[©] uses Reflectoquant[©] test strips which are dipped into the solution – in this case a filtered 1:1.5 extract from the medium – to be tested. The appropriate strip is inserted into the instrument and a digital read out is provided. The RQflex[©] works on the principle of remission photometry with the difference in intensity of emitted and reflected light allowing a determination of specific ion presence.

The 1 : 1.5 extracts were initially passed through a sieve to remove large particles then filtered through a fast filter paper and, finally, through a 0.4 μm syringe filter. The filtered sample was then stored under refrigeration in sterile tissue culture containers until testing was carried out.

Generally the test for each nutrient required a test strip to be dipped into a filtered sample which may, or may not, have been adjusted for pH or had one or more reagents added. The manufacturer's instructions for each nutrient are clearly outlined. The strip is inserted into the RQflex[©] which reads the change and provides a digital reading on the screen.

Three batches of potting media were used:
1) Freshly prepared media with controlled-release fertilizer added at the manufacturers recommended rate;
2) Freshly prepared media with twice the recommended rate of fertilizer (×2);
3) Media that had plants growing in it for over 12 months with no supplementary fertilizers added.

Each batch of media was thoroughly mixed, moistened, and left to stand for about a week. Five samples of each batch were then removed and halved. One-half was sent to a commercial laboratory for analysis using the Australian Standards (1996) technique and the other half prepared for analysis using the RQflex[©].

It was expected that the results of the comparison would differ – after all the extraction techniques, diethylenetriaminepentacetic acid (DTPA) for the Australian Standards (1996) technique and water when using the RQflex[©], are different and

there was a small number of replicates. Nonetheless it was hoped that despite the small number of replicates the results would be consistently different – such that a correlation between the two techniques could be obtained.

In this initial trial the nutrients we tested were nitrogen (ammonium and nitrate), phosphorus, and iron. Potassium was to be included in the trial however levels fell into a range where there is no specific RQflex[cl] test. The samples could have been diluted and a lower level test employed, however for this nutrient, at this concentration range, a variation of the "standard" technique is used. To avoid too many variables at this early stage, potassium was not included.

RESULTS

Iron proved difficult to test for using the RQflex[cl] system despite having the appropriate concentration strips for the nutrient. We consistently recorded a "too low" (that is, a too low to measure) result. We were possibly encountering some form of ion interference although the obvious candidates, such as copper, were eliminated. Further work will be required to determine the appropriate RQflex[cl] technique for iron determination. The results for nitrate, ammonium, and phosphate of the three mixes using both the Australian Standard (1996) technique and the RQflex[cl] are provided as an appendix. Table 1 provides the results for the "general potting mix".

Interestingly we found that the two techniques provided a close correlation for the general potting medium and that the mix in use at the time of the trial was very low in P (Handreck and Black, 1994, suggests an appropriate P : N for non-P-sensitive plants is in the range of 0.06 to 0.15). The P : N results were not as consistent for the ×2 fertiliser media with the RQflex[cl] at 0.036 compared to 0.059.

NITRATE

The results for NO_3^- were fairly consistent. The lab results using the Australian Standard (1996) technique were around 39% of the RQflex[cl] with a standard deviation of less than 10%. This was the case for both the general mix as well as the ×2 fertilizer mix. Because the lab results returned general values of <0.2 mg litre[-1] for the "old mix" it is not possible to describe a relationship. We can say, however, that the trend was in keeping with the other mixes.

AMMONIUM

For the general mix the Australian Standard (1996) method was around 95% of the RQflex[cl] result with a standard deviation of 13%. For the ×2 fertilizer mix the lab results averaged 124% of the RQflex[cl] results with an increased standard deviation of 20%. Again for the old mix it was not possible to propose a relationship.

PHOSPHATE

The Australian Standard (1996) technique results for the general mix were consistently around 46% of the RQflex[cl] results with a standard deviation of 13%. A very similar relationship and level of standard deviation occurred with the old mix, however the relationship was not as consistent with the ×2 fertiliser mix.

DISCUSSION

The use of EC as a guide for the need to apply extra fertiliser is limited by its lack of specificity — it tells us how much salt is present but it does not tell us which ones

are present nor in what proportion they are present. In order to fine tune the production process growers need to be able to identify the level of individual nutrients within the growing medium.

Despite the small number of nutrients that were tested, and the small number of replicates, the RQflex[©] appears to have potential for use in nurseries as a quick, accurate, and relatively inexpensive technique for measuring a large range of individual nutrient levels in media. By correlating the results against the Australian Standard (1996) technique it should be possible to provide a guide with "high", "low", and "optimum" ranges for a large number of nutrients. In order to accomplish this further, more substantial, trials need to be undertaken assessing a wider range of nutrients in both pine-bark- and peat-based media.

LITERATURE CITED

Australian Standard for Potting Mixtures AS 3743. 1996. Standards Australia. Homebush, NSW, Australia.

Handreck, K.A. and **N.D. Black**. 1994. Growing media for ornamental plants and turf. UNSW Press Randwick, NSW.

Whitcomb, C.E. 1984. Plant production in containers. Lacebark Productions, Stillwater, Oklahoma.

Table 1. Comparison of results obtained for general potting mix using the Australian Standard (1996) technique and the RQflex©.

	Ammonium mg·litre^{-1}		Nitrate mg·litre^{-1}		Phosphate mg·litre^{-1}		pH		EC µS·cm^{-1}
	Australian Standard	RQFlex	Australian Standard	RQFlex	Australian Standard	RQFlex	Australian Standard	Burnley	Burnley
General Mix 1	20.0	21	107.4	278	4.0	10	5.1	5.1	1605
General Mix 2	19.6	25	92.7	232	4.0	14	5.0	5.2	1540
General Mix 3	19.6	20	92.7	280	5.3	10	5.0	5.2	1680
General Mix 4	23.8	21	109.6	274	5.3	11	5.0	5.3	1610
General Mix 5	19.2	21	101.7	242	5.0	8	5.0	5.3	1630
Mean	20.4	21.6	100.8	261.2	4.7	10.6			

Phosphorus to nitrogen ratios using the mean figures for the five replicates:
P : N = 0.038 (Australian Standard, 1996, technique)
P : N = 0.037 (Rqflex©)

Appendix 1. Results for all media.

	Ammonium mg·litre⁻¹		Nitrate mg·litre⁻¹		Phosphate mg·litre⁻¹		pH		EC µS·cm⁻¹
	Australian Standard	RQFlex	Australian Standard	RQFlex	Australian Standard	RQFlex	Australian Standard	Burnley	Burnley
General Mix 1	20.0	21	107.4	278	4.0	10	5.1	5.1	1605
General Mix 2	19.6	25	92.7	232	4.0	14	5.0	5.2	1540
General Mix 3	19.6	20	92.7	280	5.3	10	5.0	5.2	1680
General Mix 4	23.8	21	109.6	274	5.3	11	5.0	5.3	1610
General Mix 5	19.2	21	101.7	242	5.0	8	5.0	5.3	1630
Fert (X2) 1	33.6	27	139.0	386	9.9	12	5.0	5.3	1690
Fert (X2) 2	45.1	30	181.9	480	10.5	20	5.0	5.2	2110
Fert (X2) 3	32.9	30	145.8	402	9.3	16	5.0	5.2	1745
Fert (X2) 4	37.0	27	169.5	360	13.0	11	5.0	5.4	1620
Fert (X2) 5	29.1	30	149.2	374	14.6	18	5.0	5.3	1860
Old Mix 1	0.3	0.9	< 0.2	6	4.0	11	5.7	5.5	146
Old Mix 2	0.3	0.4	< 0.2	6	4.3	9	5.7	5.5	120
Old Mix 3	< 0.3	0.5	< 0.2	5	5.0	9	5.7	5.6	110
Old Mix 4	< 0.3	0.7	< 0.2	10	3.7	12	5.7	5.6	155
Old Mix 5	0.3	0.7	< 0.2	10	7.1	11	5.6	5.7	155