Testing Prevents Disasters

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Imagine the situation in which all of a batch of your most difficult-to-propagate tubestock died soon after potting up because of extreme salinity in the mix. Or imagine the situation in which despite all assurances from your potting mix manufacturer your phosphorus-sensitive plants kept dying in large numbers. Or how about a batch of nice yellow rhododendrons that died, because the supposedly acid mix contained chunks of limestone. Imagine, too, having your income for the year eliminated because your cyclamen seedlings died through suffocation in waterlogged mix.

These are all recent examples of actual disasters in Australian nurseries that could have been prevented through the use of very simple tests that take only minutes of your valuable time. Use of an EC meter, a phosphorus test kit, a pH meter, and a milk carton before potting would have prevented all of these disasters. The $300 cost of this testing gear would have prevented losses of income amounting to well over a million dollars in one case. The incomes of lawyers and companies that manufacture headache relievers would have been reduced. The purpose of this talk is to convince you that:

- Testing is really easy
- Testing is cheap
- Testing can save you big money
- Testing replaces guessing with sound decisions
- Testing can help you to sleep soundly at night, because
- Testing sharpens your management skills, and
- Testing prevents disasters

The emphasis here is on testing before potting, but some of these tests can be used to monitor the plants during the growing period. Here are some details of the tests that you can do.

AIR-FILLED POROSITY

A determination of air-filled porosity (AFP) is spread over a couple of hours, but for 95% of that time a grower can be doing something else. A grower need not spend a cent on the apparatus: simply use a milk carton, a plastic bucket, a kitchen measuring jug, and a baking dish, or ice cream container. However, the nursery will be in business for many years, so a grower will want to use something better than a milk carton. A test vessel that will last forever can be made from two 120-mm lengths of 90-mm diameter PVC pipe and 90-mm cap. The "recipes" for making the vessel and for carrying out the test are given in the Australian Standard for Potting Mixes (Standards Australia, 1993) and in Handreck and Black (1994).

The cost per determination is nil, plus your time. Had the cyclamen grower who lost all seedlings for a year used this test, he would have found that a new brand of peat gave an AFP of only 4%, compared with an AFP of 12% for the previous brand. He would have found another peat or would have modified the formulation of the mix so that its AFP was as needed, or he would have increased the height of the germination containers (Handreck, 1993a)

CHECKING THE CHEMISTRY OF THE MIX

Properties such as pH, EC, and phosphate, ammonium, and nitrate concentrations, are most easily determined on a water extract of the bulk mix. Mix already in pots can also be analysed by this technique, but the "pour-through" technique may be found to be easier. I describe both techniques.

THE VERSATILE WATER EXTRACT OF A MIX

Several key properties of a mix can be determined on one simple water extract. Preparation of the water extract involves the following simple steps:

1) Take a representative sample of the mix and slowly add water to it until you can just hear water squelching when a sample of the moistened mix is squeezed.

2) Measure 50 ml of this moistened mix and put it into a container that will hold at least 150 ml.

3) Add 1.5 volumes (75 ml) of deionised water (or rain water or tap water if it is very pure).

4) Shake or stir the mixture several times, let it sit for 5 min, shake or stir again, and then start testing.

EC and pH. These two tests are absolutely essential and should be done on every batch of mix made or purchased. A pocket-sized EC meter and a pocket-sized pH meter are needed. They may be purchased from hydroponics supply shops or from scientific supply firms. The total cost is about $180 for the two. To determine the pH, *simply dip the electrode of the pH meter into the moistened mix and water* slurry (1 : 1.5, v/v) and read the digital display. The cost is ½¢ for the water, plus 10¢ for depreciation of the meter over about 1000 samples.

A note of caution is needed. The pH meter must be calibrated against standard pH solutions before it is used for the first time. Instruments may have been set at the factory, but all too often they have gone out of calibration. New ones have been known to be a full 2 pH units wrong! Calibration should also be checked at least once each day that the meter is used.

If only the pH is to be checked a colorimetric pH test kit can be used. To determine the pH with a kit, add a liquid to a small sample of mix, stir, wait 30 seconds, dust the sample with a white powder, and compare the colour produced with patches on the chart. The cost is less than 20¢. The results are interpretted according to the pH requirements of the plants being grown.

For an EC determination, filter the 1 : 1.5 (v/v) slurry through a piece of panty hose held in a small kitchen strainer and dip the meter electrode into the filtrate for a direct reading of the salinity. Total cost is about 10¢. This test will alert growers to events such as excessive release of salts from controlled-release fertilisers in the mix, the use of an excessive amount of soluble fertiliser or, at the other end of the scale, an inadequate supply of soluble nutrients for excellent early plant growth.

An EC of 0.2 dS m^{-1} (deciSiemens per metre) can probably be interpreted as indicating inadequate nutrition, unless a grower is sure that controlled-release fertiliser is still supplying nutrients which are all being taken up by the plants. On the other hand, an EC higher than about 2 dS m^{-1} would probably indicate an excessive level of salts and a need for leaching.

The total time taken to do these two tests will be about 10 min—five of which could be devoted to doing something else—and is very cheap insurance indeed. However, a grower can still go much further with this basic extract.

Phosphate. Every nursery that grows phosphorus-sensitive plants should invest in a kit for determining the phosphate content of their mix before potting. One such kit is the Merck Aquaquant 14449 kit. The filtrate left over from the EC determination can be used. It will probably be rather grubby and need cleaning up by passing it through a slow-filtering paper, such as Whatman No. 54 or 42, held in a small kitchen funnel. Proceed as indicated by the instructions.

The results are interpreted as follows. A concentration of less than 1 mg litre^{-1} is the starvation level for all plants. Three milligrams per litre phosphorus indicates an inadequate supply for most plants, but a non-toxic supply for phosphorus-sensitive plants. A concentration in the approximate range 3 to 6 mg litre^{-1} should be tolerated by plants that are only moderately sensitive to phosphorus. It will be a useful starting amount for other plants. Higher concentrations are unsuitable for plants that have any sensitivity to phosphorus. Concentrations over 40 mg litre^{-1} may indicate an excessive and even toxic supply to many plants (See Handreck and Anderson, 1994 for details).

Ammonium for Propagators. Some seedlings and recently-rooted cuttings are very sensitive to ammonium ions in the mix around their roots. The Australian Standard reflects experience in requiring that mixes for young plants contain less than 50 mg litre^{-1} nitrogen in ammonium form in a 1 : 1.5 (v/v) water extract. The filtrate is prepared as described for the phosphate determination, or the filtrate in the tube to which chemical had not been added for the phosphate determination can be used. A Merckoquant ammonium test kit or similar kit is needed.

Nitrate in the Extract. Nitrate is determined with Merckoquant or similar test strips. A strip is simply dipped into the filtered extract and the colour of the lower paper patch on the strip is read against the colour code provided. Since the reading is for nitrate, actual nitrogen (in nitrate form) is obtained by multiplying the strip reading by 0.226. Some interpretation guidelines for nitrogen are as follows:

- A zero nitrate figure on top of a zero ammonium figure indicates that the mix contains no soluble nitrogen. Therefore, some soluble nitrogen should be added to newly planted small plants so they can start growing before their roots make contact with granules of controlled-release fertiliser.
- A zero or low nitrate figure and a high ammonium figures can indicate that the mix has been made with incompletely composted materials. Its pH may drop sharply soon after potting as ammonium is converted to nitrate.
- Any colour in the upper patch on the nitrate test strip indicates the presence of nitrite in the mix. This is a sure sign of anaerobic conditions and/or incomplete composting. Don't use the mix until it has had time to mature.
- A nitrate concentration in the 100 to 200 mg litre^{-1} range, together with some ammonium, indicates a good early supply of soluble nitrogen.

Other Tests on the Extract? A really keen grower could buy further test kits (for over $1000) that would allow determining concentrations of potassium, sulphur, calcium, and magnesium in the extract. I suggest that this is a waste of money for most nurseries. Analysis for trace elements requires use of an extractant other than water and the use of specialised laboratory instruments—this should be left to the professionals.

Those who make their own mix are strongly encouraged to occasionally have the mix tested by a laboratory. Certainly this must be done when first formulating a mix. Further checking should be done annually and when one of the components has changed. Ask for analysis according to the methods of the Australian Standard. The less than $200 cost could well save thousands of dollars.

THE POUR-THROUGH TECHNIQUE

The pour-through technique may be used to roughly assess the current pH, EC, and soluble nutrient status of a mix already in a container. A few hours (or the afternoon) before the actual test, pour water onto each of a few pots in the batch to be tested. Pour on enough so that just a little drainage occurs when the pot is tilted. At the time chosen for sample collection pour sufficient water onto the mix surface to give 10 to 15 ml of drainage. The aim is to displace some of the water in the pot. Don't add so much that the added water flows all the way through the mix.

EC and pH are determined directly on the displaced water. For tests for phosphate, ammonium, and nitrate (if needed) the water may need to be filtered. The testing procedures are then as given above for the 1 : 1.5 (v/v) extract. The results give data for the lowermost part of the root ball. Thus, if there is a strong pH profile in the pot, the pH obtained with this technique will be that of this lowermost mix, rather than an average for the whole pot (Handreck 1994). A grower may sometimes need to check the rest of the mix with the 1:1.5 (v/v) method.

Because you are dealing with displaced water rather than a dilution of that water, interpretation for EC and soluble nutrients has to be against different figures. Usually, the EC and nutrient concentrations will be about four times those for an extract for a similar interpretation.

TOXICITY TEST

Pine barks and many sawdusts contain natural chemicals that are toxic to the roots of plants transplanted into them. Aging (for pine barks) and composting (for both) convert these toxins to harmless compounds. It is now rare to find toxicity in commercial mixes, but home-made mixes should be checked before use. Fill some of the mix into a small pot. Into another similar pot fill some thoroughly matured mix that you know is not toxic. Onto the surfaces of each mix place about 10 to 20 radish or cress seeds. Water, loosely cover each pot with clear plastic sheet, and place the pots in a warm place out of direct sun. After 3 to 5 days compare germination and root growth. The new mix should give at least 75% of the root growth found in the matured mix. Any mix that gives markedly lower root growth should be allowed to mature before use.

WETTABILITY

During the dry part of the year, any tendency for potting mix in pots to dry out may lead to it not being fully rewet at the next watering, if it is water-repellent. A gradual loss of water-holding capacity will lead to a lower growth rate and even plant death. This can be avoided through the addition of a wetting agent to the mix before potting, or later as a drench. A grower can easily check whether a wetting agent is needed. Place a sample of mix in a shallow vessel, such as the aluminum dishes in which cakes are sold, and dry it at 40C. Putting the dish of mix in a warm place for a couple of days, or in the sun, may be suitable. When it is dry, form a shallow depression in its surface with an electric light globe. Pour 10 ml of water into this hollow and note the time that it takes for the water to soak in. The finish point is judged by slight tilting of the dish. Any movement of water indicates a need for more soaking time. A grower should consider using a wetting agent if soak-in time is longer than about 1 min.

NITROGEN DRAWDOWN

The nitrogen drawdown index (NDI) test measures the amount of soluble nitrogen that is being used by microbes as they decompose the woody components of the mix. The lower the index number (on a scale of 1 to 0) the greater the amount of soluble nitrogen being used and the greater the amount of fertiliser nitrogen that is needed to compensate for this drawdown.

A detailed recipe of the method may be found in publications by Standards Australia (1993), Handreck (1991, 1992, 1993b), Handreck and Black (1994), and Bodman and Sharman (1993).

I urge those who produce their own mixes to use and apply this test. Technically competent manufacturers will be able to tell you the NDI of their mix.

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