Optimising and monitoring plant nutrition in poinsettia crops

Figure 1. Interveinal leaf chlorosis – a potential nutrient deficiency symptom on poinsettia

Action points

- **Always analyse a sample of the freshly delivered growing media (using the available water-soluble nutrient analysis) to create a reference point at the start of each growing season**
- **Analyse the irrigation water each year to determine and compensate for alkalinity and nutrient loading**
- **Adopt a programme of regular growing media analyses during the growing season, at least every three weeks following potting**
- **Undertake regular tissue analysis one month after potting, focusing on calcium and phosphorus levels**
- **Around the end of August/start of September, as flower initiation commences, pay particular attention to the levels of available phosphorus in the growing media**
- **Be prepared to switch water-soluble fertiliser formulations at various growth stages during production to match the specific need of the crop**

Introduction

The number of poinsettia plants produced per annum in the UK has fluctuated over the last 20 years or so, from a maximum of around eight million, to a low of just over two million. In recent years, total production has also been linked to the introduction of the Renewable Heat Incentive and increased adoption of biomass boilers by nurseries for heat generation. Currently, the estimated production is around five million plants, destined mainly for the multiple retailer market.

In terms of nutrition, poinsettias are one of the more demanding crops. Nutrient-related symptoms can be expressed on both leaves and bracts during both the production and marketing phases (Figure 1). Severe symptoms expressed later on in the growing season are difficult to correct and may result in substantial crop rejection and wastage.

Prior to the introduction of the Poinsettia Monitoring Scheme in 1998, several cultural issues were experienced each year, which were assumed to be linked to plant nutrition. In some cases, the symptoms appeared rapidly and, because there were only limited historical growing

media and leaf tissue analytical records to interrogate, it was very difficult to fully understand the problems and take appropriate corrective action in a timely manner. Once monitoring became established and more frequent in more plant varieties, then trends in plant growth and performance could be related back to the leaf tissue analysis and the reserves remaining in the growing media, providing a greater understanding of the interactions between crop quality and nutrient availability.

Crop nutrition programmes

Most poinsettia growers use ready-made growing media mixes that are specific to the poinsettia crop. Currently – and for several years – the favoured physical mix for the crop is one based on peat and perlite (the latter included between 20–30% by total volume). Along with lime as required, an agreed base fertiliser is added to these mixes and then subsequent plant growth relies on the application of water-soluble fertilisers. In recent years, very encouraging results have been observed in numerous trials examining peat-free growing media mixes for the crop, with improvements noted in root development.

Base and water-soluble fertiliser regimes

Growing media manufacturers add various ingredients to the basic physical mix. Commonly, a base fertiliser, such as a 15-10-20 NPK fertiliser, is applied at a rate of 1 g/L. Lime is also included to bring the medium pH to between 5.8 and 6.4. Even in peat-free growing media mixes, poinsettias still require both calcium and magnesium, which are mainly supplied via the lime added to peat-based mixes. Therefore, an alternative strategy, using gypsum and Epsom salts in the base fertiliser mix to supply these two essential elements, may be needed in such media types.

Generally, base fertilisers give three to four weeks of overall crop nutrition, depending upon the vigour of crop growth and the frequency of irrigation.

Following potting, any initial crop nutrient demand is best supplied using calcium nitrate. Usually, a stock solution is created at a rate of 1 kg/10 L of water and this is then applied at a dilution rate of 1 in 100 (1%) at every irrigation. Calcium nitrate is very useful because (a) it ensures that the developing plant tissue has plenty of available calcium and (b) nitrogen is most easily taken up and utilised by the plants in the nitrate form, supporting the initial vegetative phase of growth. Note that fertilisers high in nitrate-N do not cause a drop in medium pH, unlike ammonium-N fertilisers, which will cause the pH of the medium to drop over time.

After the plants have been pinched back, it may be worthwhile alternating applications of calcium nitrate with a proprietary water-soluble fertiliser such as an 18-10-18, both used at half strength at every watering (0.5 kg/10 L stock solution applied at 1 in 100 (1%)). It is far better to regularly liquid feed the crop at a lower level than to apply infrequent large amounts of nutrients.

At the end of August and into the first two or three weeks of September, a lift in phosphorus levels is required to coincide with the demands of flower initiation. This is achieved by using either mono-ammonium phosphate (MAP) or a proprietary water-soluble fertiliser such as a 10-52-10. Both of these fertilisers can be used to create a stock solution at 1 kg/10 L and subsequently applied at 1 in 100 (1%).

For the remainder of the growing season, a switch to a 14-5-30 proprietary water-soluble fertiliser or similar, in which the potassium level is higher, will assist with bract and flower development and help to tone plants prior to marketing (Figure 2).

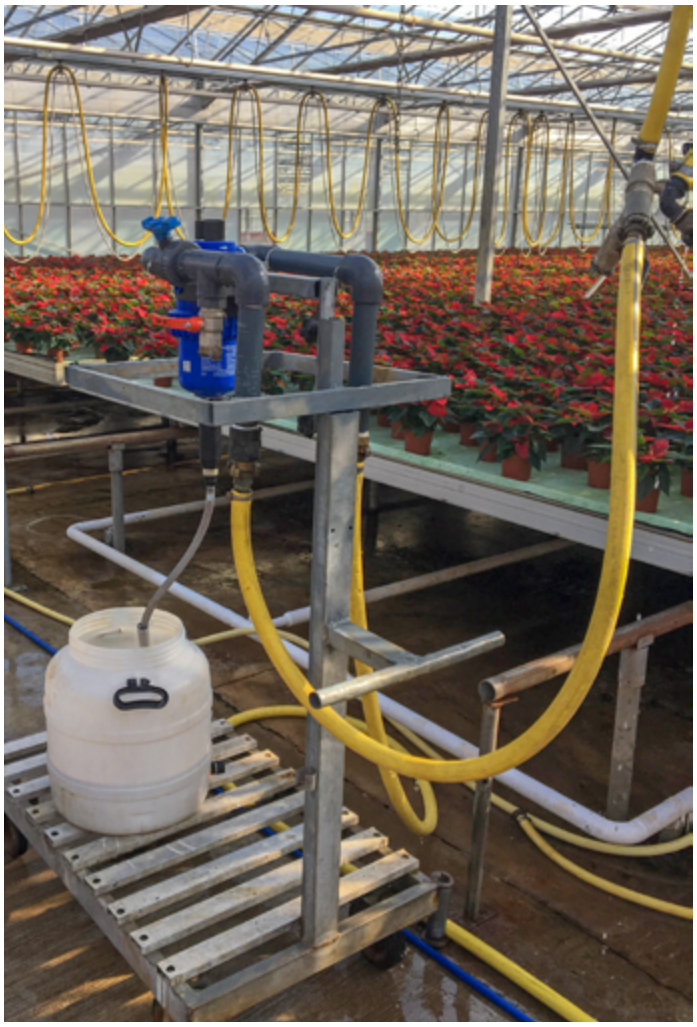

Figure 2. Liquid feeding a maturing poinsettia crop in November to ensure correct bract and flower development and to tone the plants

Controlled release fertiliser regimes

An alternative crop nutrition strategy is to use a low level of controlled release fertiliser (CRF) incorporated into the fertiliser base mix to provide longer term nutrition. This is not widely used within the industry, because of concerns about growing media temperatures under glasshouse structures, especially during weeks 25–35, and the effect of high temperatures on nutrient release from the CRF. High media temperatures can encourage a rapid release of nutrients from the CRF granules, raising the electrical conductivity (EC) levels above those desired in the early stages of root establishment and growth. However, where CRF granules are incorporated, it is generally of the five to six month longevity-type products, at low rates between 1.5–2.5 g/L.

Analysis of the growing media during the growing season still indicates the need for additional phosphorus around

flower initiation and, even when using the CRF approach, attention is also required to ensure that calcium and magnesium levels are maintained. Where the low level CRF approach is adopted, water-soluble fertilisers |should be used to supplement the crop at specific times. Towards the end of August and the beginning of September, fertilisers with a high available phosphorus content should be used to prevent the plants from mobilising phosphorus from older leaves to sustain the initiation and development of the bracts and flowers.

Crop and input monitoring during the growing season

Interpretation of irrigation water analysis results

Water can be categorised according to its bicarbonate content or alkalinity (Table 1). Where the bicarbonate content is low (below 125 ppm), water is categorised as soft, while above this are varying levels of hardness in which the bicarbonate content can reach over 300 ppm (for further information see Factsheet 10/16 ***Sampling methodologies and analysis interpretation for growers of hardy nursery stock***). While soft water, such as that collected from glasshouse roofs, is desirable for irrigation, it is low in calcium and magnesium. Therefore, in terms of plant nutrition, extra calcium nitrate or Epsom salts may be required where soft water is the primary source of irrigation water.

At the other extreme, irrigating crops with a hard water source is almost equivalent to applying a 'lime-wash' solution to the growing medium and this can result in an increase in medium pH, 'chalk' deposits on foliage and blockages in irrigation nozzles. Treatment with acids (most often nitric acid) breaks down calcium and magnesium carbonates and releases the elements, but will also introduce nitrate-N into the water. For example, if water has an alkalinity of 300 ppm and 60% nitric acid is used to reduce this level to 80 ppm, around 40 ppm of nitrogen will be generated. Fertiliser applications should be adjusted to take this extra source of nitrogen into account.

Table 1. Definition of water hardness and the need for treatment

Water type	Alkalinity level (ppm or mg/l)	Need for acid treatment
Soft	<125	No, but review need for calcium inputs
Hard	125–200	Worth considering
Very hard	201–300	Yes
Extremely hard	>301	Essential

High levels of boron (over 1.0 ppm) can indicate industrial contamination of the water source. High iron levels (over 0.5 ppm) can cause precipitation in irrigation equipment or leave deposits on foliage. Plants do not need great quantities of chloride or sulphate, but both will add to the overall EC of irrigation water. High chloride (and sodium levels) may indicate salinity issues with the irrigation water, and boreholes drilled into rock composed of gypsum can give rise to high sulphate levels. In extreme cases, the EC of such sulphate-rich water can be 1000–2000 µS/cm, in turn causing irrigation water containing water-soluble fertiliser to have an EC of up to 3000 µS/cm. Experience has shown that although this may seem problematic, this type of water can be used without apparent problems.

Interpretation of growing media analysis results

It is generally accepted that poinsettias are an unforgiving crop because anything that is sub-optimal during the growing season often manifests as plant downgrading at marketing. Therefore, a thorough knowledge of the growing media used at delivery and during the growing season is essential to avoid any nutrition-related issues. Before use, always carry out an initial available water-soluble nutrient analysis of the growing media to create a reference point at the start of the growing season. As more peat-reduced and peat-free mixes are adopted, then analysis to ensure an adequate initial supply of nutrients, such as nitrate-N and phosphorus, is essential. Remember that many peat replacement mixes show a nitrogen 'draw down' as a result of microbial interactions in the media and additional nitrogen may well be needed to counter such effects.

Once in use, the growing medium should ideally be sampled and analysed every three weeks during the growing season, which, at the end of the season, equates to around six or seven samples per season. Table 2 shows the desirable pH and EC levels and quantities of various elements and nutrients that should be present in growing media sampled during production. The ranges are based on the available water-soluble nutrient analysis using the 1:5 water extraction method. For further information about this extraction method, see Factsheet 10/16 ***Sampling methodologies and analysis interpretation for growers of hardy nursery stock***.

Table 2. Interpretation of growing media available water-soluble nutrient analysis results

Criteria/ element	Unit of measurement	Suggested desirable range*
pH	pH units	5.8–6.2
Electrical conductivity (EC)	µS/cm	150–400
Nitrate-N	mg/l	80–150
Ammonium-N	mg/l	10–30
Phosphorus	mg/l	25–40
Potassium	mg/l	100–300
Magnesium	mg/l	15–35
Calcium	mg/l	50–200
Sodium	mg/l	10–30
Chloride	mg/l	30-80
Sulphate	mg/l	100–300

*Desirable ranges based on analysis using the 1:5 water extraction method

Key indicators to bear in mind include:

- The pH should not to fall below 5.5, but should remain in the ideal range of 5.8–6.2. Levels below 5.5 encourage the uptake of elements such as manganese, which may accumulate to toxic levels within plants
- The EC level should be between 150–400 µS/cm, but in areas with permanent hard water, high alkalinity may cause the growing media EC to rise into the 800s
- Nitrate-N should be around 80–150 mg/l
- The level of ammonium-N should always be much lower than the level of nitrate-N
- The level of phosphorus should be around 30 mg/l
- Chloride levels should normally be around 20–40 mg/l; however, if peat replacement mixes are used then the level can be as high as 150 mg/l and this can interfere with nitrate-N uptake
- Sulphate levels should generally be around 200 mg/l, but water source quality can affect this

Interpretation of leaf tissue analysis results

Tissue taken from fully expanded leaves, avoiding the youngest and oldest leaves, provides an historical record of the nutrients the plant has taken up. In some circumstances, for example if there are odd markings or discolouration on the plant, it is worthwhile sampling leaves from the affected area, as well as obtaining a number of unaffected leaves, to permit comparison of the results. See Factsheet 10/16 ***Sampling methodologies and analysis interpretation for growers of hardy nursery stock*** for further information.

Table 3. Interpretation of leaf tissue analysis results for *Euphorbia pulcherrima* (poinsettia)

Element	Unit of measurement	Stated historic values (based on most recently mature leaf)
Nitrogen	%	4.0–6.0
Phosphorus	%	0.3–0.5
Potassium	%	1.5–3.5
Magnesium	%	0.3–1.0
Calcium	%	0.7–2.0
Sulphur	%	0.25–0.7
Copper	ppm	3.0–25
Zinc	ppm	25–100
Manganese	ppm	45–300
Iron	ppm	100–300
Boron	ppm	30–100
Molybdenum	ppm	1.0–5.0

Stated historic levels are available to compare the values generated by leaf tissue analysis (as presented in Table 3), but care is required here; varieties have changed since the values in Table 3 were generated and, as a result, the desirable ranges presented may vary, particularly for some of the trace elements like boron. Evidence accumulated over the 20 year duration of the Poinsettia Monitoring Scheme clearly indicates that varieties have different levels of specific elements in their leaf tissue. For example, the value for boron indicates a range of 30–100 ppm in mature leaf tissue; however, in the case of varieties examined since the late 1990s, values have been in the range of 18–25 ppm with no suggestion of any deficiency issues. This emphasises the value of local, long-term nutrient level recording efforts.

For many years, 'bract blackening' has been noted in crops, which is associated with calcium distribution in the leaf and bract tissue (Figure 3). Calcium is needed continuously in the development of a plant, even short-term interruptions in supply can cause developing cell walls to be calcium deficient, in turn leading to collapse of the developing plant tissue and bract blackening symptoms. Once calcium is fixed within the cell walls, it stays there throughout the life of the plant, hence it cannot be remobilised to the growing points. This explains why symptoms are only expressed at the growing points and bracts.

Figure 3. Bract edge necrosis, which can develop as a result of insufficient calcium

However, bear in mind that just because calcium is available in the growing medium, it doesn't mean that levels within the plant will be optimal. Calcium is passively swept into the plant roots and then the xylem transport vessels within the plant, by way of the transpiration stream, to the leaf stomata. If plants are prevented from transpiring for any length of time, then calcium uptake is restricted and – again – new tissue may suffer damage. In the case of poinsettia, the dry matter calcium content of leaves should be around 1%.

Figure 4. Phosphorus deficiency in older poinsettia leaves caused by phosphorus mobilisation

Phosphorus is an element that is heavily involved in energy transfer within plants. It is in high demand as the plant switches from vegetative growth to floral initiation. In poinsettia, flower initiation occurs from the end of August/start of September onwards, as day lengths start to shorten. If the plant is unable to access sufficient phosphorus from the growing media, it will remobilise it from older leaves, which will cause these older leaves to display interveinal chlorosis and/or purpling (Figure 4). Some varieties suffer much worse than others; for example, the variety 'Infinity' has proven particularly prone to such visual symptoms if the phosphorus level in the growing media falls to 10–20 mg/l and the tissue level is 0.5% or less dry matter content.

In the past, molybdenum deficiency was reportedly common in poinsettia crops. Molybdenum deficiency symptoms manifest as 'rabbit tracks'; white spots along either side of the leaf mid-rib. To counter this, a foliar application of sodium molybdate at 0.1 ppm was recommended. However, in recent years, with the emergence of specific poinsettia water-soluble fertilisers with slightly increased molybdenum content, the need for any additional sprays has all but disappeared. Levels in tissue appear to average around 3 ppm and this appears satisfactory for modern varieties.

For future crops, the levels of nitrogen in leaf tissue may well become an issue as peat replacement in growing media mixes continues. Levels of nitrogen in leaf tissue normally start from 2% dry matter content, with 4–5% being normal. If there are components within mixes that adsorb more nitrogen to satisfy microbial demands, or if mixes become more open structured with less buffering capacity, then nitrogen levels in tissue may fall below 1.5% and general yellowing and stunting of growth may be observed (Figure 5).

The importance of site-specific records

As previously elaborated, standard values are a useful starting point in terms of understanding analysis results; however, the real benefit is gained from generating a record from crops grown on site. It is recommended that, at the end of each growing season, after reviewing and acting upon results, values are stored to provide an historical record of trends relative to the growing media mix used, varieties grown and the prevailing weather conditions experienced during the growing season.

Figure 5. Extreme induced nitrogen deficiency (left), as a result of nitrogen adsorption by the growing medium examined

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Further information

AHDB Horticulture factsheets and other information

- Factsheet 13/18 ***Calibrating a water-powered proportional dilutor***
- Factsheet 10/16 ***Sampling methodologies and analysis interpretation for growers of hardy nursery stock***
- ***Bedding and Pot Plants Crop Walkers' Guide***

Acknowledgements

Leaf tissue analysis information in Table 3 is based upon information contained within *Plant Nutrient Disorders 5 – Ornamental Plants and Shrubs*, Cresswell and Weir 1997.

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