Grower Summary

Developing Nutrient Management Recommendations for Selected Horticulture Crops.

HNS 200

Annual report 2020

Project title:	Developing Nutrient Management Recommendations for Selected Horticulture Crops
Project number:	HNS 200
Project leader:	Dr Jill England, RSK ADAS
Report:	Annual report, March 2020
Previous report:	First report
Key staff:	Dr Jill England, RSK ADAS David Talbot, RSK ADAS Elysia Bartel, RSK ADAS Chloe Whiteside, RSK ADAS
Location of project:	Field trial: James Coles & Sons Nurseries, 624 Uppingham Rd, Leicester LE7 9QB Container trial: ADAS Boxworth, Battlegate Rd, Boxworth, Cambs CB23 4NN
Industry Representative:	James Moffatt, James Coles & Sons Nurseries
Date project commenced:	1 April 2019

DISCLAIMER

The results and conclusions in this report are based on an investigation conducted over a one-year period. The conditions under which the experiments were carried out and the results have been reported in detail and with accuracy. However, because of the biological nature of the work it must be borne in mind that different circumstances and conditions could produce different results. Therefore, care must be taken with interpretation of the results, especially if they are used as the basis for commercial product recommendations.

AUTHENTICATION

We declare that this work was done under our supervision according to the procedures described herein and that the report represents a true and accurate record of the results obtained.

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GROWER SUMMARY

Headline

- *Spiraea japonica* 'Sparkling Champagne', G*eranium* x *cantabrigiense* 'Westray' and *Tradescantia pallida* 'Purple Sabre' performance improved at a high feed rate (6 g/L CRF, 2% liquid feed).
- *Prunus lusitanica* 'Myrtifolia' performance improved at a low feed rate (2 g/L CRF, 0.5% liquid feed).
- Nitrate-N in run-off water exceeded the Nitrate Vulnerable Zone (NVZ) nitrogen limit in drinking water of 50 mg/L for *Prunus lusitanica* 'Myrtifolia' (4 g/L and 6 g/L CRF rates) and *Spiraea japonica* 'Sparkling Champagne' (6 g/L CRF rate).

Background

The majority of nursery stock growers currently use a base fertiliser with controlled release fertiliser (CRF), usually added by the growing media manufacturer, to provide sufficient nutrition for the production phase. There is increased interest in using lower CRF rates and supplementing with liquid feed to provide sufficient nutrition during key growth phases, to avoid excess fertiliser at other times and to reduce the potential for nutrient loss in run-off water. The combination of CRF and liquid feed can provide growers with greater control but still meet plant nutrient requirements. Crop safety can be improved by using a lower CRF rate for autumn potting under glass and topping up with liquid feed in the spring as appropriate. Growers could benefit from the associated nutrient cost savings, but with more control over growth, there is an opportunity to optimise productivity and improve quality, while reducing crop waste and minimising point source nutrient pollution from grower holdings.

Year 1 of this work programme focussed on obtaining separate baseline data for CRF and liquid feed uptake in nursery stock liners for a range of nursery stock subjects. Year 2 trials will be based on the data obtained in year 1, and will combine lower CRF rates with a range of liquid feeding regimes to develop 'feed to need' strategies. Year 3 trials will be based on the outcomes of year 2, and will be designed to confirm the reproducibility of the results.

This project is comprised of three work packages:

WP1. HNS (field and container) Literature review

WP2. Field tree production. To establish baseline information on nutrition for field-grown HNS trees by categorising the main plant families into vigour groups (e.g. Low; low – medium; medium - high), explore novel methods for applying fertilisers and determine the most suitable analyses (soil EC, tissue and/or leaf chlorophyll) to assess crop nutrient status (submitted as a separate report)

WP3. Container production. Optimisation of combined controlled release fertiliser (CRF) and liquid feed regimes for nursery stock liner production under protection

This is the report for WP3. **The reports for WP1 and WP2 are submitted separately.**

Summary

Two separate trials looked at the effect of CRF and liquid feed dose rate on plant growth and quality to find baseline data for four hardy nursery stock species: *Prunus lusitanica* ‘Myrtifolia’, *Spiraea japonica* ‘Sparkling champagne’, G*eranium* x *cantabrigiense* ‘Westray’ and *Tradescantia pallida* ‘Purple Sabre’. Species selection was based on plant vigour, related to nutrient uptake, as more vigorous species require greater nutrient supply, and included both woody and herbaceous species. The trial was located in a polytunnel at ADAS Boxworth. Plug plants were transplanted into 9 cm liners (70% peat, 30% wood fibre, SinclairPro; base fertiliser 0.75 kg/m^3 PG mix 12-14-24) on 20 June 2019. The trials were irrigated by overhead irrigation with additional spot watering as required.

CRF trial treatments. CRF (Osmocote Exact Standard, 12–14 month), an industry standard formulation, was incorporated into the growing media at transplant at three dose rates (**Table 1**). Prills were dibbled into the centre of each pot beneath the plug and the pots were placed into trays with drainage holes, stacked directly above a trough to collect run-off; each tray formed a single plot.

Liquid feed trial treatments. Liquid feed treatments were applied weekly. Two proprietary, industry standard, feed formulations were applied: Peters Professional Plant Starter (ICL, 10:52:10 + TE) to promote root development for the first four weeks (week 26 to week 30), and Peters Professional Grow-Mix (ICL, 3:1:3 + 3 MgO + TE) to promote vegetative growth from week 31 to week 44 (**Table 1**). Each plot received 2 L of feed weekly between week 26 and week 43, reduced to 1 L per week in weeks 43 and 44 when the weather turned cooler; feed volume was linked to uptake, allowing the growing media to dry back between applications. The pots were placed into impermeable trays to ensure that all liquid feed and water applied was taken up by the crop (**Figure 9**).

Table 1. CRF and liquid feed treatment rates. Liquid feed Peters Professional 10:52:10 feed was applied for 4 weeks, followed by Peters Professional Grow-Mix 3:1:3 for the remainder of the trial.

Liquid feed trial			
Treatment	**Dose**	**Volume of stock solution / plot**	**Volume of water / plot**
T1	0.5%	10 ml	1.99 L
T2	1.0%	20 ml	1.98 L
T3	2.0%	40 ml	1.96 L
CRF trial			
T1	2 g / L		
T2	4 g / L		
T3	6 g / L		

Growing media electrical conductivity (EC) and leaf chlorophyll (using a SPAD meter) were measured weekly. Growing media and leaf tissue samples were submitted for laboratory analysis at the start of the trial, in November 2019 (final assessment) and in January 2020. Plant height, plant quality and root quality were

assessed at the interim (September 2019) and final assessments (November 2019). Fresh and dry weights and the run-off water from the CRF trial were measured at the final assessment.

Although the *Spiraea, Geranium* and *Tradescantia* did appear to benefit from the high CRF rate through increased plant height, this may not be the optimum rate and further examination will clarify the effect of reduced nutrient application. The run-off analysis indicated that there may be an opportunity to reduce nutrient rates without impacting on plant quality, and this would also reduce potential leaching of nitrogen and phosphate into the groundwater.

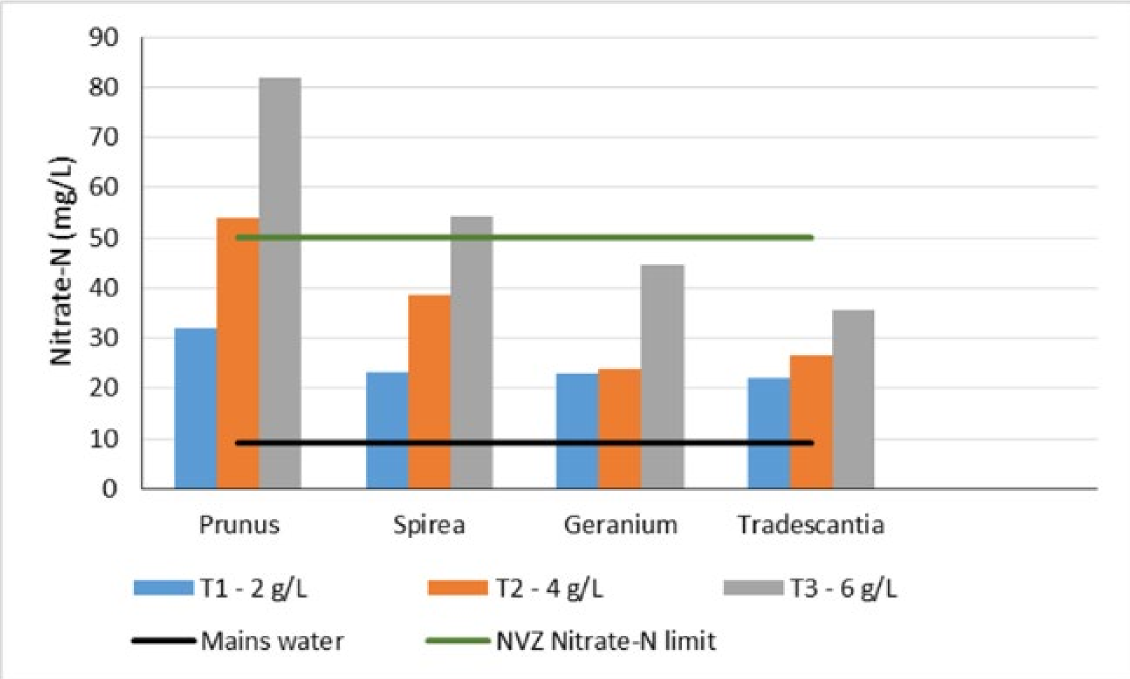

Figure 1. Nitrate-N quantity in run-off water. 14 November 2019. Black horizontal line: nitrate level in the mains water at ADAS Boxworth. Green horizontal line: NVZ drinking water nitrate-N limit (50 mg/L)

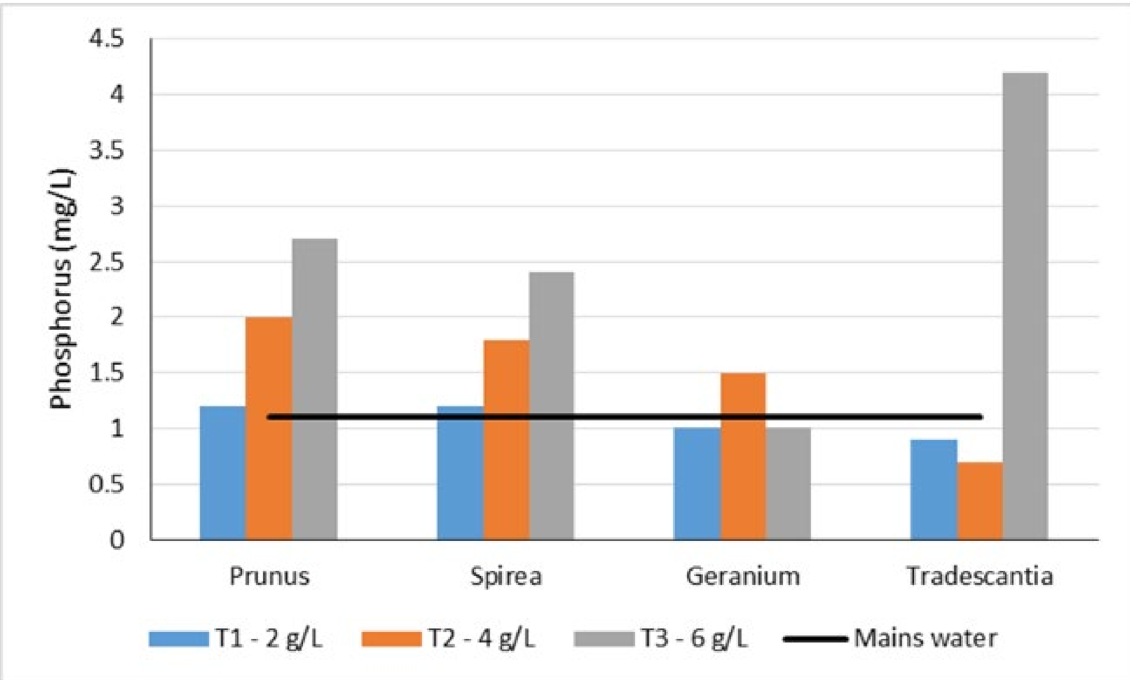

Figure 2. Phosphorus (P) quantity in run-off water. 14 November 2019. Black horizontal line: nitrate level in the mains water at ADAS Boxworth.

Prunus lusitanica is generally considered to be a vigorous species, but in this trial it produced greater growth and acceptable plant quality at the lowest feed rates (2 g/L CRF and 2% liquid feed rates), with increased nitrate in the run-off at the higher dose rates in the CRF trial (**Figure 1**).

Nitrogen (N) and phosphorus (P) levels in the run-off water were generally greatest in the *Prunus*, however the *Tradescantia* appears to have limited P uptake at the 6 g/L rate with high levels in the run-off (4.2 mg/L) compared with the *Prunus* (2.7 mg/L), *Spiraea* (2.4 Mg/L) and *Geranium* (1.0 mg/L) (**Figure 2**). In this trial the *Tradescantia* did not appear to need the amount of P provided in the CRF, as there were low levels in the leaf tissue and high levels in the substrate and in the run-off water, at the high CRF rate. It is worth noting that not all of the P would usually be released by the CRF, and some would become unavailable over time due to forming complexes with calcium, for example. Although the *Tradescantia* performed better at the higher feed rates in both trials, in the liquid feed trial this did not translate into improved plant quality; leaf tissue N levels were low, and this suggests that the liquid feed rate may have provided insufficient nutrients.

Growing media EC was higher in the liquid feed (LF) trial than the CRF trial. For example, in week 34, the EC for *Prunus* was 445 µS/cm in the LF trial, and 157 µS/cm in the CRF trial. This may be because the plants being liquid fed were in non-draining trays that prevented salts from being washed through the growing media, while the CRF trial was set-up in a system designed to allow water and nutrients to drain through for collection of the run-off water for analysis.

The weekly substrate EC measurements were a useful tool to indicate the nutrient status of the growing media and leaf tissue, with – clear differences were seen due to plant response to treatments. EC was generally higher in the higher feed treatments (**Figure 3** and **Figure 4**). For *Tradescantia,* the EC readings reflect that this is a vigorous crop, with few nutrients available in the substrate in the liquid feed trial. Substrate moisture level affects EC measurements, with lower readings in drier substrate. Readings were taken at the same time of day on each occasion, before irrigation was applied to standardise the procedure. However, weather conditions have an impact on EC readings; in this trial, dips in EC coincided with particularly hot weather conditions in week 32, which caused drier growing media moisture.

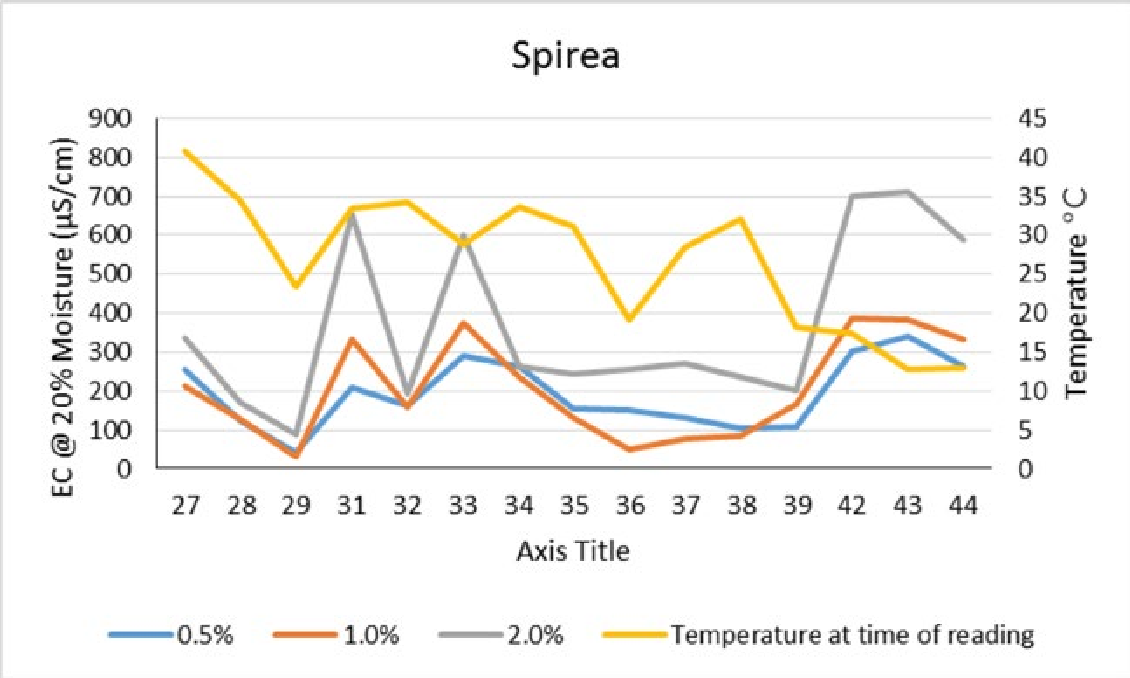

Figure 3. Liquid feed trial. *Spiraea japonica* 'Sparkling Champagne' 'Purple Sabre' (right). Electrical conductivity (EC) adjusted to 20% moisture content

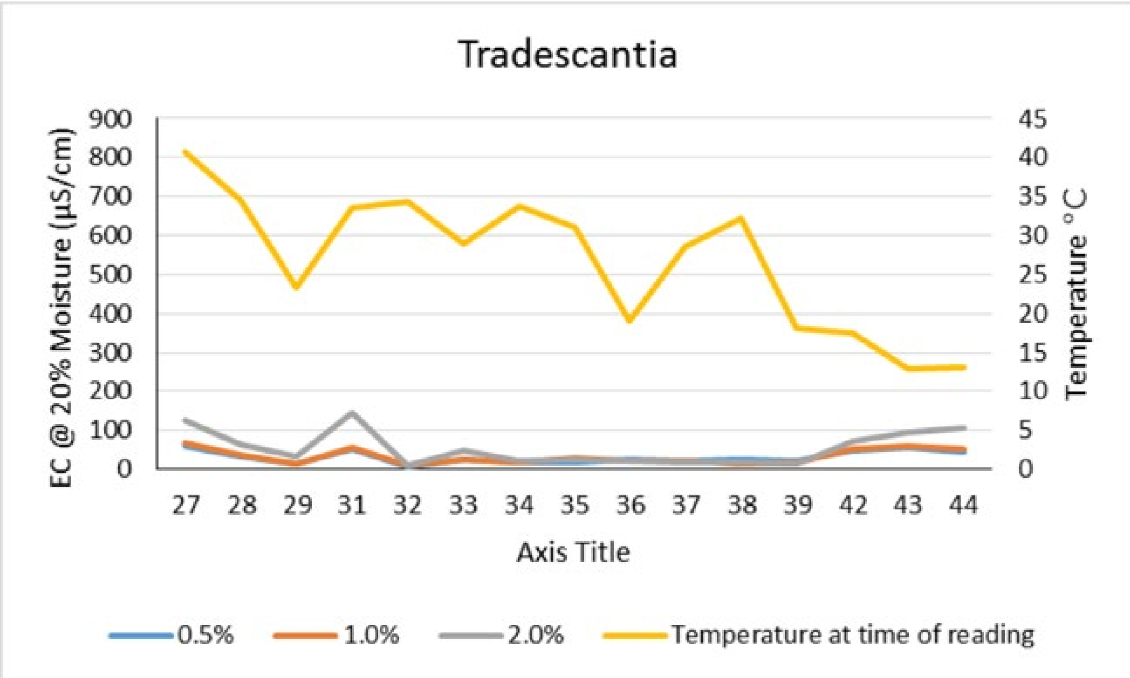

Figure 4. Liquid feed trial. *Tradescantia pallida* 'Purple Sabre' (right). Electrical conductivity (EC) adjusted to 20% moisture content

Leaf chlorophyll (SPAD) readings were similar across all treatments for all species, except for the *Prunus* in this trial, which may be an indication that the treatments were not sufficiently different to affect leaf chlorophyll for the majority of subjects in this trial. Leaf chlorophyll appeared to be within specific ranges for each plant. For example, they were around 30 to 40 for *Spirea* (**Figure 5**), but 35 to 50 for *Tradescantia,* and these findings were common across the LF and CRF trials (**Figure 6**).

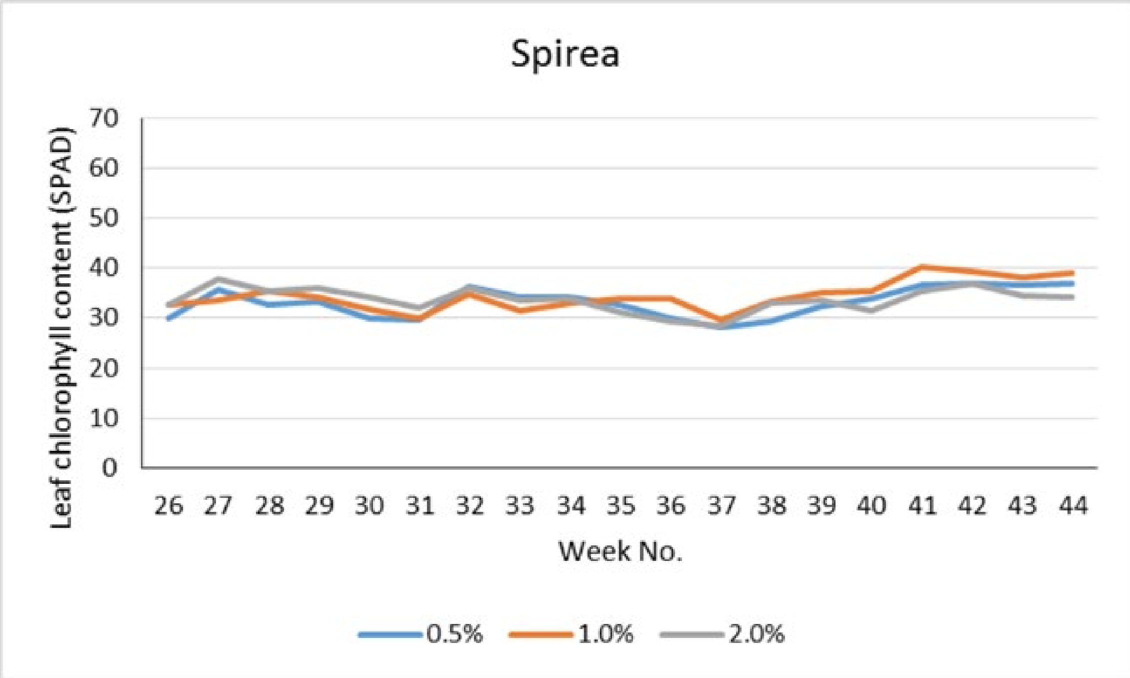

Figure 5. Liquid feed trial. *Spiraea japonica* ‘Sparkling Champagne’. Leaf chlorophyll content

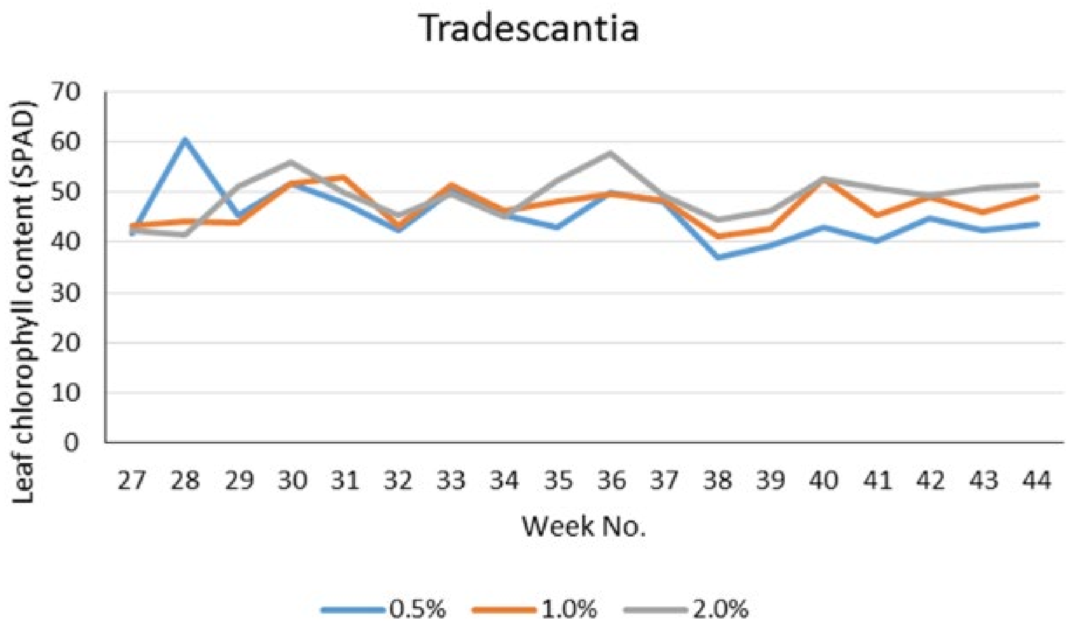

Figure 6. Liquid feed trial. *Tradescantia pallida* ‘Purple Sabre’. Leaf chlorophyll content

Conclusions

A number of tissue N and P measurements obtained within these trials were outside the published standard ranges (**Mills and Jones, 1996**) with no visible deficiency symptoms.

These results show that plant vigour is important; for some species, good quality plants can be grown at low CRF rates, but for others high feed rates are needed to produce marketable crops. *Prunus lusitanica* is generally considered to be a vigorous plant, but in this trial performed better at the lowest dose feeds, with nitrates in the run-off water above the NVZ limit at higher dose rates. The *Spiraea, Geranium* and *Tradescantia* all performed better at the higher dose rates. However, detailed monitoring and analysis revealed different plant requirements for specific plant nutrients, i.e. *Tradescantia* performed better overall at the high feed rates, but appears to need lower levels of P. Greater understanding of plant vigour enables plants to be arranged within vigour groups so that fertilisers can be applied according to plant need, helping growers with better management of input costs and nutrient run-off.

Financial Benefits

Routine monitoring will identify low nutrient levels and allow corrective action to be taken before deficiency symptoms appear. A nutrient management regime could include regular on-site monitoring of EC and perhaps leaf chlorophyll, with laboratory irrigation water, substrate and leaf tissue analysis as appropriate.

While there are costs associated with purchasing monitoring equipment and submitting samples for laboratory analysis, there are some lower cost options, and these costs can be offset through reduced crop losses due nutrition problems. Regular on-site substrate EC measurements in this trial were carried out using a Terros 12 sensor with a ProCheck hand held reader (**Table 2**). Leaf chlorophyll was measured using a SPAD, but the AtLEAF is a useful less expensive alternative that was tested in AHDB project HNS 193 (**Adlam, 2016**).

An example of the cost of laboratory analysis monitoring regime for irrigation water, substrate and leaf tissue samples on a medium sized, single site HNS nursery, extracted from Bragg and Holmes (**2016**), is presented in **Table 3**.

Crop losses due to nutrition problems can approach 1% - 3% of the value of the crop. While crop value will vary depending on the species and market, assuming a farm gate value of 80p per plant for 9 cm liners, an estimated 750,000 plants per hectare, this equates to between £6,000 and £18,000 per hectare per annum.

Table 2. Crop monitoring equipment example costs. The AtLeaf sensor was not used in this trial, but is included as an example. *Costs derived from 2019 quotations.

Device	Purpose	Cost (+VAT)
Decagon ProCheck *	Handheld reader for Terros 12 sensor	£425
Terros 12*	Substrate EC and moisture sensor	£200
Minolta SPAD 502 Plus	Chlorophyll sensor	£2,680
AtLEAF Standard version*		£268
AtLEAF Standard version plus USB connection*		£339
AtLEAF Standard version plus Bluetooth connection*		£372

Table 3. Analysis costs: growing media, water (including run-off), liquid feed and plant tissue, based on a medium sized, single site nursery. Extracted from Bragg and Holmes (**2016**).

Analysis	No of analyses	Cost	Comments
Water	4 analyses per year	£100 - £150	Includes irrigation and run-off water.
Growing media	18 analyses over 18 months	£360	Analysis of three substrate batches or crops; four samples per batch analysed per year.
Leaf tissue	12 analyses over 18 months	£360	Three indicator crops in three substrate mixes, four samples per crop over 18 months.
Total		£820 - £870	

Action Points

- Improve understanding of crop vigour and nutrient requirements through planned monitoring and recording of growing media EC and pH, run-off water and submission of samples for laboratory analysis.
- Build up an on-nursery database of tissue, growing media and irrigation water analyses over seasons, including samples from plants with potential nutrient problems and healthy plants, determining critical thresholds where possible.
- Group plant