Grower Summary

Developing Nutrient Management Recommendations for Selected Horticulture Crops.

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

HNS 200

Final report

Project title:	Developing Nutrient Management Recommendations for Selected Horticulture Crops. **WP3.** Container production. Optimisation of combined controlled release fertiliser (CRF) and liquid feed regimes for hardy nursery stock production under protection.
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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

- Liquid feed applied weekly (0.5% and 1.0%) produced more marketable plants than higher dose rates for *Prunus lusitanica* 'Myrtifolia', *Spiraea arguta* and *Geranium* x *cantabrigiense* 'Westray'
- Liquid feed applied weekly (1.0%) was the most suitable feed for short term, vigorous crops such as *Tradescantia pallida* 'Purple Sabre'. Lower dose feeds can be used to restrict growth of this vigorous species.
- Liquid feed applied at every watering produced taller, less bushy plants. Lower dose rates could address this.
- Regular EC monitoring is useful for identifying excessive feed, particularly in shortening days and cooler temperatures, allowing growers to adjust feed rates. EC was generally more useful than SPAD for managing nutrient status.

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 enough nutrition for the production phase. Some growers buy growing media with just base fertiliser added and then 'dibble' in the CRF at potting, which makes altering the rate used easier. There is increased interest in using lower CRF rates and supplementing with liquid feed to provide enough 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 plant growth, there is an opportunity to optimise productivity and improve quality while reducing crop waste and minimising the potential for point source nutrient pollution from grower holdings.

Year 1 of this work programme focused 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 were based on the data obtained in year 1 and combined lower CRF rates with a range of liquid feeding regimes to develop 'feed to need' strategies. Year 3 trials in 2021 replicated those carried out in year 2 to confirm the reproducibility of the results and provide recommendations for growers.

Summary

The Year 3 HNS container trial took place at ADAS, Boxworth from May – October 2021 using four hardy nursery stock species (**Table 1**). Plants were supplied as 9 cm liners (*Prunus* and *Spiraea*) or 5 cm plugs (*Tradescantia* and *Geranium*) and transplanted into 3 L pots on 7 May 2021, (Week 20). SinclairPro (70% peat, 30% woodfibre) growing media was used, with no base fertiliser. Osmocote Exact 12-14 month CRF was dibbled into each pot at a single dose rate (1.5 g/L) at the time of transplant. For the 3L pots, 4.5 g of CRF was required per pot and the prills were measured out individually by weight for each plot. A 10:52:10 (ICL - Plant Starter) feed was used for four weeks from transplant, followed by a 3:1:3 (ICL – Grow Mix) feed until the end of the trial. All plants were irrigated by hand for the duration of the trial.

Table 1. Hardy Nursery Stock species

Species	Vigour	Term
Prunus lusitanica 'Myrtifolia'	vigorous	long
Spiraea arguta	moderate	long
Geranium x cantabrigiense 'Westray'	moderate	short
Tradescantia pallida 'Purple Sabre'	vigorous	short

There were 5 different feed treatment regimens (**Table 2**), including an untreated control, T1 (water only, no liquid feed), which were applied once per week from trial set-up, aside from T4 which received nutrients at every watering. Treatment T5 ('feed to need') was applied as required, according to weekly SPAD and EC measurements.

Table 2. Liquid feed treatments used in the container trial, 2021

Treatment No.	Treatment
1	No liquid feed
2	Liquid feed applied once per week (0.5%)
3	Liquid feed applied once per week (1.0%)
4	Low dose liquid feed (0.5%) at each watering
5	Feed to need applied weekly (0% / 1.0%). Timing based on EC/SPAD monitoring

The *Prunus* and *Spiraea* were grouped together as one trial. The *Geranium* and *Tradescantia* were grouped together as a second trial within the same polytunnel.

A pre-potting assessment was conducted for all species, including plant height, plant quality, and root coverage prior to any feed treatment applications to establish baselines for each ornamental species. Weekly assessments began one week after potting and lasted for the duration of the trial. They were completed on the same day each week, prior to irrigation: growing media electrical conductivity (EC, µS/cm), moisture content (%VMC), and leaf chlorophyll content (SPAD meter).

A mid-season assessment at week 13 (28 July 2021; *Prunus* and *Spiraea*) and week 12 (28 July 2021; *Geranium* and *Tradescantia*) assessed plant height, plant quality and root development. Final assessments were carried out in week 23 (5th October 2021; *Spiraea* and *Prunus*) and week 23 (11th October 2021; *Geranium* and *Tradescantia*). Plant height, quality, root coverage, and fresh and dry weights were assessed. Growing media and plant tissue samples were analysed (by Natural Resource Management, NRM) at the start of the trial, and then for each treatment and species at the final assessment. Tissue analysis results were compared with published standard figures (**Mills and Jones, 1996**).

***Prunus lusitanica* 'Myrtifolia' (Long term, vigorous crop)**

The most successful treatment in the *Prunus* trial was T3, producing taller plants with higher quality scores, and fresh and dry weights. The shortest plants were produced in treatments T1 and T5, which received no additional feed, and the highest root quality scores were produced by T1. Plants in all treatments were marketable, scoring above 3.T4 and T3 had the highest EC for most of the trial while leaf chlorophyll (SPAD) measurements were similar for all treatments until 16 weeks after potting, when measurements increased for T4 until the end of the trial. The high EC suggests that T3 and T4 were providing more nutrients than the plants were able to utilise. The growing media analysis of ground samples showed there were plentiful reserves of nutrients, except for T5 which had received no liquid feed. Reserves were particularly high in T4. Tissue analysis indicated that nutrient levels were within or above the standard range for T2, T3 and T4, but were below range for P and K in treatments T1 and T5. As plant quality scores were good for all treatments, this suggests that feed rates could potentially be reduced for this crop group without a negative impact on plant quality.

***Spiraea arguta* (Long term, moderate vigour crop)**

The *Spiraea* produced the tallest plants and highest plant quality scores in T2 and T3, although plants in all treatments were marketable. Root quality scores were similar in all treatments, although the lowest score was achieved in T4. Fresh and dry weights were highest in T3, but similar to T2 and T4. The lowest height, plant quality fresh and dry weight

scores were produced by T1 and T2 which did not receive additional feed. EC measurements were highest in T4 throughout most of the trial, while leaf chlorophyll (SPAD) measurements were tightly grouped for all treatments. Growing media analysis indicated that nutrient reserves were low in both ground and unground samples, except for T3 (P, K and Mg), T4 (nitrate-N, P, K and Mg). There was sufficient Mg in all treatments except for T5 (both ground and unground). Tissue analysis indicated that nutrient levels were within the standard range except for K, which was low in all treatments except for T4. While there were differences between the plants produced in each treatment, all treatments including the untreated controls produced good quality plants, indicating that additional liquid feed was beneficial but not essential in producing marketable plants.

***Geranium x cantabrigiense* 'Westray' (Short term, moderate vigour crop)**

The *Geraniums* that produced the best overall plants were from T3. They were taller, with the best foliage colour and plant and root quality scores, and higher fresh and dry weight. However, these measurements were not significantly different from the other treatments where nutrients were applied (T2, T3 and T4). EC measurements in T4 treatment were higher than other treatments, most notably for the first 13 weeks after potting, and after 22 weeks. Growing media analysis showed that by the end of the trial there were generally sufficient nutrients remaining, although ammonia-N reserves were low in all treatments except for T4, and EC and K were low in T5. Plant tissue analysis values were low in all treatments except for N and P in T4 compared with the standard range, and Mg levels were high for all treatments. This suggests that the although the *Geranium* have been termed 'moderately vigorous', they require less feed than the *Spiraea* (long term, moderate vigour). As plant quality scores were good for T2, T3 and T4, feed rates could potentially be reduced for this crop group without a negative impact on plant quality.

***Tradescantia pallida* 'Purple Sabre' (Short term, vigorous crop)**

At the end of the trial period and throughout, there was very little difference between treatments for plant quality and growth as all plants grew vigorously in all treatments. Plants grown in T3 were taller, with higher fresh and dry weights than other treatments and similar plant quality. T2 and T4 still produced marketable plants that were significantly different to the untreated plants (for plant and root quality), despite the various amounts of feed applied. Leaf chlorophyll (SPAD) measurements were variable, but were relatively tightly grouped for all treatments. EC was low throughout the trial except most notably at the beginning where it peaked before tailing off, for all treatments. This is a vigorous plant species and potentially lower feed rates could be used to manage growth of this plant. Growing media analysis

showed that N, P and K reserves were low for most treatments by the end of the trial. Tissue analysis also showed that N, P and K were low in all treatments; Mg was high.

Summary of findings

Many of the findings for all species from the 2020 trial were reflected in 2021, although weather conditions were cooler, and action points for growers remain unchanged.

From a grower perspective, shorter but bushier plants with more breaks / side shoots are usually more marketable for this sector. *Prunus*, *Spiraea* and *Geranium* plants produced under treatments T2 and T3 were considered more marketable due to their overall quality, height, and biomass. For the *Tradescantia*, all plants were marketable, but plants produced under T3 required less labour to produce plants of similar quality; low feed regimes could be used to restrict growth of these vigorous plants. This would also make the *Tradescantia* easier to handle without breakages.

T2 and T3, produced the most marketable plants with a bushier habit than other treatments, while T4 tended to produce taller, less bushy plants and appeared to provide excess nutrients. However, it may be that the habit of the plants in T4 (little and often) could be improved with lower dose rates.

T5 'feed to need' could be useful on nurseries producing a small range of species arranged in large blocks, but hardy nursery stock nurseries tend to have a wide range of species / cultivars; in the move away from peat based substrates plants may be held back by the time the need to feed is recognised, making this a more difficult option to manage. T3 is the more manageable treatment and produced good quality plants. No additional feed was applied to plants in T5 (no liquid feed).

The combination of SPAD and EC measurements allowed nutrient movements to be tracked. N uptake by the plants resulted in increased SPAD and lower EC readings; conversely where more liquid feed was provided than the plants required the salts remained within the growing media and the EC increased. For the *Tradescantia*, for example, the high SPAD and low growing media EC measurements indicated the plants were able to utilise the feed across all treatments.

The combination of EC and SPAD measurements is useful to identify trends. In this trial it was helpful to compare several treatments for specific species. In a nursery setting, however, growers will need to compare data for the same plant or plant group over multiple seasons to be able to make comparisons and put the data into context, for example if sufficient feed was applied in a hot season, and if it should then be reduced in a cooler season to produce marketable plants. This will also help growers to identify and rectify any issues sooner. It is

important to use the same piece of equipment throughout the season to gain the maximum benefit from the trends. Changing equipment can give variable results. It is also important with EC to take the readings at the same time each day to remove any variable moisture content that can alter the EC through the day.

High EC can be a cause for concern, particularly for sensitive plants, as it can result in root damage, and is usually addressed by irrigating to flush the salts out of the growing media. In this trial, plants were watered by hand with a measured amount of water so that treatments were standardised. The build-up of growing media EC, which could be interpreted as excess nutrient supply (given a high dose rate), could result in N or P in the run-off water, forming a potential environmental risk. The highest risk liquid feed regime would be 'little and often', where feed is applied at every irrigation (T4 in this trial). This could be mitigated by applying a lower dose feed with care to limit run-off (or capture / recycle run-off water).

There is currently a lack of tissue analysis data for specific species / cultivars, particularly for the herbaceous species. Growers will need to supplement and realign published data with their own data for tissue analysis to be used to greatest effect.

Categorising plants into long/short term and vigour groups will prove useful and will help growers to extrapolate data to a wider range of species, noting that woody and herbaceous plants are not directly comparable in terms of vigour. Grouping plants according to vigour category will make it easier to manage plant feed regimes.

In both years of this trial, the growing media used was SinclairPro 70% peat, 30% woodfibre. Growers are using more peat-free growing media, which can have higher conductivity (EC) and pH than peat-based media. Nutrients such as Mn, P and Fe can become unavailable as pH increases and this will need to be accounted for in fertigation regimes. Growers should also note that different substrates (e.g. bark) can provide a greater buffering effect which can help to protect plants against high salt levels. Substrate source and production method can also impact the way growing media materials perform in terms of water holding capacity (e.g. particle size, how fibrous the product is). Growers should trial new mixes before widespread use, with regular EC and nutrient monitoring to identify and address any deficiencies before they affect plant quality.

Treatment No.	Treatment	Outcome
2	Liquid feed applied once per week (0.5%)	Most marketable plants with bushier habit than T4, T1 and T5
3	Liquid feed applied once per week (1.0%)	Most marketable plants with bushier habit than T4, T1 and T5
4	Low dose liquid feed (0.5%) at each watering	Taller less bushy plants. Often provided excess nutrients. Dose rate could be adjusted. Risk of nutrient run-off where dose rate is too high.
5	Feed to need applied weekly (0% / 1.0%). Timing based on EC/SPAD monitoring	No liquid feed was applied for this treatment during the trial

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 3**). Leaf chlorophyll was measured using a SPAD, but the AtLEAF is a useful, less expensive alternative that was tested in AHDB project HNS 193.

Presented in **Table 4** is an example costing of a 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**).

Improving nutrient management practices can reduce plant waste and could save 1% - 3% 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, and an estimated 750,000 plants per hectare, this equates to between £6,000 and £18,000 per hectare per annum. For 3 L pots assuming a farm gate value of £3.00 per plant, with an estimated 187,500 pots per hectare, this equates to £5,625 and £16,875 per hectare per annum.

Table 3. 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

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

Table 4. 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); 2022 prices ex VAT

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	£572	Analysis of three substrate batches or crops; four samples per batch analysed per year.
Leaf tissue	12 analyses over 18 months	£425	Three indicator crops in three substrate mixes, four samples per crop over 18 months.
Total		£1,097 - £1,147	

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. This will be particularly useful to help build up the experience needed to manage crops grown in peat free growing media.
- Build up an on-nursery database of tissue, growing media and irrigation water analyses over several seasons, including samples from plants with potential nutrient problems and healthy plants, determining critical thresholds where possible.
- Group plants according to vigour groups, matching nutrient application to vigour group needs.

- Monitoring plant EC can be a useful tool to identify whether the nutrient feed thresholds are being surpassed or undercut for various ornamental species.
- Vigorous crops have higher nutrient requirements than other species and so can uptake more nutrients than the plant needs for it to be marketable.
- Combining leaf tissue and growing media analysis with weekly growing media electrical conductivity (EC) measurements will help give growers the confidence to use lower rates of CRF and liquid feed, with applications made in response to plant need.