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Date project commenced:	1 April 2019

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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

- 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.
- 'Feed to need' would be most useful on nurseries with a small range of plant species / cultivars in large batches.
- Regular EC and SPAD monitoring is useful for identifying excessive feed, particularly in shortening days and cooler temperatures, allowing growers to adjust feed rates.

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. 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 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

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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 hardy nursery stock production under protection

This is the report for WP3.

Summary

Trials work took place at ADAS Boxworth from May – October 2020 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 18 May 2020 (week 20; *Prunus* and *Spiraea*) and 09 June 2020 (week 23; *Tradescantia* and *Geranium*). SinclairPro growing media (70% peat, 30% woodfibre) 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. 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 five liquid feed treatments (**Table 6**), including an untreated control, which were applied once per week from trial set-up, aside from T4 which was applied at every watering, and T5 which was applied according to weekly SPAD and EC measurements. For the *Geranium* and *Tradescantia* trial, T5 was split into two treatments 13 weeks after potting to create T6 (feed to need #2). T6 was created so that we could see what would happen to those plants that did not receive feed, then if they started to indicate signs of deficiency through the EC and SPAD readings, they could be fed later from that point in the trial.

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Table 2. Liquid feed treatments used in the container trial, 2020

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 (1.0%). Timing based on EC/SPAD monitoring
6	Feed to need applied weekly (1.0%) #2. From week 13 (after potting). *Geranium* and *Tradescantia* only.

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

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), Leaf chlorophyll content (SPAD meter) were measured weekly.

In addition, there was a mid-season assessment in week 29 (20 July 2020; *Prunus* and *Spiraea*) and week 32 (13 August 2020; *Geranium* and *Tradescantia*), that assessed plant height, plant quality and root development. For final assessment in week 42 (20 October 2020; *Prunus* and *Spiraea*) and week 43 (27 October 2020; *Geranium* and *Tradescantia*) fresh and dry weights were also measured. 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 T4, in that plants were taller with higher root scores and a greater fresh weight, but they were less bushy compared with other treatments. However, the EC and SPAD measurements appeared to indicate that this treatment was too much and that there was excess feed. Plant quality was improved by treatments T3 and T5 compared with all other treatments, although the EC and SPAD

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measurements for T3 were still generally on the high side. The growing media analyses indicated that there was available nitrate-Nitrogen (Nitrate-N, Phosphorus (P), Potassium (K) and Magnesium (Mg) in both ground and un-ground samples from T3 and T4. Plant tissue analysis was inconsistent in terms of standard figures, but N and Mg were within range for T1, T2, T3 and T5. The growing media analyses indicated there was available Nitrate-N, P, K and Mg in both ground and un-ground samples from T3 and T4, generally above the standard range, suggesting that liquid feed rates could be reduced towards the end of the season when monitoring indicates that plants require less nutrients.

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

In the *Spiraea* trial plant quality scores indicated that while there were differences between the plants produced in each treatment, all treatments except for the untreated control produced good quality although with some visible damage, indicating that additional liquid feed was beneficial. Treatment T4 produced the shortest plants but the roots filled the pot (100% rooting). T3 produced taller plants with greater fresh weight. Both T3 and T4 produced good quality plants, and it would be grower preference as to which of these treatments produced more marketable plants. A high EC from 18 weeks after potting suggests less feed was required as the season progressed, and temperature reduced. With the growing media analysis, generally all nutrients were less available than in the *Prunus* trial, which suggests that higher dose rates were more suitable for this species. Tissue analysis was inconsistent. N and Mg were generally high, and K was generally low compared with standard figures.

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

The *Geranium* trial showed that plants from T4 were taller and had a greater fresh weight. However, EC and SPAD measurements in this treatment were high, indicating excess feed, particularly as the season progressed. Plants in treatment T3 had a slightly higher plant quality score and appeared neater than those in T4; however, plants in T3 did have the lowest root score. Growing media analysis showed that generally there was plentiful nutrients remaining in all treatments apart from T1 and T6. Plant tissue analysis values were low in T1, T5 and T6. K was low in all treatments compared with the standard and Mg was high. This suggests that the although the *Geranium* have been termed ‘moderately vigorous’, they require less feed than the *Spiraea* (long term, moderate vigour) and 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, there was very little difference between treatments for plant quality and growth. Plants grown in T4 were taller, with a higher fresh weight and improved plant quality. T3 produced marketable plants with less labour required to apply the feed.

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SPAD measurements indicate high N, whilst EC was low in all treatments. Less feed was required as the season progressed. This is a vigorous plant species; potentially lower feed rates could be used to manage growth of this plant. Growing media analysis showed that N, P and K 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

From a grower perspective, shorter but bushier plants with more breaks / side shoots are usually more marketable for this sector. *Prunus*, *Spirea* and *Geranium* plants produced under treatments T2 and T3 were considered more marketable. For the *Tradescantia*, 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.

T2 and T3, produced marketable plants with a bushier habit than other treatments, while T4 produced taller, less bushy plants and appeared to provide excess nutrients. However, it may be that the habit of the plants in T4 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 HNS nurseries tend to have a wide range of species / cultivars; T3 is the more manageable treatment and produced good quality plants.

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.

High EC can be a cause for concern, particularly for sensitive plants, as it can result in root damage, and is usually addressed by irritating 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.

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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.

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

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	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)

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 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.

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SCIENCE SECTION

Introduction

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, but not providing excess fertiliser at other times and increasing the potential for nutrient loss in run-off water, resulting in point source pollution.

Background

The combination of CRF and liquid feed provides growers with the greater control through reduced CRF application and with application of specific liquid or foliar feed formulations to meet plant requirements. Crop safety is improved by using a lower CRF rate for autumn potting under glass and topping up with liquid feed in the spring as appropriate. Growers will benefit from the associated nutrient cost savings, but with more control overgrowth there is an opportunity to optimise productivity and improve quality, while reducing plant waste and minimising point source nutrient loss from grower holdings.

The last significant review of nutrient management in container grown nursery stock raised potential environmental and quality issues concerning total reliance on CRF (**Pennell, 2013**). Firstly, temperature extremes due to changing weather patterns can give rise to nutrient release when plants are unable to utilise it, particularly in plants grown under protection, with autumn potted plants under glass being particularly at risk, and this increases the potential for nutrient leaching or plant damage due to the build-up of nutrients in the substrate. In addition to this, increasing attention is being given to environmental pollution and the prevention of the excessive loss of nutrients, particularly nitrates and phosphates into the ground water. High fertiliser rates may contravene regulations such as Nitrate Vulnerable Zones (NVZ), potential Phosphate Vulnerable Zones and drinking water legislation. In future, growers could fall foul of any regulations that are brought in and be subject to regulatory penalties.

Whilst previous work has been carried out that investigated the use of CRFs under protection (**Scott et al., 1993**), formulations and coatings have since been further developed by the manufacturers. Early work to evaluate the use of computer simulation models generally gave good predictions but were not adopted for use in commercial practice to allow for leaching of nutrients (**Scott, 1996**). Recent work has contributed methodologies for sampling and

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analysis interpretation by growers (**Bragg and Holmes, 2016**) and data on nutrient leaching (**Adlam, 2016**). This study also included a comparative study of optical sensing equipment for monitoring nutrient status (e.g. SPAD readings, AtLeaf and FieldScout GreenIndex Iphone app) and EC probes (e.g. ProCheck).

Independent laboratory analysis is underway to characterise nutrient release patterns of base fertilisers and CRFs using a range of products and formulations (coating and longevity) using the EN13266 method (**Terlingen et al., 2016**). Release patterns at different temperatures (50˚C vs 25˚C) indicate differences between products (Personal communication, Neil Bragg, Ann Mc Cann). CRFs are sensitive to both substrate moisture and temperature; although excess water does not influence nutrient release, it is positively correlated with substrate temperature and therefore sensitive to prevailing environmental conditions. For non-urea containing CRFs, nutrient release in the field can be determined effectively (and non-destructively) by measurement of electrical conductivity (EC) using the 'pour through' method (**Hojjatie and Carney, 2014**).

There are currently no independent guidelines on the most appropriate CRF (formulation and rate) / liquid feed rates (individually or in combination) or application timings, to optimise crop quality and reduce production time. Plant nutrient suppliers provide detailed guidance on the use of their products, with application rates categorised by plant groups based on low, medium, and high nutrient uptake rates.

This trial programme considers the practice of reducing CRF rates, which can then be supplemented with liquid feed as necessary to maintain plant growth and quality and will provide guidance on CRF / liquid feed combinations and delivery schedules. Combining leaf tissue and growing media analysis with weekly growing media electrical conductivity (EC) measurements will develop a practical methodology whereby growers can have confidence in using lower rates of CRF and liquid feed, with applications made in response to plant need. The trials are being carried out during the summer and autumn, when the CRFs will release more nutrients in the higher temperatures, and the plants are in growth.

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 were based on the data obtained in year 1 and combined a single, lower CRF rate with a range of liquid feeding regimes and 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 data.

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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 hardy nursery stock production under protection

This is the report for WP3.

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

Aim

To develop a 'feed to need' methodology with baseline combined low rate CRF and liquid feed recommendations for application to hardy nursery stock under protection.

Objectives

Objective 1: To measure growth and quality of four nursery stock subjects grown in 70% peat growing media supplied with one low dose CRF rate, and five liquid feed treatments (including no liquid feed).

Materials and methods

This trial was carried out within a polytunnel at ADAS Boxworth from May – October 2020 using four hardy nursery stock species (**Table 5**). Plant species selection was based on plant vigour, as related to nutrient uptake, as more vigorous species require greater nutrient supply, and included both woody and herbaceous species. Plants were supplied as 9 cm liners (*Prunus* and *Spiraea*) or 5 cm plugs (*Tradescantia* and *Geranium*) and transplanted into 3 L pots on 18 May 2020 (week 20; *Prunus* and *Spiraea*) and 09 June 2020 (week 23; *Tradescantia* and *Geranium*); the different planting dates were due to supply delays. Growing media used was SinclairPro 70% peat, 30% woodfibre, 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. All plants were irrigated by hand for the duration of the trial.

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Table 5. 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

Experimental treatments

Osmocote Exact 12-14 month CRF was used in all pots at a rate of 1.5 g/L. There were five liquid feed treatments (**Table 6**), including an untreated control, which were applied once per week from trial set-up, aside from T4 which was applied at every watering, and T5 which was applied according to weekly SPAD and EC measurements. 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. For the *Geranium* and *Tradescantia* trial, T5 was split into two treatments 13 weeks after potting to create T6 (feed to need #2). T6 was created so that we could continue to monitor to those plants that did not receive feed, then if they started to indicate signs of deficiency through the EC and SPAD readings, they could be fed later in the trial. For each liquid feed (10:52:10 and 3:1:3) a stock solution was made with 1 Kg fertiliser in 10 L water. The stock solution was then measured with a beaker and mixed with plain water in a watering can. Treatments were applied to plots using separate, labelled, 10 L watering cans. The amount of treatment applied per plot was adjusted depending on plant requirement and the weather. For T1 (no liquid feed), the same amount of plain water was applied to each plot in a separate, labelled can. On liquid feed days, no further irrigation was made to the plots.

Table 6. Liquid feed treatments used in the container trial, 2020

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 (1.0%). Timing based on EC/SPAD monitoring

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6	Feed to need applied weekly (1.0%) #2. From week 13 (after potting). *Geranium* and *Tradescantia* only.

Trial design and analysis

The *Prunus* and *Spiraea* were set-up first and therefore were grouped together as one randomised trial. The *Geranium* and *Tradescantia* were grouped together as a second separate randomised trial within the same polytunnel. For each species there were five treatments and four replications, resulting in 20 plots. Each plot contained two sub-plots, with nine plants within each sub-plot, resulting in 180 plants per species and 720 plants in total. Plants were placed directly on the mypex floor in a 3 x 3 formation (**Figure 1** and **Figure 2**). Data was analysed using ANOVA with Duncan's multiple range test.

Figure 1. **Prunus** ***and*** **Spiraea** ***plots set-out within the polytunnel, week 20, 18 May 2020***

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Figure 2. ***Geranium and Tradescantia plots set-out within the polytunnel, week 23, 9 June 2020***

Table 7. Summary of trial inspections and assessments, 2020

Date	Week No.	Action	Assessment
18.05.20	20	*Prunus* and *Spiraea* trial set-up	
26.05.20	21	Weekly assessment (P&S)	EC, leaf chlorophyll
02.06.20	22	Weekly assessment (P&S)	EC, leaf chlorophyll
03.06.20	22	Signum applied to *Prunus*	
08.06.20	23	Weekly assessment (P&S)	EC, leaf chlorophyll
09.06.20	23	*Geranium* and *Tradescantia* trial set-up	
16.06.20	24	Weekly assessment (all species)	EC, leaf chlorophyll
23.06.20	25	Weekly assessment (all species)	EC, leaf chlorophyll
30.06.20	26	Weekly assessment (all species)	EC, leaf chlorophyll
07.07.20	27	Weekly assessment (all species)	EC, leaf chlorophyll
13.07.20	28	Weekly assessment (all species)	EC, leaf chlorophyll
20.07.20	29	Mid-season assessment (*Spiraea* and *Prunus*)	Plant height, quality, root quality
21.07.20	29	Weekly assessment (all species)	EC, leaf chlorophyll
28.07.20	30	Weekly assessment (all species)	EC, leaf chlorophyll
04.08.20	31	Weekly assessment (all species)	EC, leaf chlorophyll
10.08.20	32	Weekly assessment (all species)	EC, leaf chlorophyll
13.08.20	32	Mid-season assessment (*Geranium* and *Tradescantia*)	Plant height, quality, root quality
18.08.20	33	Weekly assessment (all species)	EC, leaf chlorophyll
25.08.20	34	Weekly assessment (all species)	Leaf chlorophyll

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28.08.20	34	Weekly assessment (all species)	EC
01.09.20	35	Weekly assessment (all species)	EC, leaf chlorophyll
08.09.20	36	Weekly assessment (all species)	EC, leaf chlorophyll
09.09.20	36	T6 created (*Geranium* and *Tradescantia*)	
15.09.20	37	Weekly assessment (all species)	EC, leaf chlorophyll
22.09.20	38	Weekly assessment (all species)	EC, leaf chlorophyll
29.09.20	39	Weekly assessment (all species)	EC, leaf chlorophyll
06.10.20	40	Weekly assessment (all species)	EC, leaf chlorophyll
13.10.20	41	Weekly assessment (all species)	EC, leaf chlorophyll
20.10.20	42	Weekly assessment (all species). Final assessment (*Prunus* and *Spiraea*)	EC, leaf chlorophyll. Plant height, quality, root quality, fresh and dry weight. Growing media and foliar analysis
27.10.20	43	Weekly assessment and final assessment (*Geranium* and *Tradescantia*)	EC, leaf chlorophyll. Plant height, quality, root quality, fresh and dry weight. Growing media and foliar analysis

Assessments

Trial inspections and assessments carried out are summarised in Table 7.

Pre-potting

On the day of trial set-up, 20 plants per species were assessed for plant height (cm), plant quality (**Table 8**) and root development (**Table 9**). Photographs were also taken of the foliage and roots. Plant tissue and growing media was collected from the spare plants for each species and sent to Natural Resource Management (NRM) for analysis. A sample of growing media used for potting was also sent for analysis on both potting dates.

Table 8. ***Plant quality scores***

Score	Definition
0	Dead
1	Very poor quality
2	Poor quality
3	Good quality, some damage visible
4	Very good quality, very little damage
5	Excellent quality, no damage visible

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Table 9. ***Root development scores***

Score	Definition
0	No root development
1	Rooting in up to 25% of plug/liner
2	Rooting in 26 - 50% of plug/liner
3	Rooting in 51 - 75% of plug/liner
4	Rooting in 76 - 100% of plug/liner

Weekly assessments

At the start of the trial, five plants per species per plot were labelled for weekly assessments. These 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. Weekly assessments covered:

- **Growing media electrical conductivity, EC** (µS/cm) using a Dragon ProCheck Device and Terros 12 sensor
- **Growing media moisture content** (%VMC) using a Dragon ProCheck Device and Terros 12 sensor
- **Leaf chlorophyll content** using a SPAD monitor, sampling the newest mature fully open leaves. This measurement provides an indication of plant nutrient status
- **Photographs** of each species within each treatment

Mid-season assessment

A mid-season assessment was completed in week 29 (20 July 2020; *Prunus* and *Spiraea*) and week 32 (13 August 2020; *Geranium* and *Tradescantia*) on the same five plants per plot for the following:

- Plant height (cm)
- Plant quality (scale of 0-5; **Table 8**)
- Root development (scale of 0-4; **Table 9**)
- Photographs of each species within each treatment

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End of season assessment

A final assessment was completed in week 42 (20 October 2020; *Prunus* and *Spiraea*) and week 43 (27 October 2020; *Geranium* and *Tradescantia*) on the same five plants per plot for the following:

- Plant height (cm)
- Plant quality (scale of 0-5; **Table 8** and **Figure 3** - **Figure 6**)
- Root development (scale of 0-4; **Table 9**)
- Photographs of each species within each treatment
- Fresh and dry weight (g)
- Growing media analysis for each treatment per species
- Plant tissue analysis for each treatment per species (using left-over plants from each plot)

Figure 3. Prunus *plant quality representative plants week 42 (L-R: score 2-5, end of season assessment)*

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Figure 4. Spiraea *plant quality representative plants week 42 (L-R: score 2-5, end of season assessment)*

Figure 5. Geranium *plant quality representative plants week 43 (L-R: score 2-5, end of season assessment)*

Figure 6. Tradescantia *plant quality representative plants week 43 (L-R: score 2-5, end of season assessment)*

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For the growing media and plant tissue analysis, samples were collected from each plot, bulked together by treatment and then sub-sampled for analysis.

Crop husbandry

Temperature and humidity were recorded every 30 minutes throughout the trial using two USB data loggers. Biocontrols were introduced on a fortnightly basis for aphid control (*Aphidius colemani*) and spidermite control (*Amblyseius andersoni*). The *Prunus* were treated with boscalid + pyraclostrobin (as Signum at 1.35 Kg/ha) on the 3 June 2020 for shot-hole.

Results

The results for each species have been analysed and presented separately. Polytunnel temperature and humidity were monitored using two dataloggers located within the *Prunus* and *Spiraea* from set up, and then the *Geranium* and *Tradescantia* (**Appendix 1**). Results of the growing media and nutrient analyses, and images of treatment effects are presented in **Appendices 2** to **13**.

***Prunus lusitanica* ‘Myrtifolia’**

Quality and height

At the end of the trial period, there were no significant differences between treatments for plant height. The tallest plants were seen in T4 (0.5% at every watering; 20.1 cm) and T3 and the shortest plants were seen in T1 (no liquid feed; 13.4 cm, **Figure 7**, **Appendix 10**). There were significant differences for plant quality (p =0.022; **Table 10**) with both T3 (1.0% 1/week) and T5 (1.0% feed to need) scoring significantly higher than T1. For root scores only T4 was significantly better than T1 (p =0.008). Both T3 and T4 had a significantly higher fresh weight compared with T1 (p =0.055), however there were no significant differences for dry weight.

Table 10. Average scores for the final assessment on the Prunus *trial, week 42, 20 October 2020. Figures in red are significantly different to T1 (no liquid feed)*

	Liquid feed	Av. height (cm)	Av. quality	Av. root scores	Av. fresh weight (g)	Av. dry weight (g)
T1	None	13.4	3.00	1.25	40.5	17.0
T2	0.5% 1/wk	13.5	3.15	1.30	42.7	16.9
T3	1.0% 1/wk	17.4	4.00	1.45	46.1	17.8
T4	0.5% every watering	20.1	3.75	1.95	46.2	16.9

T5	1.0% feed to need	15.4	3.95	1.35	41.7	17.1
	F pr.	0.108	0.022	0.008	0.055	0.747
	l.s.d	5.652	0.854	0.3624	4.476	1.751
	s.e.d	2.594	0.392	0.1663	2.054	0.803

Figure 7. Prunus *plant height representative plants week 42 (L-R: T1 – T5)*

Electrical Conductivity

The weekly EC measurements are presented in **Figure 8**. Although there were some minor differences between treatments three weeks after potting, the treatments did not really start to separate out until seven weeks after potting. From this point, although trends were similar, T4 (0.5% at every watering) showed a higher EC. From 17 weeks after potting, the EC built up very quickly in T4, reaching a peak of 241.9 μS/cm in the 20 week assessment. EC levels in T4 then started to fall but were still much higher than the other treatments at the end of the trial period. T1 (no liquid feed) and T5 (1% feed to need) did not receive any feed for the first 17 weeks of the trial, however the EC levels stayed very similar to T2 (0.5% 1/week). T5

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started to receive feed from week 18 and although the EC started to increase compared to T1, levels were still very similar to T2.

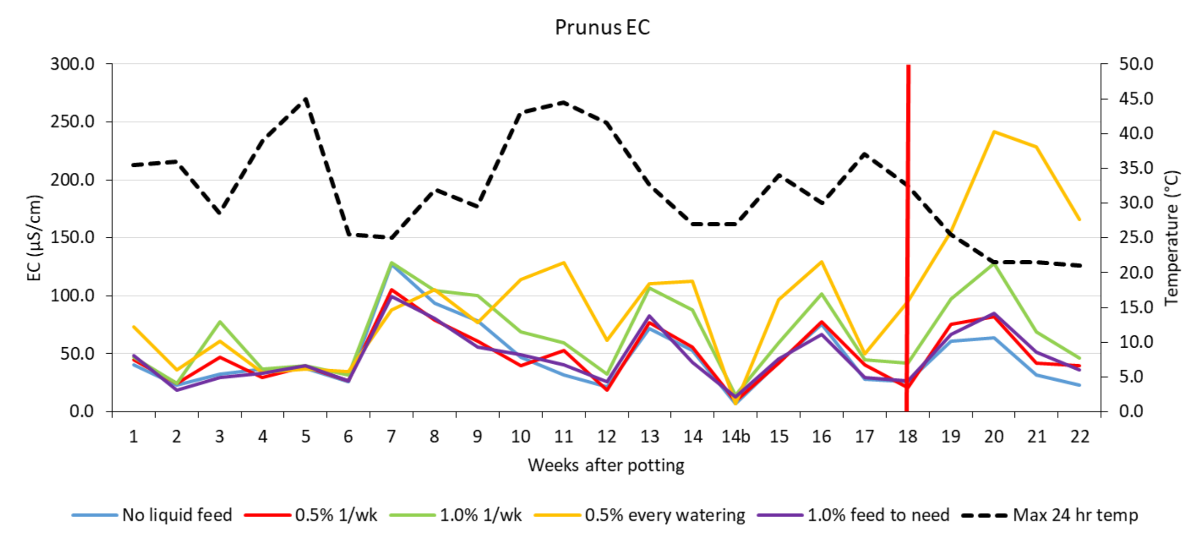

Figure 8. Weekly EC measurements for Prunus*, with the maximum 24 hour temperature for reference. The red vertical line denotes when T5 (1% feed to need) started*

Leaf Chlorophyll

The results of the weekly leaf chlorophyll measurements are presented in **Figure 9**. There was a rapid increase in leaf chlorophyll levels for all treatments two weeks after potting, this was maintained the following week and then levels dropped for all treatments four weeks after potting. Leaf chlorophyll content remained at lower levels in all treatments until 11 weeks after potting, when they started to increase again and differences between treatments started to become more apparent. From 13 weeks after potting until the end of the trial, leaf chlorophyll content was highest in T4 (0.5% every watering) and continued to increase. Interestingly, leaf chlorophyll content was lowest in T2 (0.5% 1/week) from 11 weeks after potting onwards. Levels for T1 (no liquid feed) and T5 (1.0% feed to need) were very similar throughout the trial period and even after plants in T5 started to receive feed from 18 weeks after potting week 18. Leaf chlorophyll content increased in all treatments from week 11 onwards and followed a similar trend.

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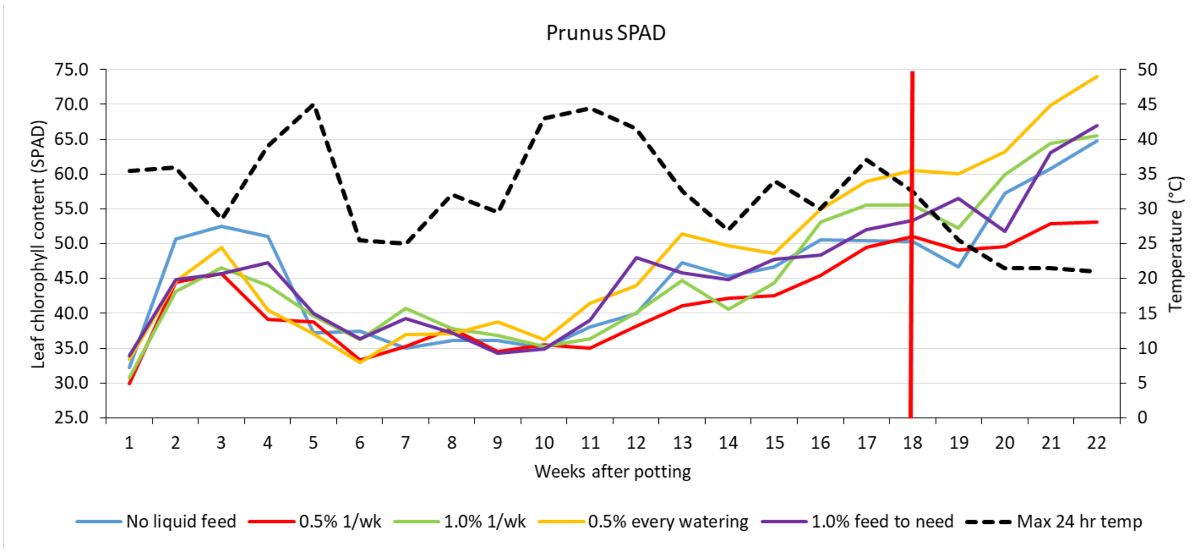

Figure 9. Weekly SPAD measurements for Prunus*, with the maximum 24 hour temperature for reference. The red vertical line denotes when T5 (1% feed to need) started*

Growing media analysis

The results from the growing media analysis at the end of the trial show that for the *Prunus*, all treatments were deficient in Ammonia-N (**Table 11**, **Appendix 2**). However, there was available Nitrate-N, P, K and Mg in both the ground and un-ground samples from T3 (1.0% 1/week) and T4 (0.5% every watering).

Table 11. Growing media analysis from the Prunus *trial, with both un-ground and ground results shown. Analysis was completed at the end of the trial in October 2020. Results from analysis of the unused growing media taken at the start of the trial in May 2020 are shown for reference.*

Date	Growing media analysis	T	pH	EC uS/cm	Ammonia-N mg/l	Nitrate-N mg/l	P mg/l	K mg/l	Mg mg/l
May-20	Unused GM		6.3	**189**	**39**	66.3	**<1.0**	**7.2**	15.6
Oct-20	Ground GM	T1	6.5	**66**	**<0.6**	**0.7**	**2.8**	**6.5**	**9.3**
	Ground GM	T2	5.9	**152**	**3.9**	**17.6**	11.2	**36.8**	22.6
	Ground GM	T3	5.8	**193**	**0.6**	44.1	15.7	63.1	33.4
	Ground GM	T4	5.2	489	**2.5**	171.4	**70.8**	195.4	**89.4**
	Ground GM	T5	6.4	**109**	**5.2**	**10.5**	11.9	**25.3**	15.2
	Unground GM	T1	7.1	**59**	**<0.6**	**<0.6**	**<1.0**	**5.3**	**8.6**
	Unground GM	T2	6.4	**145**	**<0.6**	**17.2**	**4.1**	**32.6**	25.3
	Unground GM	T3	6.2	**220**	**<0.6**	36.7	7.9	**41.2**	24.8
	Unground GM	T4	5.6	461	**3.8**	156.8	**67.7**	165.6	**86.8**
	Unground GM	T5	6.5	**76**	**<0.6**	**5.2**	**3**	**14.6**	11

Figures in red = Index 0 – deficiency. Figures in brown = Index 1. Figures in blue = >Index 6. Figures in black = normal range

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Tissue analysis

Plant tissue analysis at the end of the trial period showed that N and Mg were in range for T1 (no liquid feed), T2 (0.5% 1/week), T3 (1.0% 1/week) and T5 (1.0% feed to need; **Table 12**, **Appendix 6**). The levels for N, P, K and Mg in T4 (0.5% every watering) were above the standard range, as was P in all treatments apart from T1. Levels of K were below the standard range in T1, T2 and T5.

Table 12. Plant tissue analysis from the Prunus *trial. Analysis was completed at the end of the trial in October 2020. Results from analysis of the plant tissue taken at the start of the trial in May 2020 are shown for reference. Standard leaf analysis range sourced from Mills and Jones, 1996.*

Date	**Tissue analysis**	**T**	**N %DM**	**P %DM**	**K %DM**	**Mg %DM**
	Standard leaf analysis (range)	From	1.53	0.2	0.93	0.4
		To	2.59	0.22	1.35	0.61
May-20	Initial leaf analysis		**1.143**	**0.2487**	**0.6398**	**0.2218**
Oct-20	Foliage tissue	T1	2.154	0.2082	**0.7661**	0.4195
	Foliage tissue	T2	2.345	**0.2694**	**0.9285**	0.4474
	Foliage tissue	T3	2.55	**0.3631**	1.0638	0.4583
	Foliage tissue	T4	**3.519**	**0.6528**	**1.5981**	**0.6521**
	Foliage tissue	T5	2.202	**0.2444**	**0.8275**	0.4242

Figures in red = Index 0 – deficiency. Figures in brown = Index 1. Figures in blue = >Index 6. Figures in black = standard range

Spiraea arguta

Quality and height

At the end of the trial period, despite quality scores being lowest in T1 (no liquid feed) and highest in T5 (1.0% feed to need), results were not significant (**Table 13**). However, there were significant differences in the height of the plants ($p < .001$; **Figure 10**) with plants in T3 (1.0% 1/week) taller than the untreated (T1) and plants in T4 (0.5% every watering) shorter than the untreated. Only T4 scored significantly better than T1 for root development ($p = 0.016$). All of the treatments produced plants with a significantly higher fresh weight ($p < .001$) compared to T1. They also had a significantly higher dry weight ($p < .001$) except for T4.

Table 13. Average scores for the final assessment on the Spiraea trial, week 42, 20 October 2020. Figures in red are significantly different to T1 (no liquid feed)

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	Liquid feed	Av. height (cm)	Av. quality	Av. root scores	Av. fresh weight (g)	Av. dry weight (g)
T1	None	57.9	2.80	2.55	29.8	16.2
T2	0.5% 1/wk	60.6	3.20	2.30	38.6	20.7
T3	1.0% 1/wk	62.4	3.35	2.85	41.7	22.1
T4	0.5% every watering	53.6	3.35	3.25	35.2	17.4
T5	1.0% feed to need	60.9	3.40	2.75	36.0	19.4
	F pr.	<.001	0.269	0.016	<.001	<.001
	l.s.d	3.281	0.6246	0.5016	4.223	2.360
	s.e.d	1.506	0.2866	0.2302	1.938	1.083

Figure 10. Spiraea *plant height representative plants week 42 (L-R: T1 – T5)*

Electrical Conductivity

The EC in the *Spiraea* trial generally followed a similar trend across all treatments (**Figure 11**). There was a spike in EC in all treatments seven weeks after potting, apart from T4 (0.5% every watering). The EC remained highest in T1 (no liquid feed) for the next four weeks, although it was gradually decreasing in line with the other treatments. Whilst there was no discernible difference between T1 and T5 (1% feed to need) throughout most of the trial, plants in T5 did start to receive feed from 18 weeks after potting, to see if this had any effect on the EC between these two treatments. Despite the feed, no differences were observed

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between any of the treatments from week 18 until the end of the trial, with the exception of T4. There was a sharp increase in EC in T4 towards the end of the trial, reaching a peak of 170.6 µS/cm in the 20 week assessment. Whilst this was not maintained and decreased the following week, EC was still much higher in T4 at the end of the trial.

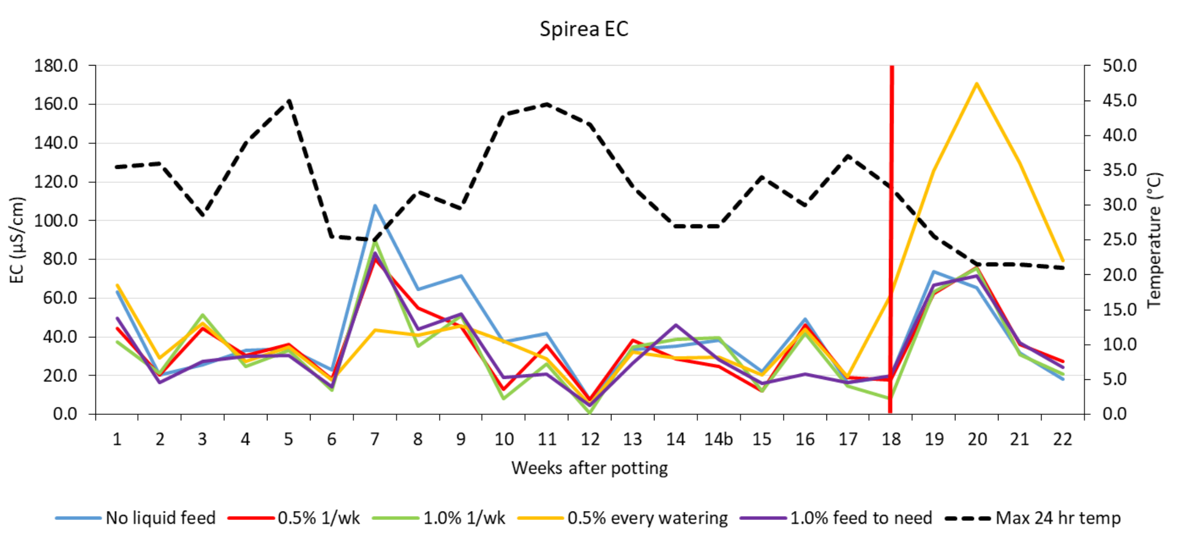

Figure 11. Weekly EC measurements for Spiraea*, with the maximum 24 hour temperature for reference. The red vertical line denotes when T5 (1% feed to need) started*

Leaf Chlorophyll

For the first 13 weeks of the trial, leaf chlorophyll measurements were generally very similar between the five treatments, and were gradually increasing as time went by (**Figure 12**). After 14 weeks, there was quite a sharp drop in leaf chlorophyll measurements in T3 (1.0% 1/week), measurements also fell in T1 (no liquid feed) and T5 (1.0% feed to need). From week 15 onwards, leaf chlorophyll measurements continued to steadily increase in T2 (0.5% 1/week), with some fluctuations in the other treatments. Leaf chlorophyll did appear to be decreasing in T5, so feed was introduced to this treatment from week 18. However, by the end of the trial period, leaf chlorophyll levels were still very similar between all treatments, including T1, except for T2.

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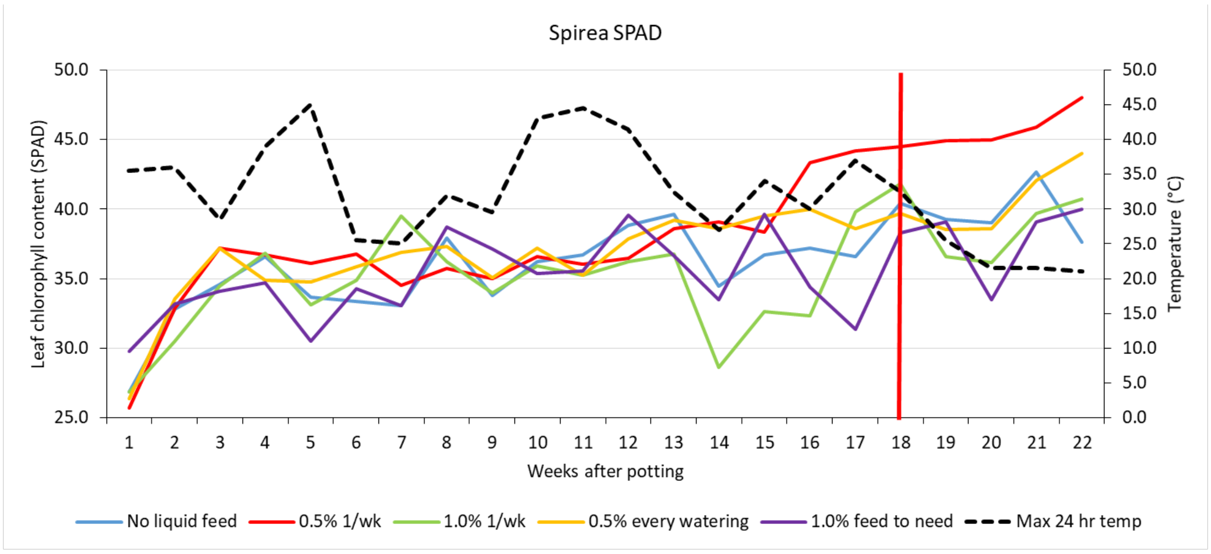

Figure 12. Weekly SPAD measurements for Spiraea, *with the maximum 24 hour temperature for reference. The red vertical line denotes when T5 (1% feed to need) started*

Growing media analysis

The growing media analysis at the end of the trial period showed that for *Spiraea*, Ammonia-N was deficient in all treatments (ground and un-ground), as was Nitrate-N, apart from T4 (0.5% every watering; **Table 14**, **Appendix 3)**. There was available P in ground samples of T2 (0.5% 1/week), T3 (1.0% 1/week) and T5 (1.0% feed to need) and available K in ground samples of T3 and T4. Mg was available in all treatments (ground and un-ground), with excess levels in T4.

Table 14. Growing media analysis from the Spiraea *trial, with both un-ground and ground results shown. Analysis was completed at the end of the trial in October 2020. Results from analysis of the unused growing media taken at the start of the trial in May 2020 are shown for reference.*

Date	Growing media analysis	T	pH	EC uS/cm	Ammonia-N mg/l	Nitrate-N mg/l	P mg/l	K mg/l	Mg mg/l
May-20	Unused GM		6.3	189	39	66.3	<1.0	7.2	15.6
Oct-20	Ground GM	T1	6.1	131	<0.6	<0.6	2.5	16.2	22
	Ground GM	T2	5.9	174	2.5	2.3	8.8	35.1	29.5
	Ground GM	T3	6.0	158	1.1	1.4	15	50.4	22.9
	Ground GM	T4	5.3	541	42.2	137.6	105.5	224.6	80.1
	Ground GM	T5	5.9	128	2.5	3.4	7.3	24	19.5
	Unground GM	T1	6.5	90	<0.6	<0.6	<1.0	7.7	14.3
	Unground GM	T2	6.8	126	<0.6	<0.6	4.8	17.5	17.3
	Unground GM	T3	6.5	107	<0.6	<0.6	8.6	30.6	13.9
	Unground GM	T4	5.8	333	4.3	89.7	58.2	128.5	58.5
	Unground GM	T5	6.7	96	<0.6	<0.6	5.6	18.8	12.9

*Figures in red = Index 0 – deficiency. *Figures in brown = Index 1. *Figures in blue = >Index 6. Figures in black = normal range

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Tissue analysis

Plant tissue analysis at the end of the trial showed that N was above the standard range for all treatments, as was P for T3 (1.0% 1/week) and T4 (0.5% every watering; **Table 15**, **Appendix 7**). K was below the standard range for all treatments apart from T4 where it was above the standard range. Mg was on target for T4 and above the standard range for the rest of the treatments.

Table 15. Plant tissue analysis from the Spiraea *trial. Analysis was completed at the end of the trial in October 2020. Results from analysis of the plant tissue taken at the start of the trial in May 2020 are shown for reference. Standard leaf analysis range sourced from Mills and Jones, 1996.*

Date	Tissue analysis	T	N %DM	P %DM	K %DM	Mg %DM
	Standard leaf analysis (range)	From	1.5	0.16	1.5	0.2
		To	2.16	0.31	1.6	0.29
May-20	Initial leaf analysis		**2.493**	**0.4018**	**1.1992**	0.2089
Oct-20	Foliage tissue	T1	**2.511**	0.1771	**0.8327**	**0.461**
	Foliage tissue	T2	**2.716**	0.2959	**0.8665**	**0.3294**
	Foliage tissue	T3	**3.071**	**0.3665**	**0.9911**	**0.341**
	Foliage tissue	T4	**3.809**	**0.6044**	**1.882**	0.2727
	Foliage tissue	T5	**2.616**	0.2681	**0.8656**	**0.419**

*Figures in red = Below standard range. *Figures in blue = Above standard range. Figures in black = standard range

***Geranium x cantabrigiense* 'Westray'**

Quality and height

At the end of the trial period there were no significant differences between treatments for either plant quality or root development (**Table 16**). In terms of plant height, only T4 (0.5% every watering) was significantly greater than T1 (no liquid feed) (p =0.014; **Figure 13**, **Appendix 12**). This treatment also produced plants with the greatest fresh weight (50.4 g). Both T4 and T3 (1.0% 1/week) had a significantly greater fresh weight compared to T1 (p =0.001). There were no significant differences between treatments for dry weight.

Table 16. Average scores for the final assessment on the Geranium *trial, week 43, 27 October 2020. Figures in red are significantly different to T1 (no liquid feed)*

	Liquid feed	Av. height (cm)	Av. quality	Av. root scores	Av. fresh weight (g)	Av. dry weight (g)
T1	None	8.1	3.45	2.30	36.8	8.8
T2	0.5% 1/wk	8.6	3.90	2.35	40.2	8.8
T3	1.0% 1/wk	9.0	4.05	1.85	45.3	9.8
T4	0.5% every watering	10.2	3.85	2.25	50.4	10.6
T5	1.0% feed to need	8.4	3.65	2.10	34.3	8.8
T6	1.0% feed to need #2	7.9	3.69	2.31	38.3	8.5
	F pr.	0.014	0.382	0.143	0.001	0.270
	l.s.d	1.194	0.5991	0.4080	6.570	2.017
	s.e.d	0.560	0.2811	0.1914	3.082	0.946

Figure 13. Geranium *plant height representative plants week 43 (L-R: T1 – T6)*

Electrical Conductivity

EC remained very similar between all treatments for the first six weeks after potting (**Figure 14**). After that point EC levels in T4 (0.5% every watering) remained slightly higher than the other treatments, although the levels followed a similar trend. After 13 weeks, plants in T5 (1.0% feed to need) were separated out to create another feed to need treatment (T6), and T5 started to receive feed. EC levels remained very similar in T1 (no liquid feed), T2 (0.5% 1/week), T3 (1.0% 1/week) and T5. T4 rapidly increased from 15 weeks after potting, reaching a peak of 223.6 μS/cm in the 17 week assessment. EC levels in T6 (1.0% feed to need #2)

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remained low and so feeding of this treatment began 17 weeks after potting. However, this made little impact on EC levels.

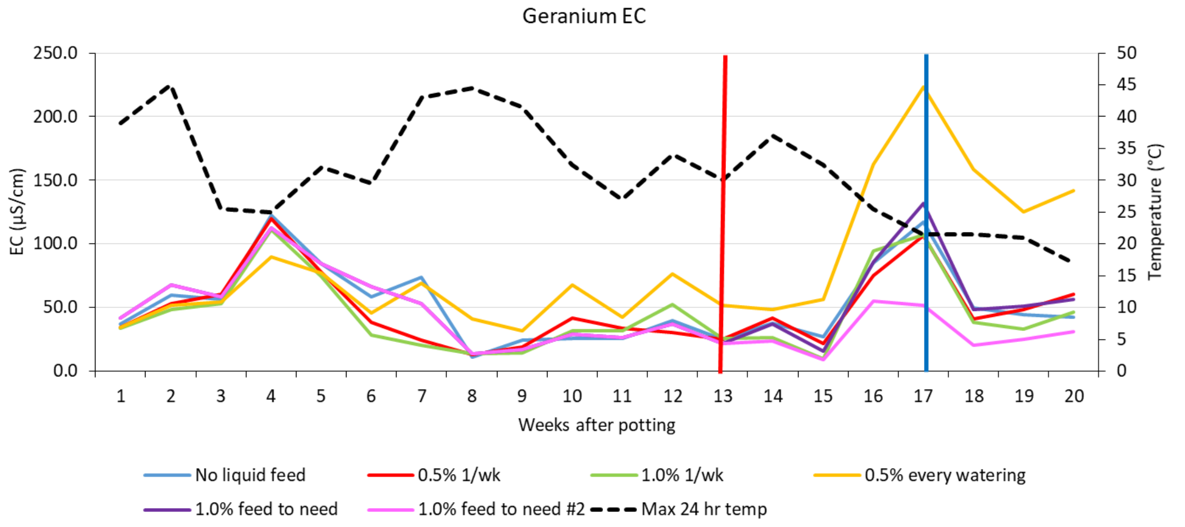

Figure 14. Weekly EC measurements for Geranium, *with the maximum 24 hour temperature for reference. The red vertical line denotes when T5 (1% feed to need) started and the blue vertical line denotes when T6 (1% feed to need #2) started*

Leaf Chlorophyll

Leaf chlorophyll measurements rose very sharply in all treatments in the *Geranium* trial after four weeks (**Figure 15**). After that, all treatments followed a similar trend, dipping in week nine and then increasing again. Leaf chlorophyll measurements started to increase in T4 (0.5% every watering) after 10 weeks, with the lowest levels seen in T1 (no liquid feed) and T5 (1.0% feed to need). Once T5 was split into two treatments and feed was applied from week 13 (after potting), leaf chlorophyll content did begin to decrease in T6 (1.0% feed to need #2). Feed was introduced to this treatment from week 17 and there was some increase in leaf chlorophyll content, but by the end of the trial, this treatment still had the lowest levels, followed by T1.

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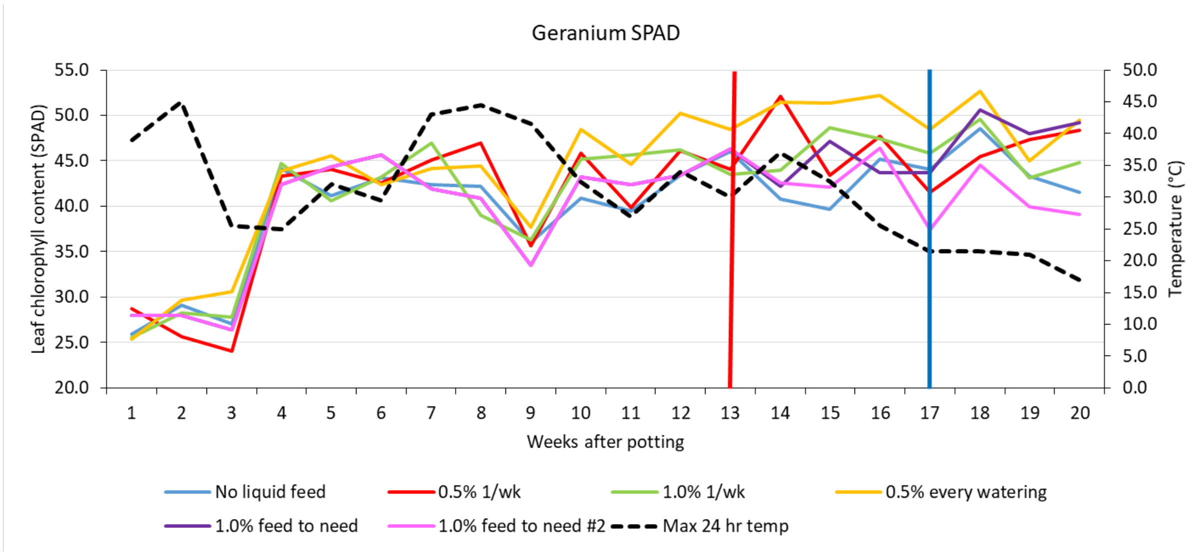

Figure 15. Weekly SPAD measurements for Geranium*, with the maximum 24 hour temperature for reference. The red vertical line denotes when T5 (1% feed to need) started and the blue vertical line denotes when T6 (1% feed to need #2) started*

Growing media analysis

The growing media analysis at the end of the *Geranium* trial showed that generally there were plentiful nutrients remaining, except for Ammonia-N in T1 (no liquid feed) and T6 (1.0% feed to need #2). Mg levels were excessive in all treatments (ground; **Table 17**, **Appendix 4**).

Table 17. Growing media analysis from the Geranium *trial, with both un-ground and ground results shown. Analysis was completed at the end of the trial in October 2020. Results from analysis of the unused growing media taken at the start of the trial in June 2020 are shown for reference.*

Date	Growing media analysis	T	pH	EC uS/cm	Ammonia-N mg/l	Nitrate-N mg/l	P mg/l	K mg/l	Mg mg/l
Jun-20	Unused GM		6.2	**156**	**24.6**	64.3	**<1.0**	**7.6**	27.8
Oct-20	Ground GM	T1	5.1	394	**48.2**	70	37.8	98.2	**71.7**
	Ground GM	T2	5	671	105.4	174.2	**71.3**	210.9	**110.5**
	Ground GM	T3	4.9	**1266**	**290.1**	**338.9**	**167.2**	**464.5**	**160.5**
	Ground GM	T4	5	685	60	**234.3**	**52.2**	226.3	**136.1**
	Ground GM	T5	5.1	**1009**	**221.6**	**263.6**	**124.7**	321.2	**141**
	Ground GM	T6	5.3	**264**	**12.5**	52.9	9.9	59.5	**50.5**
	Unground GM	T1	5.4	**248**	**44.5**	44.5	15.1	56.4	39.4
	Unground GM	T2	5.2	472	62.1	145.8	34.7	137.2	**75**
	Unground GM	T3	5.2	646	77.7	173.4	**51**	210.6	**110.7**
	Unground GM	T4	5.1	523	**43.1**	184.6	32.3	168	**90.1**
	Unground GM	T5	5.4	422	50.9	104.4	29	99.5	**73**
	Unground GM	T6	5.6	**194**	**3.3**	38.3	**1.1**	**36.2**	41.1

*Figures in red = Index 0 – deficiency. *Figures in brown = Index 1. *Figures in blue = >Index 6. Figures in black = normal range

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Tissue analysis

Plant tissue analysis showed that Mg was above the standard range and K was below the standard range for all treatments (**Table 18**, **Appendix 8**). Levels of N were above standard for all treatments apart from T1 (no liquid feed) and P was above range in T3 (1.0% 1/week) and T4 (0.5% every watering).

Table 18. Plant tissue analysis from the Geranium *trial. Analysis was completed at the end of the trial in October 2020. Results from analysis of the plant tissue taken at the start of the trial in June 2020 are shown for reference. Standard leaf analysis range sourced from Mills and Jones, 1996.*

Date	**Tissue analysis**	**T**	**N %DM**	**P %DM**	**K %DM**	**Mg %DM**
	Standard leaf analysis (value)		2.96	0.69	2.95	0.34
June-20	Initial leaf analysis		**1.165**	**0.3787**	**2.6664**	**0.3554**
Oct-20	Foliage tissue	T1	**2.632**	**0.2701**	**1.1472**	**0.8374**
	Foliage tissue	T2	**3.268**	**0.4631**	**1.4954**	**0.9176**
	Foliage tissue	T3	**3.357**	**0.7191**	**1.7866**	**0.9544**
	Foliage tissue	T4	**3.729**	**0.9488**	**1.9445**	**0.991**
	Foliage tissue	T5	**3.268**	**0.4899**	**1.6291**	**0.9221**
	Foliage tissue	T6	**2.969**	**0.4346**	**1.6211**	**0.9186**

*Figures in red = Below standard range. *Figures in blue = Above standard range. Figures in black = standard range

Tradescantia pallida ‘Purple Sabre’

Quality and height

Throughout the trial period it was quite difficult to differentiate between the various treatments and at the end of the trial there were only three significant differences (**Table 19**). T4 (0.5% every watering) received the best plant quality score of 3.9 which was significantly better than T1 (no liquid feed; p =0.027). There was some white residue on the leaves, but this was caused by the overhead irrigation and affected all *Tradescantia* plants within the trial. T4 also produced plants which were significantly taller (p =0.006; **Figure 16**, **Appendix 13**). Root development was significantly lower than T1 in T3 (1.0% 1/week; p =0.009). There were no significant differences between treatments for fresh or dry weight.

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Table 19. Average scores for the final assessment on the Tradescantia *trial, week 43, 27 October 2020. Figures in red are significantly different to T1 (no liquid feed)*

	Liquid feed	Av. height (cm)	Av. quality	Av. root scores	Av. fresh weight (g)	Av. dry weight (g)
T1	None	27.6	2.75	3.10	198.5	14.5
T2	0.5% 1/wk	26.9	3.01	2.74	197.8	14.4
T3	1.0% 1/wk	27.8	2.75	2.34	192.3	14.1
T4	0.5% every watering	32.8	3.90	2.85	225.4	14.8
T5	1.0% feed to need	27.9	2.70	3.20	202.7	14.3
T6	1.0% feed to need #2	26.9	2.44	3.25	206.7	15.2
	F pr.	0.006	0.027	0.009	0.128	0.980
	l.s.d	2.983	0.826	0.4798	24.40	3.150
	s.e.d	1.399	0.387	0.2251	11.45	1.478

Figure 16. Tradescantia *plant height representative plants week 43 (L-R: T1 – T5)*

Electrical Conductivity

There were some differences between treatments for EC early on in the trial (**Figure 17**), with the lowest EC levels in T4 (0.5% every watering) and the highest EC levels in T1 (no liquid feed) and T3 (1.0% 1/week) four weeks after potting. EC levels then fell sharply for all treatments and remained at low levels up until 15 weeks after potting. T5 (1.0% feed to need) began to receive feed after 13 weeks and T6 (1.0% feed to need #2) began to receive feed after 17 weeks. EC levels peaked again for all treatments after 16 weeks and by the end of the trial had reduced again, with the highest EC seen in T6 (57.6 µS/cm) and the lowest EC seen in T5 (17.0 µS/cm).

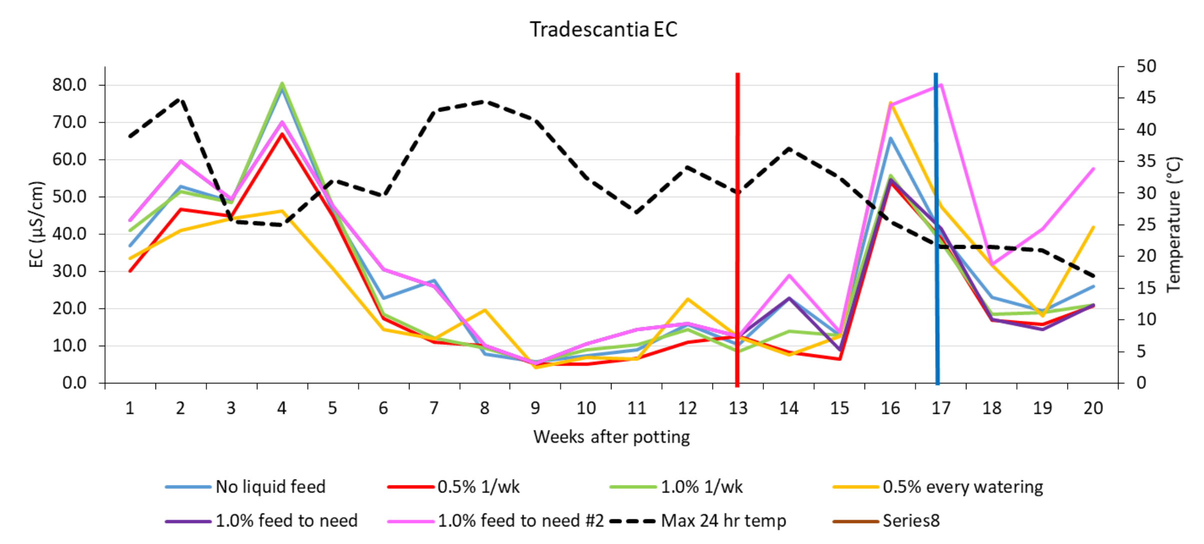

Figure 17. Weekly EC measurements for Tradescantia*, with the maximum 24 hour temperature for reference. The red vertical line denotes when T5 (1% feed to need) started and the blue vertical line denotes when T6 (1% feed to need #2) started*

Leaf Chlorophyll

Leaf chlorophyll measurements increased for the first three weeks after potting in all treatments, they then levelled out or dipped slightly before increasing again up to six weeks after potting (**Figure 18**). Leaf chlorophyll measurements dipped for all treatments after 8 weeks, and then slowly rose and levelled off until 15 weeks after potting. The trend for all treatments was similar, although T4 (0.5% every watering) did have higher leaf chlorophyll levels from week seven onwards, and the lowest levels were recorded in T5 (1.0% feed to need) and T1 (no liquid feed). At the end of the trial period leaf chlorophyll levels were highest in T4 (51.0) and lowest in T1 (36.0).

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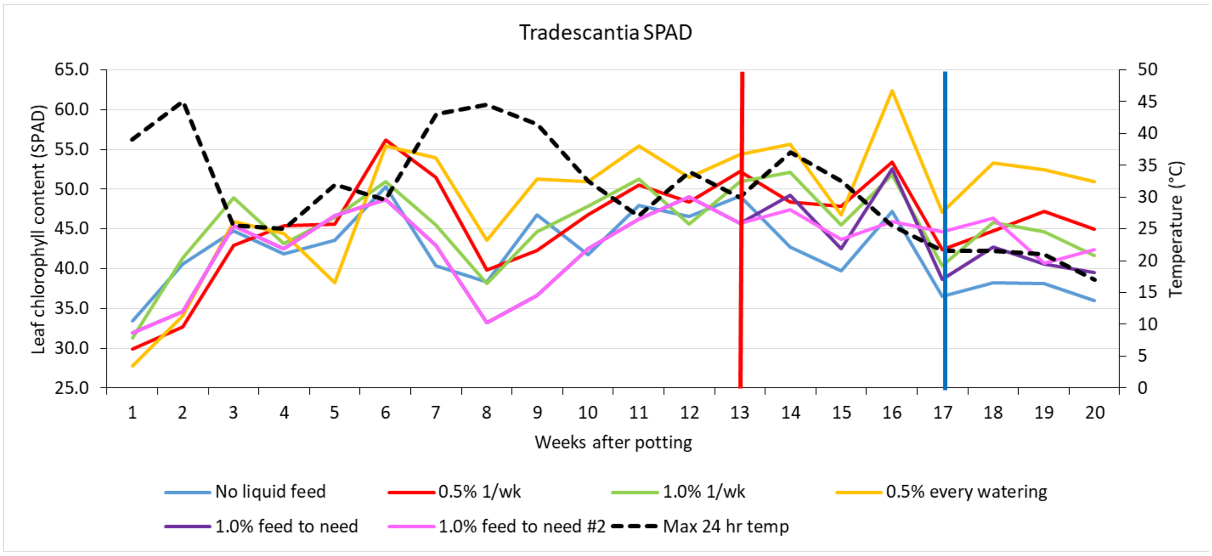

Figure 18. Weekly SPAD measurements for Tradescantia*, with the maximum 24 hour temperature for reference. The red vertical line denotes when T5 (1% feed to need) started and the blue vertical line denotes when T6 (1% feed to need #2) started*

Growing media analysis

At the end of the trial period, growing media analysis in the *Tradescantia* trial showed that N and K were low in most treatments, for both ground and un-ground samples (**Table 20**, **Appendix 5**). There were no excessive amounts of nutrients left in any of the treatments. Ammonia-N was deficient. Levels of P and Mg were within range for all treatments (ground samples).

Table 20. Growing media analysis from the Tradescantia *trial, with both un-ground and ground results shown. Analysis was completed at the end of the trial in October 2020. Results from analysis of the unused growing media taken at the start of the trial in June 2020 are shown for reference.*

Date	Growing media analysis	T	pH	EC uS/cm	Ammonia-N mg/l	Nitrate-N mg/l	P mg/l	K mg/l	Mg mg/l
Jun-20	Unused GM		6.2	**156**	**24.6**	64.3	**<1.0**	**7.6**	27.8
Oct-20	Ground GM	T1	5.5	**143**	**16.8**	**20.1**	15.9	**31.1**	15.3
	Ground GM	T2	5.4	**98**	**8.8**	**11.8**	9.5	**17.9**	10.8
	Ground GM	T3	5.4	**183**	**23.5**	28.1	24.8	**46.1**	26.2
	Ground GM	T4	5.4	**182**	**25**	29.1	38.9	51.1	23.6
	Ground GM	T5	5.6	**141**	**12.9**	**22.5**	13.5	**30.1**	20.2
	Ground GM	T6	5.4	**273**	**42.7**	46.2	33.3	86.7	30.9
	Unground GM	T1	6	**94**	**7.9**	**13.8**	**6.3**	**13.7**	**9.2**
	Unground GM	T2	5.6	**95**	**10.8**	**17**	8.4	**15.1**	13.1
	Unground GM	T3	5.4	**122**	**11.8**	**14.3**	17.1	**21.4**	17.7
	Unground GM	T4	5.6	**144**	**16.2**	**22.6**	28.2	**27.9**	18.9
	Unground GM	T5	5.8	**50**	**2.1**	**4.6**	**2.1**	**4.2**	**2.7**
	Unground GM	T6	6.1	**55**	**2.6**	**4.7**	**2.2**	**5.7**	**2.9**

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*Figures in red = Index 0 – deficiency. *Figures in brown = Index 1. Figures in black = normal range

Tissue analysis

Plant tissue analysis at the end of the trial period showed that N, P and K were below the standard range for all treatments, with the exception of P in T4 (0.5% every watering), which was above the standard range (**Table 21**, **Appendix 9**). Levels of Mg were above the standard range for all treatments.

Table 21. Plant tissue analysis from the Tradescantia *trial. Analysis was completed at the end of the trial in October 2020. Results from analysis of the plant tissue taken at the start of the trial in June 2020 are shown for reference. Standard leaf analysis range sourced from Mills and Jones, 1996.*

Date	Tissue analysis	T	N %DM	P %DM	K %DM	Mg %DM
	Standard leaf analysis (value)		4.84	0.52	5.41	0.36
June-20	Initial leaf analysis		**2.83**	**0.5106**	**3.6874**	**2.022**
Oct-20	Foliage tissue	T1	**2.056**	**0.2025**	**1.0578**	**1.5455**
	Foliage tissue	T2	**2.547**	**0.2725**	**1.1512**	**1.5023**
	Foliage tissue	T3	**2.795**	**0.4001**	**1.5135**	**1.4459**
	Foliage tissue	T4	**3.995**	**0.6442**	**2.5879**	**1.1827**
	Foliage tissue	T5	**2.422**	**0.2062**	**1.2099**	**1.6158**
	Foliage tissue	T6	**2.249**	**0.1738**	**0.8665**	**1.6693**

*Figures in red = Below standard range. *Figures in blue = Above standard range. Figures in black = standard range

Discussion

Prunus lusitanica **'Myrtifolia' - Long term, vigorous**

The most successful treatment in the *Prunus* trial was T4 (0.5% every watering), with taller but less bushy plants, higher root scores and a greater fresh weight compared with other treatments. However, the EC and SPAD measurements were higher for T4 compared with other treatments, as more nutrients were supplied (at every irrigation); the plants were able to utilise more of the nutrients, but there was still excess and this was seen in the high growing media EC. This may mean the dose rate used in this treatment is not suitable for *Prunus* and a lower dose rate could be applied that would produce plants of similar quality.

Plant quality scores were higher for plants in treatments T3 (1.0% 1/week) and T5 (1.0% feed to need) although the EC and SPAD measurements for T3 indicated that, like T4, more feed was applied than the plant required. The increase in EC from 18 weeks after potting indicates that the plants required less feed as days shortened and temperatures reduced. The growing media analyses indicated there was available Nitrate-N, P, K and Mg in both ground and un-ground samples from T3 and T4, generally above the standard range, suggesting that liquid

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feed rates could be reduced towards the end of the season when monitoring indicates that plants require less nutrients.

***Spiraea arguta* – long term, moderate vigour**

In the *Spiraea* trial there were no significant differences between treatments for plant quality. T4 (0.5% every watering) produced a shorter plant, however the fresh weight was greater, and rooting was improved compared with all other treatments. Plants grown under T1 and T5 were sparse with fewer break and shoots. Plants produced under T2 and T3 were considered the most marketable.

For Spiraea, the EC was higher in T1 than the other treatments. These plants received no liquid feed, and plants in all treatments received the same quantity of CRF at transplant. Growing media moisture can affect EC measurements, therefore measurements were made at the same time each week, prior to the plants being irrigated to minimise distorted readings. EC will be affected not only by the liquid feed, but also the CRF, which is released in response to high temperature and requires moisture for nutrient release, and this can cause spikes in EC.

As for the *Prunus,* high EC from 18 weeks after potting suggests less feed was required as the season progressed, days shortened, and temperature reduced.

With the growing media analysis, generally all nutrients were less available than in the *Prunus* trial, which suggests greater uptake by the plants. Despite higher nutrient levels remaining in the growing media (both ground and unground) for T4, the tissue analysis indicated that quantities taken up by the plants were below the standard range; this may be an indication that the standard range used may not be suitable for *Spirea arguta.*

***Geranium x cantabrigiense* 'Westray' – short term, moderate vigour**

The *Geranium* trial showed that plants from T4 (0.5% every watering) were taller and had a greater fresh weight. However, EC and SPAD measurements in this treatment were high, indicating excess feed, particularly as the season progressed. As for the *Prunus* and *Spiraea*, plants in T2 and T3 were considered more marketable than those in T4. EC and SPAD measurements for T5 (1.0% feed to need) and T6 (1.0% feed to need #2) fluctuated through the season, so while it may appear that there was a response to the liquid feed application this was not clear or consistent across the *Geranium* and *Tradescantia.* Growing media analysis showed that generally there were plentiful nutrients remaining in all treatments apart from T1 (no liquid feed) and T6. This suggests that the although the *Geranium* have been termed 'moderately vigorous', they require less feed than the *Spiraea* (long term, moderate vigour) and feed rates could potentially be reduced for this crop group without a negative impact on plant quality. Only a single value was provided for the standard tissue analysis rather than a range (for the *Spiraea* and *Tradescantia)*, which has the immediate effect of making it look as if plant tissue analyses are high or low, when in fact a nutrient range is not provided. Plant tissue analysis values were below range in T1, T5 and T6. K was below range in all treatments compared with the standard and Mg was high, but a range is required for this crop.

***Tradescantia pallida* 'Purple Sabre' – short term, vigorous**

It was difficult to measure the size of the *Tradescantia* as it tends to be brittle and is easily broken so the plants had to be handled as little as possible. It was not possible to straighten the stems to measure the full height (or length for horizontal stems), as was done for the *Geranium*, and height from the top of the pot to the highest point was found to be most appropriate measurement to use for this species.

At the end of the trial period, there was very little difference between treatments for plant quality and growth. While T4 (0.5% every watering) may be thought the most appropriate treatment for this vigorous plant, and it did produce the largest plants, overall plant marketability may be improved by applying less feed (e.g. T3 or T2) to restrict growth, producing smaller plants that may be less prone to breakage.

Growing media analysis showed that N, P and K were low in the unground samples for most treatments by the end of the trial, and slightly higher in the ground samples, so there were some CRF reserves at the end of the trial. Tissue analysis also indicated low leaf N, P and K for all treatments compared with the standard nutrient levels. As there was little difference in plant quality between treatments, it could be that the *Tradescantia* does not need the tissue nutrient levels suggested by the standard tissue analysis for the plant to be of marketable quality.

While both *Prunus* and *Tradescantia* are both categorised as vigorous plants, the *Tradescantia* utilised most of the feed applied which suggests it has different nutrient requirements than the *Prunus*, and may be more vigorous in terms of the amount of nutrients required to produce a marketable plant; this is converse to *Spiraea* vs *Geranium* (both denoted as moderately vigorous), the herbaceous Geranium (short term, moderate vigour) is less vigorous than the woody Spiraea (long term, moderate vigour).

General discussion

For this trial, although significant differences between treatments were considered in terms of plant height, from a grower perspective shorter but bushier plants with more breaks / side shoots are usually more marketable for this sector. For this reason, *Prunus*, *Spiraea* and

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Geranium plants produced under treatments T2 and T3 were considered more marketable than those produced under treatment T4, which generally produced taller plants with fewer breaks. T2 and T3 were also easier to manage as the plants were fed weekly (not daily as in T4) and had a lower labour requirement. For the *Tradescantia* in particular, there was little difference in the effect of the treatments on plant quality, 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. Similarly, T5 required weekly monitoring and a decision whether to apply liquid feed each week. This would be more difficult to implement nursery wide where many species or cultivars are grown, and perhaps in small numbers.

The combination of SPAD and EC measurements was useful as it 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 in all treatments indicated the feed was taken up across all treatments.

For treatment 4, both the EC and SPAD measurements were generally high compared with other treatments, because more nutrients were supplied (at every irrigation); the plants were able to use more of the nutrients, but there was still excess and this was seen in the high growing media EC.

High EC can be a cause for concern, particularly for sensitive plants, as it can result in root damage, and is usually addressed by irritating to flush the salts out of the growing media. Incorporating a lower rate of CRF in the growing media helps to reduce the risk of release of excessive CRF in high temperatures. 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 and recycle run-off water).

The relationship between EC and SPAD measurements provided a useful indication of when the plants required less feed as the season progressed into shorter days and cooler temperatures and nutrients accumulated in the growing media, with less uptake by the plants. This is a good example of when the general approach of providing low dose CRF supplemented with liquid feed can provide a level of flexibility that allows the grower to match nutrient supply with plant need.

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Weekly measurement of EC and leaf chlorophyll proved useful tools to monitor nutrient uptake in this trial, particularly as plant nutrient requirements diminished towards the end of the season, or where differences between treatments became more extreme. However, while such EC measurements show changes in salt level (i.e. total nutrient level) within the growing media this is a broad measurement that does not identify which nutrients contributed to a high EC or which may be deficient or excessive; growing media analysis provides more detailed information on individual nutrient levels. All of these measurements (EC, leaf chlorophyll, growing media analysis) are most useful if carried out regularly so that trends can be identified, ideally over multiple seasons, then signs of deficiency can be identified early and adjustments made to the feed regime before symptoms become visible and affect the marketability of the plants. Similarly, if excessive salts build up in the growing media, liquid feed applications can be reduced.

P was generally high in the growing media and tissue analyses, particularly for the *Geranium*. P levels can be high in proprietary fertilisers, and was more apparent in these results for the moderately vigorous *Geranium* which utilised less P than other species, and in T4 (Prunus and Spiraea), where more P was supplied than was taken up by the plants.

Considering tissue analyses, values obtained, particularly for P, were often outside the published standard ranges for all species in this trial (**Mills and Jones, 1996**), with no visible deficiency symptoms. These standard ranges should be viewed with caution as they are historical, specific for variety/cultivar and are means of data. For example, there are ten standard values for *Spirea*, but no specific ranges for *Spirea arguta.* This project will build a record of values over years, which will supplement existing published data. Where standard nutrient analysis values are not available / published for all cultivars, it is important that growers keep records for the specific important cultivars that they grow, alongside commentary on plant quality and any visual symptoms of nutrient imbalance.

Conclusions

T2 and T3 produced marketable plants with a bushier habit than other treatments, while T4 produced taller less bushy plants and appeared to provide excess nutrients. However, it may be that the habit of the plants in T4 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 HNS nurseries tend to have a wide range of species / cultivars; T3 is the more manageable treatment and produced good quality plants.

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,

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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 be reduced in a cooler season to produce marketable plants. This will also help growers to identify and rectify any issues sooner.

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.

Knowledge and Technology Transfer

- Growing media developments and nutrient management in hardy nursery stock production. Coles Nurseries. 12 September 2019. Presentation and workshop demonstration of trial.
- Herbaceous Perennials Technical Discussion Group presentation. Environmental protection best practice - nutrient management and water treatment and recycling on nurseries. 25 February 2020. Presentation.

References

Adlam, J. (2016) Nutrient management in Hardy Nursery Stock (NutrHONS) AHDB project report for HNS 193.

Bragg, N., and Holmes, S. (2016). Sampling methodologies and analysis interpretation for growers of hardy nursery stock. AHDB Factsheet 1f0/16.

Bragg, N.C. and Fuller, A.K. (1997). Cultural control of plant growth – a fresh look. Acta Hortic. 450, 535-544

Briercliffe, T., Bragg, N., Coutts, S., Kitchener, H., Jevans, A., Pettitt, T and Clarke, I. (2000). Protected ornamentals: the efficiency of water use in different production systems. Horticulture Development Company project report for PC 166.

Frith, G. J. T. (1975). Nitrogen uptake by apple seedlings as affected by light, and nutrient stress in part of the root system. Scoresby Horticultural Research Station, Ferntree Gully, Victoria 3156, Australia.https://doi.org/10.1111/j.1399-3054.1975.tb03806.x

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Hojjatie, M. and Carney, F. (2014). Review of analytical methods for slow and controlled release fertilisers. International Fertilizer Industry Association (IFA).

Mills H. A, Jones J. B Jr. (1996). Plant analysis handbook. II: a practical sample, preparation, analysis and interpretation guide. Athens (GA): Micromacro Publishing. 422 p.

Pennell, D., Holmes, S., and Hutchinson, D. (2013). Study to review and improve nutrient management in container grown nursery stock. AHDB project report for HNS 189.

RB209 (2010). Fertiliser Manual. Defra, 8th Edition, June 2010.

Scott, M. (2004). Nursery stock propagation: nutrition of rooted cuttings in modular trays. HDC project report for HNS 90.

Scott, M. A. (1994). Container nursery stock: investigation of use of controlled release fertilisers under protection. HDC project report for 43.

Scott, M. A. (1996). Evaluation of computer simulation models for advice on the availability of nutrients from controlled release fertilisers. HDC project report for 43b.

Taylor, B. K and Goubran, F. H. (1976). The phosphorus nutrition of the apple tree. II. Effects of localized phosphate placement on the growth and phosphorus content of split-root trees. Australian Journal of Agricultural Research 27(4) 533 - 9 http://www.publish.csiro.au/CP/AR9760533.

Terlingen, J. G. A., Radersma, S., Out, G. J. J., Hernández-Mártinez, J., and Raemakers-Franken, P. C. (2016). Current development in controlled release fertilisers. Proceedings No. 781. International Fertiliser Society.

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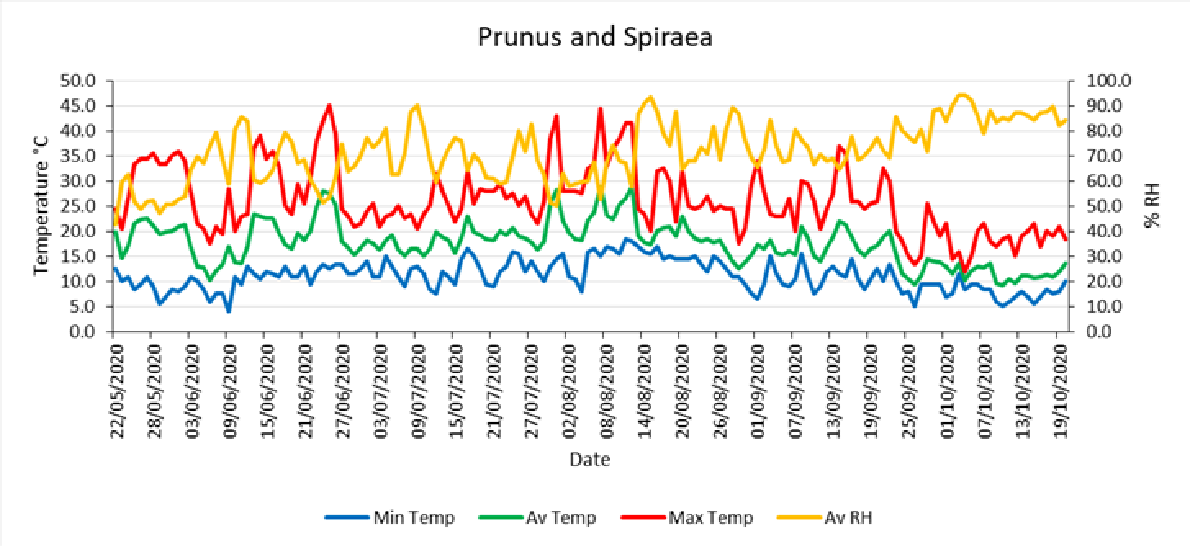
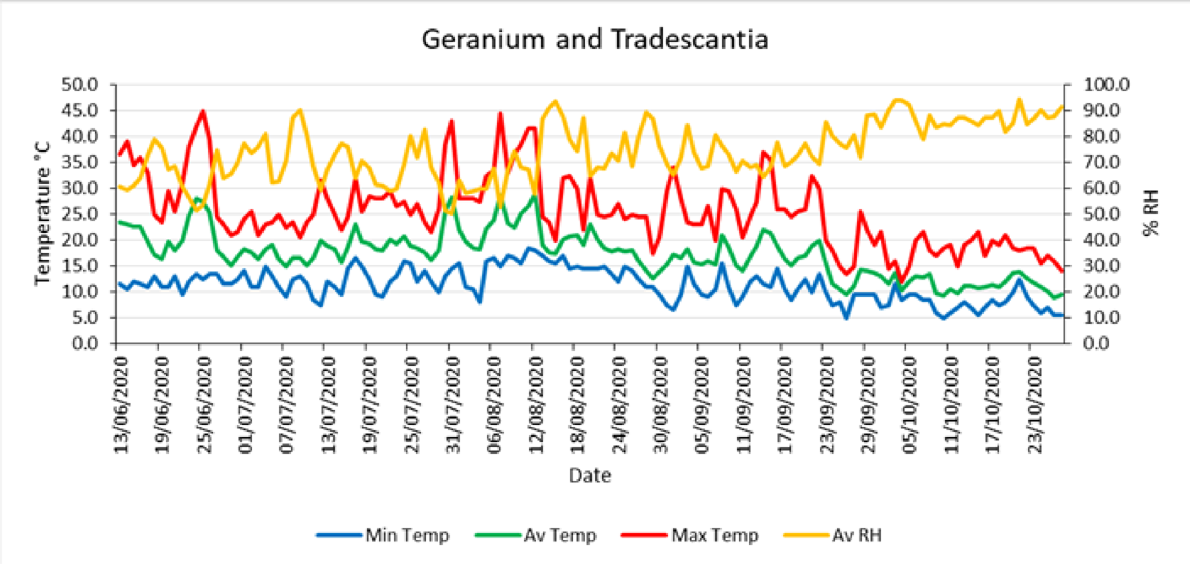
Appendices

Appendix 1. ***Polytunnel temperature and humidity. Two dataloggers were placed within the polytunnel, to monitor the*** **Prunus** ***and*** **Spiraea** ***from set up, and then the*** **Geranium** ***and*** **Tradescantia.**





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Appendix 2. ***Growing media analyses.*** **Prunus lusitanica** ***'Myrtifolia'. Liquid feed treatments: T1 = no liquid feed; T2 = 0.5% 1/week; T3 = 1.0% 1/week; T4 = 0.5% every watering; T5 = 1.0% feed to need; T6 = 1.0% feed to need from week 13*** *(after potting).* **Geranium** ***and*** **Tradescantia** ***only. U = unground and G = ground***

Treatment		Date 2020	pH	EC uS/cm	NH_4^- mg/l	NO_3^- mg/l	N mg/l	P mg/l	K mg/l	Mg mg/l	Ca mg/l	Fe mg/l	Cu mg/l	Mn mg/l	Zn mg/l	Na mg/l	B mg/l	SO_4 mg/l	Cl mg/l	Density kg/m^3	Dry matter %	Dry density kg/m^3
Supplier growing media		22-May	5.9	96	2.3	1.9	4.2	5.2	24	7	10.6	0.63	0.02	<0.01	0.04	35.9	0.19	102.3	49.4	397	29.6	117.5
Unused			6.3	189	39.0	66.3	105.3	<1.0	7.2	15.6	17.7	0.77	0.01	0.03	0.10	15.5	<0.05	37.4	20.0	345	40.5	139.7
T1	U		6.9	92	1.9	2.7	4.6	<1.0	6.6	7	10.1	0.35	<0.01	<0.01	0.02	25.1	<0.05	31.2	53.3	430	31.4	135.0
T4	U	04-Sep	5.7	446	6.2	158.2	164.3	23.2	111.2	96.4	99.6	0.61	<0.01	0.15	0.03	42.4	0.06	95.5	76.5	399	44.7	178.4
T5	U		6.6	91	2.5	7.4	9.9	<1.0	11.6	9.5	13.9	0.34	<0.01	<0.01	<0.02	20.9	<0.05	27.9	46.8	420	36.1	151.6
T1	U		7.1	59	<0.6	<0.6	<0.6	<1.0	5.3	8.6	14.2	0.48	<0.01	<0.01	<0.02	23.00	<0.05	28.6	47.0	294	40.3	118.5
T2	U		6.4	145	<0.6	17.2	17.6	4.1	32.6	25.3	31.4	0.25	<0.01	<0.01	<0.02	46.90	0.05	85.2	98.0	343	35.5	121.8
T3	U	27-Oct	6.2	220	<0.6	36.7	37.1	7.9	41.2	24.8	34.0	0.20	<0.01	<0.01	<0.02	0.20	0.11	59.2	50.8	341	36.4	124.1
T4	U		5.6	461	3.8	156.8	160.6	67.7	165.6	86.8	126.5	0.67	<0.01	0.20	0.07	0.67	0.12	162.5	99.1	366	34.6	126.6
T5	U		6.5	76	<0.6	5.2	5.4	3.0	14.6	11.0	14.1	0.26	<0.01	<0.01	<0.02	0.26	0.05	39.0	48.6	317	37.5	118.9
T1	G		6.5	66	<0.6	0.7	1.0	2.8	6.5	9.3	10.6	0.20	<0.01	<0.01	<0.02	24.40	0.05	38.0	45.6	294	40.3	118.5
T2	G		5.9	152	3.9	17.6	21.6	11.2	36.8	22.6	29.3	0.31	<0.01	<0.01	0.04	43.80	0.10	95.4	84.1	343	35.5	121.8
T3	G	29-Oct	5.8	193	0.6	44.1	44.8	15.7	63.1	33.4	43.6	0.30	<0.01	0.01	0.04	40.10	0.10	91.1	69.2	341	36.4	124.1
T4	G		5.2	489	2.5	171.4	173.9	70.8	195.4	89.4	132.4	0.75	<0.01	0.34	0.10	0.75	0.16	167.9	94.4	366	34.6	126.6
T5	G		6.4	109	5.2	10.5	15.7	11.9	25.3	15.2	19.3	0.32	<0.01	<0.01	0.06	0.32	0.06	60.9	48.1	317	37.5	118.9

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Appendix 3. ***Growing media analyses.*** **Spiraea arguta*.*** ***Liquid feed treatments: T1 = no liquid feed; T2 = 0.5% 1/week; T3 = 1.0% 1/week; T4 = 0.5% every watering; T5 = 1.0% feed to need; T6 = 1.0% feed to need from week 13 (after potting).*** **Geranium** ***and*** **Tradescantia** ***only. U = unground and G = ground***

Treatment		Date 2020	pH	EC uS/cm	NH_4^- mg/l	NO_3^- mg/l	N mg/l	P mg/l	K mg/l	Mg mg/l	Ca mg/l	Fe mg/l	Cu mg/l	Mn mg/l	Zn mg/l	Na mg/l	B mg/l	SO_4 mg/l	Cl mg/l	Density kg/m^3	Dry matter %	Dry density kg/m^3
Supplier growing media		22-May	7.2	96	0.9	<0.06	0.9	1.4	21.2	4.2	13.5	0.26	0.01	<0.01	0.04	28.8	0.16	56.6	50.7	589	14.5	85.4
Unused			6.3	189	39.0	66.3	105.3	<1.0	7.2	15.6	17.7	0.77	0.01	0.03	0.10	15.5	<0.05	37.4	20.0	345	40.5	139.7
T1	U	27-Oct	6.5	90	<0.6	<0.6	<0.6	<1	7.7	14.3	20.4	0.20	<0.01	<0.01	<0.02	30.5	<0.05	74.3	69.6	277	44.8	124.1
T2	U		6.8	126	<0.6	<0.6	<0.6	4.8	17.5	17.3	33.0	0.32	<0.01	<0.01	0.02	39.5	0.06	97.0	91.4	258	56.2	145.0
T3	U		6.5	107	<0.6	<0.6	<0.6	8.6	30.6	13.9	20.7	0.35	<0.01	<0.01	<0.02	35.5	<0.05	87.4	67.4	287	52.5	150.7
T4	U		5.8	333	4.3	89.7	93.9	58.2	128.5	58.5	78.4	0.78	<0.01	0.06	0.10	46.3	0.12	163.4	83.5	327	43.4	141.9
T5	U		6.7	96	<0.6	<0.6	<0.6	5.6	18.8	12.9	23.9	0.26	<0.01	<0.01	0.04	28.6	<0.05	84.9	61.6	258	45.2	116.6
T1	G	29-Oct	6.1	131	<0.6	<0.6	<0.6	2.5	16.2	22.0	31.7	0.19	<0.01	<0.01	0.03	42.1	<0.05	111.7	92.7	277	44.8	124.1
T2	G		5.9	174	2.5	2.3	4.8	8.8	35.1	29.5	43.3	0.40	<0.01	<0.01	0.04	56.3	<0.05	149.7	124.1	258	56.2	145.0
T3	G		6.0	158	1.1	1.4	2.4	15.0	50.4	22.9	28.7	0.44	<0.01	<0.01	0.06	46.8	0.05	124.9	99.8	287	52.5	150.7
T4	G		5.3	541	42.2	137.6	179.8	105.5	224.6	80.1	114.3	1.91	0.07	0.18	0.28	49.8	0.25	371.1	81.1	327	43.4	141.9
T5	G		5.9	128	2.5	3.4	6.0	7.3	24	19.5	30.2	0.38	<0.01	<0.01	0.04	36.5	<0.05	111.6	75.8	258	45.2	116.6

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Appendix 4. ***Growing media analyses.*** **Geranium *x* cantabrigiense *'Westray'*. *Liquid feed treatments: T1 = no liquid feed; T2 = 0.5% 1/week; T3 = 1.0% 1/week; T4 = 0.5% every watering; T5 = 1.0% feed to need; T6 = 1.0% feed to need from week 13.* Geranium *and* Tradescantia *only. U = unground and G = ground***

Treatment		Date 2020	pH	EC uS/cm	NH_4^- mg/l	NO_3^- mg/l	N mg/l	P mg/l	K mg/l	Mg mg/l	Ca mg/l	Fe mg/l	Cu mg/l	Mn mg/l	Zn mg/l	Na mg/l	B mg/l	SO_4 mg/l	Cl mg/l	Density kg/m^3	Dry matter %	Dry density kg/m^3
Supplier growing media		16-Jun	6.9	163	<0.06	<0.06	<0.06	4.8	141.6	5.4	6.4	0.36	0.03	<0.01	<0.02	52.1	0.09	230.3	47.6	388	23.5	91.2
Unused			6.2	156	24.6	64.3	88.9	<1.0	7.6	27.8	26.1	0.3	0.02	0.05	<0.02	18.3	<0.05	36.0	13.9	284.0	44.4	126.1
T1	U	03-Nov	5.4	248	44.5	44.5	71.2	15.1	56.4	39.4	37.50	1.29	0.04	0.09	0.05	38.0	0.11	278.3	39.7	326	44.8	146.0
T2	U		5.2	472	62.1	145.8	207.9	34.7	137.2	75.0	76.10	1.86	0.07	0.27	0.09	41.3	0.31	375.2	57.1	301	51.1	153.8
T3	U		5.2	646	77.7	173.4	251.1	51.0	210.6	110.7	113.50	3.19	0.18	0.44	0.17	59.6	0.33	642.5	67.2	351	42.8	150.2
T4	U		5.1	523	43.1	184.6	227.7	32.3	168.0	90.1	96.50	1.45	0.04	0.39	0.08	49.1	0.13	317.8	59.1	305	43.4	132.4
T5	U		5.4	422	50.9	104.4	155.3	29.0	99.5	73.0	73.90	1.95	0.14	0.18	0.13	47.5	0.17	413.0	62.7	310	46.1	142.9
T6	U		5.6	194	3.3	38.3	41.6	1.1	36.2	41.1	37.40	0.91	0.04	0.05	0.06	43.1	0.08	190.9	55.5	345	38.3	132.1
T1	G	03-Nov	5.1	394	48.2	70.0	118.2	37.8	98.2	71.7	66.30	1.75	0.05	0.26	0.07	48.7	0.18	479.0	52.3	326	44.8	146
T2	G		5.0	671	105.4	174.2	279.6	71.3	210.9	110.5	112.50	2.86	0.14	0.55	0.20	59.0	0.47	684.1	74.2	301	51.1	153.8
T3	G		4.9	1266	290.1	338.9	629.0	167.2	464.5	160.5	161.00	6.31	0.47	1.05	0.34	67.7	0.72	1355.0	63.0	351	42.8	150.2
T4	G		5.0	685	60.0	234.3	294.2	52.2	226.3	136.1	137.80	2.31	0.06	0.62	0.13	65.4	0.23	536.1	78.5	305	43.4	132.4
T5	G		5.1	1009	221.6	263.6	485.1	124.7	321.2	141	134.30	4.18	0.32	0.81	0.46	56.1	0.54	1062.7	71.2	310	46.1	142.9
T6	G		5.3	264	12.5	52.9	65.4	9.9	59.5	50.5	50.60	1.26	0.04	0.19	0.05	46.3	0.60	264.6	60.0	345	38.3	132.1

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Appendix 5. ***Growing media analyses.*** **Tradescantia pallida** ***'Purple Sabre'. Liquid feed treatments: T1 = no liquid feed; T2 = 0.5% 1/week; T3 = 1.0% 1/week; T4 = 0.5% every watering; T5 = 1.0% feed to need; T6 = 1.0% feed to need from week 13 (after potting).*** **Geranium** ***and*** **Tradescantia** ***only. U = unground and G = ground***

Treatment		Date 2020	pH	EC uS/cm	NH_4^- mg/l	NO_3^- mg/l	N mg/l	P mg/l	K mg/l	Mg mg/l	Ca mg/l	Fe mg/l	Cu mg/l	Mn mg/l	Zn mg/l	Na mg/l	B mg/l	SO_4 mg/l	Cl mg/l	Density kg/m^3	Dry matter %	Dry density kg/m^3
Supplier growing media		16-Jun	6.6	98	1.3	8.4	9.8	4.8	52.1	3.6	4.8	0.4	0.03	<0.01	0.06	30.4	0.18	88.7	19.8	516	18.4	94.9
Unused		16-Jun	6.2	156	24.6	64.3	88.9	<1.0	7.6	27.8	26.1	0.3	0.02	0.05	<0.02	18.3	<0.05	36.0	13.9	284	44.4	126.1
T1	U	03-Nov	6.0	94	7.9	13.8	21.7	6.3	13.7	9.2	13.1	0.62	0.02	<0.01	0.05	34.2	0.11	112.9	11.1	294	40.4	118.8
T2	U	03-Nov	5.6	95	10.8	17.0	27.8	8.4	15.1	13.1	10.7	1.49	0.05	0.01	0.04	32.3	0.07	121.1	7.8	266	56.2	149.5
T3	U	03-Nov	5.4	122	11.8	14.3	26.1	17.1	21.4	17.7	18.3	2.30	0.10	0.03	0.07	38.5	0.11	178.0	7.7	237	43.9	104.0
T4	U	03-Nov	5.6	144	16.2	22.6	38.8	28.2	27.9	18.9	18.5	1.83	0.04	0.03	0.07	41.6	0.10	161.9	13.4	306	44.0	134.6
T5	U	03-Nov	5.8	50	2.1	4.6	6.6	2.1	4.2	2.7	2.9	0.69	0.02	<0.01	0.02	28.1	0.07	63.9	8.4	269	43.2	116.2
T6	U	03-Nov	6.1	55	2.6	4.7	7.3	2.2	5.7	2.9	3.5	0.60	0.02	<0.01	0.06	30.7	0.07	67.6	8.8	328	37.3	122.3
T1	G	03-Nov	5.5	143	16.8	20.1	36.9	15.9	31.1	15.3	21.9	1.32	0.05	0.06	0.04	40.7	0.21	173.6	12.8	294	40.4	118.8
T2	G	03-Nov	5.4	98	8.8	11.8	20.6	9.5	17.9	10.8	9.8	1.06	0.06	0.03	<0.02	35.5	0.10	116.3	10.3	266	56.2	149.5
T3	G	03-Nov	5.4	183	23.5	28.1	51.6	24.8	46.1	26.2	25.3	2.02	0.06	0.08	0.15	38.1	0.12	239.4	9.2	237	43.9	104.0
T4	G	03-Nov	5.4	182	25.0	29.1	54.1	38.9	51.1	23.6	23.8	0.90	0.12	0.08	0.07	48.1	0.18	211.7	12.5	306	44.0	134.6
T5	G	03-Nov	5.6	141	12.9	22.5	35.4	13.5	30.1	20.2	23.3	1.20	0.05	0.07	0.07	41.9	0.12	174.3	14.5	269	43.2	116.2
T6	G	03-Nov	5.4	273	42.7	46.2	88.9	33.3	86.7	30.9	37.6	1.68	0.05	0.11	0.11	51.8	0.23	341.9	15.2	328	37.3	122.3

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Appendix 6. ***Tissue analyses.*** **Prunus lusitanica** ***'Myrtifolia'. Liquid feed treatments: T1 = no liquid feed; T2 = 0.5% 1/week; T3 = 1.0% 1/week; T4 = 0.5% every watering; T5 = 1.0% feed to need. Standard range extracted from Mills and Jones,1996***

Date			N		P		K		Ca		Mg		S	Mn	Cu	Zn	Fe	B	Mo	Na	Al
2020	Treatment / analysis		%DM	ppm	%DM	ppm	%DM	ppm	%DM	ppm	%DM	ppm	%DM	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
	Standard leaf analysis (range)	From	1.53	-	0.2	-	0.93	-	1.18	-	0.4	-	0.09	409	6	22	31	26	0.12	79	24
		To	2.59	-	0.22	-	1.35	-	2.24	-	0.61	-	0.11	643	11	35	97	34	1.35	205	74
20-May	Initial leaf analysis		1.143	2487	0.2487	6398	0.6398	10446	1.0446	2218	0.2218	949	0.095	34.8	1.5	12.5	93.9	19.8	not tested		
	T1		2.154	2082	0.2082	7661	0.7661	11357	1.1357	4195	0.4195	1490	1.490	45.2	1.6	13.8	52.4	19.9			
	T2		2.345	2694	0.2694	9285	0.9285	12399	1.2399	4474	0.4474	1507	1.507	49.0	1.2	13.9	67.7	20.4			
04-Nov	T3		2.550	3631	0.3631	10638	1.0638	13345	1.3345	4583	0.4583	1546	1.546	59.9	1.3	15.4	71.6	20.2	not tested		
	T4		3.519	6528	0.6528	15981	1.5981	19406	1.9406	6521	0.6521	1812	1.812	110.0	1.8	18.9	91.3	22.5			
	T5		2.202	2444	0.2444	8275	0.8275	12380	1.238	4242	0.4242	1515	1.515	43.1	1.5	16.3	57.5	21.0			

Key:
Higher than standard range
Within standard range
Lower than standard range

Appendix 7. ***Tissue analyses.*** **Spiraea arguta.** ***Liquid feed treatments: T1 = no liquid feed; T2 = 0.5% 1/week; T3 = 1.0% 1/week; T4 = 0.5% every watering; T5 = 1.0% feed to need. Standard range extracted from Mills and Jones,1996***

Date			N		P		K		Ca		Mg		S	Mn	Cu	Zn	Fe	B	Mo	Na	Al
2020	Treatment / analysis		%DM	ppm	%DM	ppm	%DM	ppm	%DM	ppm	%DM	ppm	%DM	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
	Standard leaf analysis (range)	From	1.5	-	0.16	-	1.5	-	0.69	-	0.2	-	0.12	103	3	18	75	36	1.26	31	49
		To	2.16	-	0.31	-	1.6	-	1.18	-	0.29	-	0.16	189	6	32	84	44	1.32	74	156
20-May	Initial leaf analysis		2.493	4018	0.4018	11992	1.1992	13235	1.3235	2089	0.2089	2084	0.2084	62	4.4	28.8	113.0	18.7	not tested		
	T1		2.511	1771	0.1771	8327	0.8327	10562	1.0562	4610	0.4610	1813	0.1813	129	4.5	19.0	94.5	23.4			
	T2		2.716	2959	0.2959	8665	0.8665	7874	0.7874	3294	0.3294	1998	0.1998	146	1.7	19.5	85.4	20.7			
04-Nov	T3		3.071	3665	0.3665	9911	0.9911	8922	0.8922	3410	0.3410	2210	0.2210	151	1.8	28.8	92.2	20.9	not tested		
	T4		3.809	6044	0.6044	18820	1.8820	8070	0.8070	2727	0.2727	2539	0.2539	269	1.4	29.9	74.8	14.3			
	T5		2.616	2681	0.2681	8656	0.8656	9707	0.9707	4190	0.4190	2010	0.2010	153	1.7	18.7	80.2	23.4			

Key:
Higher than standard range
Within standard range
Lower than standard range

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Appendix 8. ***Tissue analyses.*** **Geranium x cantabrigiense** ***'Westray'. Liquid feed treatments: T1 = no liquid feed; T2 = 0.5% 1/week; T3 = 1.0% 1/week; T4 = 0.5% every watering; T5 = 1.0% feed to need; T6 = 1.0% feed to need from week 13 (after potting),*** **Geranium** ***and*** **Tradescantia** ***only. Standard range extracted from Mills and Jones,1996. Note: for*** **Geranium** ***and*** **Tradescantia** ***there is no lower standard range.***

Date 2020	Treatment / analysis		N %DM	N ppm	P %DM	P ppm	K %DM	K ppm	Ca %DM	Ca ppm	Mg %DM	Mg ppm	S %DM	Mn ppm	Cu ppm	Zn ppm	Fe ppm	B ppm	Mo ppm	Na ppm	Al ppm
	Standard leaf analysis (range)	From	2.96		0.69		2.95		1.33		0.34		0.29	55	8	55	51	25	0.25	164	19
		To	2.96		0.69		2.95		1.33		0.34		0.29	55	8	55	51	25	0.25	164	19
30-Jun	Initial leaf analysis		1.165	3787	0.3787	26664	2.6664	7023	0.7023	3554	0.3554	1341	0.1341	25.6	1.8	27.9	85.4	44.4	not tested		
12-Nov	T1		2.632	2701	0.2701	11472	1.1472	23223	2.3223	8374	0.8374	3648	0.3648	88.4	<0.2	19.1	87.5	23.9	not tested		
	T2		3.268	4631	0.4631	14954	1.4954	24044	2.4044	9176	0.9176	4457	0.4457	99.4	<0.2	24.0	84.9	22.3			
	T3		3.357	7191	0.7191	17866	1.7866	23944	2.3944	9544	0.9544	5023	0.5023	94.7	0.6	25.9	84.8	29.6			
	T4		3.729	9488	0.9488	19445	1.9445	25370	2.5370	9910	0.9910	4609	0.4609	128.0	0.6	28.0	99.3	30.4			
	T5		3.268	4899	0.4899	16291	1.6291	22286	2.2286	9221	0.9221	4217	0.4217	93.7	0.3	25.6	84.9	27.9			
	T6		2.969	4346	0.4346	16211	1.6211	22891	2.2891	9186	0.9186	4222	0.4222	88.0	0.5	22.9	80.8	30.7			

Key:
Higher than standard range
Within standard range
Lower than standard range

Appendix 9. ***Tissue analyses.*** **Tradescantia pallida** ***'Purple Sabre'. Liquid feed treatments: T1 = no liquid feed; T2 = 0.5% 1/week; T3 = 1.0% 1/week; T4 = 0.5% every watering; T5 = 1.0% feed to need; T6 = 1.0% feed to need from week 13 (after potting),*** **Geranium** ***and*** **Tradescantia** ***only. Standard range extracted from Mills and Jones,1996. Note: for*** **Geranium** ***and*** **Tradescantia** ***there is no lower standard range.***

Date 2020	Treatment / analysis		N %DM	N ppm	P %DM	P ppm	K %DM	K ppm	Ca %DM	Ca ppm	Mg %DM	Mg ppm	S %DM	Mn ppm	Cu ppm	Zn ppm	Fe ppm	B ppm	Mo ppm	Na ppm	Al ppm
	Standard leaf analysis (range)	From	4.84		0.52		5.41		2.07		0.36		0.31	1069	10	63	127	20	0.43	147	246
		To	4.84		0.52		5.41		2.07		0.36		0.31	1069	10	63	127	20	0.43	147	246
30-Jun	Initial leaf analysis		2.830	5106	0.5106	36874	3.6874	26311	2.6311	20220	2.022	4613	0.4613	159	16.2	78.5	175	25.4	not tested		
12-Nov	T1		2.056	2025	0.2025	10578	1.0578	43303	4.3303	15455	1.5455	5138	0.5138	116	3.0	28.8	105	16.3	not tested		
	T2		2.547	2725	0.2725	11512	1.1512	38383	3.8383	15023	1.5023	6019	0.6019	122	3.1	29.7	107	16.6			
	T3		2.795	4001	0.4001	15135	1.5135	38540	3.8540	14459	1.4459	6703	0.6703	117	3.5	30.0	117	18.5			
	T4		3.995	6442	0.6442	25879	2.5879	33485	3.3485	11827	1.1827	6543	0.6543	124	4.9	33.1	128	20.4			
	T5		2.422	2062	0.2062	12099	1.2099	42456	4.2456	16158	1.6158	5794	0.5794	113	4.9	37.1	116	16.7			
	T6		2.249	1738	0.1738	8665	0.8665	42722	4.2722	16693	1.6693	5133	0.5133	106	3.0	31.2	92	13.9			

Key:
Higher than standard range
Within standard range
Lower than standard range

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Appendix 10. **Prunus lusitanica *'Myrtifolia'. Treatment effects. Final assessment, week 42, 20 October 2020***

	
T1 – No liquid feed	T2 – 0.5% once per week
	
T3 – 1.0% once per week	T4 – 0.5% every watering
	
T5 – 1.0% feed to need	

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Appendix 11. *Spiraea arguta*. Treatment effects. Final assessment, week 42, 20 October 2020

	
T1 – No liquid feed	T2 – 0.5% once per week
	
T3 – 1.0% once per week	T4 – 0.5% every watering
	
T5 – 1.0% feed to need	

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Appendix 12. **Geranium x cantabrigiense 'Westray'**. ***Treatment effects. Final assessment, week 43, 27 October 2020***

	
T1 – No liquid feed	T2 – 0.5% once per week
	
T3 – 1.0% once per week	T4 – 0.5% every watering
	
T5 – 1.0% feed to need	T6 – 1.0% feed to need #2

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Appendix 13. ***Tradescantia pallida** 'Purple Sabre'. Final assessment, week 43, 27 October 2020*

	
T1 – No liquid feed	T2 – 0.5% once per week
	
T3 – 1.0% once per week	T4 – 0.5% every watering
	
T5 – 1.0% feed to need	T6 – 1.0% feed to need #2

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