Grower Summary

Developing Nutrient Management Recommendations for Selected Horticulture Crops

HNS 200

Interim report

Project title:	Developing Nutrient Management Recommendations for Selected Horticulture Crops.
Project number:	HNS 200.
Project leader:	Jill England, RSK ADAS Ltd.
Report:	Annual report, June 2023.
Previous report:	N/A
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Date project commenced:	1 April 2019

DISCLAIMER

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

AUTHENTICATION

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

David Talbot

Senior Horticulture Consultant

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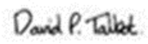
Signature ....  .... Date ....21 June 2023................

Dr Jill England

Technical Director, Head of Horticulture

ADAS

Signature ....  .... Date ....21 June 2023................

GROWER SUMMARY

Headline

- Under low soil mineral N (SNS Index 0) and Magnesium (Mg) (Index 1) indices, growth of *Betula pendula, Carpinus betulus* and *Crataegus monogyna* was not increased by additional fertiliser nitrogen (N).
- No difference in mean plant height was obtained when *Betula pendula, Carpinus betulus* and *Crataegus monogyna* were fertilised with standard or slow-release N fertilisers.

Background

Field HNS growers typically use single nutrients known as straights (e.g., ammonium nitrate) or compound fertilisers (containing mixes of nitrogen (N), phosphorus (P) and potassium (K) fertilisers or nitrogen (N) and sulphur (S), with limited use of slow / controlled release fertilisers in some crops. Some nurseries carry out regular soil analysis to find out what levels of P, K, and magnesium (Mg) are present in soil to help determine rates of fertiliser to apply. Soil sampling for soil mineral nitrogen (SMN) is less common than sampling for P, K & Mg however there has been increased interest in this approach following the rapid increase in fertiliser N prices in 2022. In the past, some nurseries have not historically carried out regular soil analysis and have instead applied the same rates of fertiliser every year, regardless of soil nutrient indices / crop need. Some of those that do carry out regular soil analysis sometimes struggle to interpret the results The situation is complicated by the fact that there are no readily accessible standard fertiliser recommendations for field, soil-grown HNS species for UK growers. The most recent recommendations were published in 1988 in the 5th Edition of RB209 (MAFF, 1988) Soil testing for P, K, Mg, and pH is now a legal requirement in England under the Farming Rules for Water (FRfW).

Because of the high value of field grown HNS in relation to the price of fertiliser (despite recent high N prices), the cost of the fertiliser and its application is not always considered. Many growers use historic application rates of fertiliser rather than analysis-based application rates, which can result in excessive use of nutrients. However, there is the potential for savings to be made which can contribute to improved profitability (refer to financial benefits).

Growers must also comply with legislation such as limits on the amount of N (a total N limit of 250 kg/ha) contained in organic materials such as manure or green compost that can be applied in Nitrate Vulnerable Zones (NVZs) to prevent the pollution of water. There are no Nmax limits for manufactured nitrogen fertiliser applied to HNS in the NVZ rules. In England 55% of land is in a designated NVZ. Fertiliser production and usage directly contributes to greenhouse gas emissions and hence climate change so efficient use of N fertilisers is vitally important in the horticulture sectors transition to net zero. High levels of P should be avoided (above Index 3) as surface run off (particularly where soil erosion is a problem) can transport phosphates into water courses.

Maintaining an unnecessarily high P index is considered bad practice as it increases the risk of P loss to water and further legislation such as the implementation of phosphate vulnerable zones. There are not currently any phosphate vulnerable zones in the UK but in Northern Ireland phosphate regulations are now part of their nutrient action programme – since January 2020, there are restrictions on the maximum phosphate fertiliser applications allowed in certain situations.

A better understanding of the nutritional needs of field grown HNS species, and the optimum type of fertiliser for HNS could help to optimise crop nutrition. For example, fertilisers containing muriate of potash (potassium chloride) can scorch the foliage and result in slow establishment of some ornamental chloride-sensitive genera; potassium sulphate is a more suitable K source for ornamental crops (Lindberg, B. and Cregg, B., C., 2022). The potash in muriate of potash (MOP) is fully available to plants. High rates of application should be avoided at crop establishment particularly when placed next to the seed, as this can inhibit germination or damage the seedling. MOP is suitable for all arable crops and grassland. The chloride content can be a disadvantage in certain specialist horticultural crops. Although sulphate of potash (SOP) is generally regarded as a relatively high cost source of potash for application to soil in agriculture, but a very important source of nutrient in horticulture, suitable in situations where both potash and sulphur are required or where chloride is a concern. (The fertiliser directory materials guide).

Aim of the trial: To determine the impact of novel fertiliser application methods on plant nutrient status and evaluate crop nutrient assessment methods (soil electrical conductivity (EC), tissue analysis or leaf chlorophyll measurement) to provide data that correlate most closely to crop nutritional needs.

Year 2

Objective 1: To further evaluate / validate the soil and tissue analysis methods used in year one for correlation with crop nutritional needs on up to three commonly grown species from three vigour groups (high, medium, and low)

Objective 2: Establish baseline nutritional information for specific crops (i.e., seedlings, vigour groups).

Objective 3: To compare crop nutrient status as a result of different fertiliser delivery systems (i.e., straight or compound fertilisers, slow-release N).

This project is comprised of three work packages:

WP1. HNS (field and container) Literature review

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

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

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

Summary

During 2022 a field tree nutrition trial was carried out on field grown *Betula pendula* (high vigour), *Carpinus betulus* (low vigour) and *Crataegus monogyna* (medium vigour) 1+1 transplants, post planting in their second year of growth using the host nursery's standard rate of fertiliser, Treatment 2, Table 1.

Table 1. 2022 Field tree trial year two treatments, quantities of products applied in kg/ha. Quantities of nutrients supplied to each treatment in kg /ha hectare are shown as footnotes below this table.

Treatment number	Product (name)	Nutrient content	Application 1 June, Rate (kg/ha)	Application 2 July, Rate (kg/ha)	Application 3 August, Rate (kg/ha)
1. Untreated	-	-	Untreated	Untreated	Untreated
2. Grower standard[1]	Origin 27% N (27 - 0 - 0 + 10 SO3)	NS Compound	90	90	
	Potash Plus (0 – 0 – 37 – 23 SO3 – 8 Mg0 – 8 Ca)	MOP, KCL, Polysulphate, Ca + Mg	125	-	-
3. Straight N, P, K, Mg[2]	Origin 27% N (27 - 0 - 0 + 10 SO3)	NS Compound	186	186	186
	Tripple super phosphate (0 - 46 - 0)	TSP	55		
	Sulphate of Potash (0-0-51+18 S03)	SOP	148		
	Kieserite (16% Mg)	Mg0	313		
4. Straight N (Floranid N31), P, K, Mg[3]	Floranid N31 (31% N)	N	323	162	
	Tripple super phosphate (0 - 46 - 0)	TSP	55		
	Sulphate of Potash (0 - 0 -51+18 S03)	SOP	148		
	Kieserite (16% Mg)	Mg	313		

Actual nutrient content applied in kg/ha by treatment:

[1]The grower standard treatment supplied two applications of 24.3 kg/ha N. In addition, the following quantities of nutrients were supplied at application 1: 46.3 kg/ha K, 37.8 kg/ha SO3,10 kg/ha Mg & 10 kg/ha Ca. 9 kg/ha SO3 was applied at application 2.

[2]Treatment 3 supplied three applications of 50.2 kg/ha N. In addition, the following quantities of nutrients were supplied at application 1: 25.3 kg/ha P, 75.5 kg/ha K + 45.2 kg/ha SO3, and 50.1 kg/ha Mg. 18.6 kg/ha SO3 was applied at application 2 and 3.

[3]Treatment 4 supplied 100.1 and 50.2 kg/ha N at applications 1 & 2 respectively. In addition, the following quantities of nutrients were supplied at application 1: 25.3 kg/ha P, 75.5 kg/ha K, 26.6 kg/ha SO3, and 50.1 kg/ha Mg.

2022 Field Tree Trial

This field tree nutrition trial was set up in 2022 at Wyevale Nurseries, Transplant division, Ledbury, Herefordshire on three different species of transplants. Transplants were planted as one year old graded field grown seedlings of *Betula pendula, Carpinus betulus* and *Crataegus monogyna.* The one-year-old cold stored seedlings were planted on a standard system of four crop rows on a 1.2 m wide bed in loamy sand soil in late spring, plots were 3 m long. The aim of the work carried out was to determine if slow-release forms of nitrogen impacted on plant nutrient status and growth and evaluate crop nutrient assessment methods (soil electrical conductivity (EC), tissue analysis or leaf chlorophyll measurement) to provide data that correlates most closely to crop nutritional needs. Floranid N31 was used as the slow-release N straight fertiliser, 3% of granules are coated with urea, the remaining 90% are coated in IBDU. The urea component requires microbial activity to release N as temperatures rise and the IBDU is broken down by the presence of water at 4°C and above, the product also contains a proportion of readily available N. This gives an activity index of 98 – 99%; meaning that almost all the N can be taken up by the crop, preventing leeching – the product also has a low salt index. Standard straight fertilisers (e.g., Origin 27% N & 10 SO3) are much more prone to leaching following heavy rainfall.

Betula pendula were 60 – 80cm (high vigour), *Crataegus monogyna* were 40 – 60 cm (medium vigour) and *Carpinus betulus* (low vigour) were 20 – 40 cm transplants. These species were chosen as they are important species grown in large numbers, they also vary in vigour so were categorised into vigour groups.

The fertiliser used are listed in **Table 1**. Leaf tissue analysis, measurements of the chlorophyll content of leaves (using an atLEAF hand-held device), soil EC, water content and temperature were carried out throughout the growing season. The height of selected young trees was also measured at the start of the trial and at the end of the growing season to determine differences in growth between treatments. Crop height is the main measure of crop performance for the grower.

The soil was loamy sand. Soil analysis was taken prior to fertiliser application (see **Table 3, Science section).** Topsoil samples (0-15 cm) were taken for pH and extractable P, K and Mg, and soil mineral nitrogen samples were taken to 90 cm. The site was SMN Index 0, P Index 3, K Index 2+ and Mg Index 1; P, K and Mg levels were below the target levels in RB209 5^{th} edition.

There were no statistically significant differences (*P*>0.05) in mean height measurements between treatments (including the untreated controls) in all three species when measured in weeks 30, 34 and 37.

There were no statistically significant differences (*P*>0.05) in mean chlorophyll content between treatments or species measured by the atLEAF 30 at any of the assessment dates.

There were no statistically significant differences (*P*>0.05) in leaf tissue analysis results between treatments within species. Results from tissue analysis, compared with published figures, indicated that levels of some major and micronutrients were either low or high in all species / treatments combination throughout the growing season (see **Table 5**)

Discussion

There was no effect of fertiliser treatments on crop growth (assessed by height measurements) in *Betula, Carpinus* or *Crataegus* within this trial during the 2022 growing season. The fact that plants performed equally well where fertiliser NPK and no fertiliser was applied despite the low SNS (P index 3, K index 2+) indicates a low requirement for additional nitrogen However, the potential for a crop response to additional fertiliser NPK may have been limited by the very dry and hot summer of 2022. Less irrigation was applied to the trial plots during 2022 compared to a typical growing season due to a limited supply of water in the reservoir and the need to prioritise irrigation for crops with the highest irrigation need (e.g., first year seedlings). It is estimated that around 40% less irrigation was applied to trial (and much of the commercial crop on the nursery) compared to an average season, due to limited water resources. Monitoring the soils moisture content showed the soil to be consistently dry at the three assessment dates when soil volumetric water content was measured (see **Appendix 5**). The host grower reported a significant impact on growth during 2022 due to a combination of high temperatures inducing periods of crop dormancy during the growing season, drought is also thought to have impacted on crop growth compared to an average season.

This is the second year of fertiliser response experiments on HNS. The first year was in 2019 and tested the effect of broadcast compared to band spread application of nitrogen fertiliser. Results from the first year showed no growth response to N, and it was suggested that this may be as the species tested have a low requirement for N. This second fertiliser response experiment has also shown no response to N, and although the response to N may have been limited by the drought, the two years of no fertiliser N response despite low SNS index at both sites is an important result for growers and indicates that *Betula, Carpinus* and *Crataegus* requirement for N may be less than previously thought.

There was no correlation between chlorophyll content and growth in *Betula pendula, Carpinus betulus* or *Crataegus monogyna* at the soil N, P, K and Mg indices tested with and without fertilisers.

Conclusions

- No difference in growth (determined by height measurements) occurred within species between any of the three test subjects where no fertiliser was applied or where fertiliser was broadcast over plots. However, the hot and dry weather during summer 2022 may have affected crop growth and limited the response to fertiliser.
- Good nutrient management is fundamental to economic and environmentally sustainable crop production by helping growers match inputs of nutrients (in fertiliser and organic materials) to crop demand.
- Soil testing for pH, and extractable P, K and Mg is now a legal requirement for farmers in England under the Farming Rules for Water. Growers must test their soil at least every 5 years.
- Field grown HNS growers should aim to maintain soil at P Index 2, K index 2 and Mg Index 2, which is consistent with target index values for arable and fruit crops published in RB209.

Financial Benefits

The host nursery application of 180 kg/ha 27-0-0+10S, (27% N), P, K, Mg and Ca fertiliser cost £323/ha. The slow-release form of N (Floranid N31) is more expensive per kilogram of N than the grower standard fertiliser. Floranid N31 is described by the manufacturer as providing a controlled release of N over a period of 3-4 months. Controlled/slow-release fertilisers can help reduce N losses to the environment and therefore ensure more of the N is available to the crop. The use of controlled release N fertiliser is likely to be most beneficial in wet years when there is risk of fertiliser N leaching below rooting depth following heavy rainfall.

There was no difference in growth between any of the treatments within any species including the untreated plots that received no fertiliser (where N and Mg was the only likely limiting factor). Although this implies these species have a low N requirement, the hot dry conditions of 2022 may have limited growth and response to fertiliser. *Betula* may not have a high N requirement for growth as it readily naturally colonises heathland and other habitats that are naturally low in N. These results indicate that there may be potential for growers to reduce N applications on these species (growers typically apply 150 kg N/ha) whilst maintaining crop growth.

A modest reduction of 30 kg N/ha to typical fertiliser N application rates would save growers £34/ha at current fertiliser prices of £390/tonne of Ammonium Nitrate (AHDB, 2023).

Action Points

- Test soil for pH, P, K and Mg at least every 5 years and ideally every 3 years. Aim to keep soil at P Index 2 and K Index 2-. There may be no need to apply additional fertiliser P and K above these target soil indices.
- Assess soil nitrogen supply (SNS) using guidance in AHDB Nutrient Management Guide. Consider sampling for soil mineral nitrogen (0-90 cm) to further improve N management.
- Review current N application rates to field grown HNS and consider whether reductions can be made.