Project title:	Developing Nutrient Management Recommendations for Rhubarb
Project number:	SF172
Project leader:	Angela Huckle, ADAS Boxworth
Report:	Annual report, 31 March 2020
Previous report:	None
Key staff:	Dr Ewan Gage (ADAS), Senior Horticulture Consultant Angela Huckle (ADAS), Senior Horticulture Consultant Chris Creed (ADAS), Senior Horticulture Consultant Dr Clive Rahn (Plant Nutrition Consulting) Dr Richard Weightman (Independent)
Location of project:	Barfoots Farms Ltd., Hammonds & Sons Ltd.
Industry Representative:	Neil Cairns, Barfoots Farms Ltd.Sefter Farm, Pagham Road, Bognor Regis, W. Sussex, PO21 3PX Philip Lilley, T H Hammond & Sons, New Farm, Redhill, Nottingham, NG5 8PB Lindsay Hulme-Oldroyd, E Oldroyd and Sons, Hopefield Farm, The Shutts, Leadwell Ln, Rothwell, Leeds, LS26 0ST

Date project commenced: 1 April 2019

Date project completed 31 March 2023

(or expected completion date):

DISCLAIMER

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.

Angle Huckle

Senior Horticulture Consultant

ADAS

Signature   Date 12/8/20

Dr Ewan Gage

Horticulture Consultant

ADAS

Signature   Date 12/8/20

Chris Creed

Senior Horticulture Consultant

ADAS

Signature   Date 12/8/20

Report authorised by:

Dr Barry Mulholland

Head of Horticulture

ADAS

Signature   Date 12/8/20

1 Contents

1. Grower Summary 5

1.1 Headline 5

1.2 Background 5

1.3 Summary 6

1.4 Action points 11

1. Grower Summary

1.1 Headline

- Significant variation is seen in nutrient management recommendations for commercial rhubarb production, cultivation methods and nutrient management approaches for commercial practice. Variation in rates, timings and method of application present additional challenges when developing best practice recommendations.
- Pre-emergence nitrogen applications do not have any significant impact on early season yield or total nitrogen offtake.
- Early season, pre-emergence nitrogen applications did not have an impact on first pull harvests.
- It is likely that early season production draws on reserves of nutrients and sugars in the crown to achieve additional growth, and so pre-emergence nutrient applications may not have a significant impact of subsequent initial yields.
- Nutrient management later in the season, especially when the crop is developed and more capable of assimilating nutrients, may have a greater impact than pre-emergence nutrient applications.
- There is further scope for crown-based analysis to be used to inform subsequent yield estimates and nutrient management approaches.

1.2 Background

Rhubarb is currently produced in over 550 ha of land in the UK, and while this is a niche crop it can achieve a high market value, especially early season forced rhubarb. Rhubarb is a perennial crop, with petioles harvested from crowns in the early spring and the crop remaining in the ground for up to five years. This creates a complex nutrient management problem – growth is seen in the early season when fertilisers are not normally applied due to high rainfall, and the crown creates an additional (if not predominant) source of nutrients for early growth in addition to newly-absorbed nutrients. The influence of crop productivity and growth in the previous year, coupled with nutrient applications that may be spaced over several months to correspond with postharvest applications of multiple harvests, makes it difficult to track and interpret crop requirements to achieve peak nutrient use efficiency. Recommendations for rhubarb are significantly out of date and may not reflect current practice such as the use of multiple selective pulls or include references to practices that are no longer suitable (e.g. manure use). Other cultural approaches which include the use of wool waste (“shoddy”) and the discarding of leaves onto the soil surface and a secondary source of nutrients add further layers of complexity to understanding the nutrient supply in a dynamic, multi-season environment. There is a pressing need for growers to have clear guidance as to optimal nutrition management in rhubarb so as to maximise yield productivity whilst minimising the economic and environmental cost of application. This project was undertaken to address these specific knowledge gaps and to use the data to update the nutrient management manual (RB209). The work will address the following objectives:

1. To update information on nutrition and feeding for rhubarb
2. To determine whether additional feeding of green rhubarb increases yield, quality and season length when pulled multiple times during a season
3. Knowledge exchange to include provision of speakers for AHDB or third parties events throughout the project duration
4. To update relevant sections of the Nutrient Management Guide (RB209)

1.3 Summary

Initially a literature review and sector survey was carried out to define current and recommended approaches to nutrition management in rhubarb. This demonstrated that whilst a limited range of cultivars were grown (predominately Timperley Early, Stockbridge Arrow) and some common cultivation approaches were followed such as multiple (up to three) harvests with a level of selective pulling and split nutrient applications there was significant variation against this background.

Existing recommendations are for 175 kg N/ha at SNS 2 during establishment, split between before and after initial crop growth, followed by applications of 70 – 300 kg N/ha in established crops (RB 209, 5th Ed.). Assuming yields of 15 – 20 tonnes/ha and total nitrogen (N) content of 7.2% (Allison, 1966), crop offtake is 60 – 85 kg N/ha, considerably lower than recommended applications (although this does not take into account any N accumulation in the crown). The impact of splitting N is likely to vary depending on the ability of the crop to uptake and utilise it, although this may have greater impact on sandy soils by extending the period over which N is available before significant leaching can occur. From the growers interviewed, current standard practice was to apply 100 – 250 kg N/year, typically split into 50 – 100 kg N per cut although a variety of products were used. Growers targeted N dosage based on current crop conditions, past history and intended marketing/harvest schedule although growers were concerned that too little N would adversely affect yields, whilst excessive application would promote flowering. It is noteworthy that the consensus application of 150 kg N/ha and above is greater than the typical recommendations of RB209. Similar variation was seen in other nutrients, although the impact of N applications was considered to be a priority for examination as this is likely to have the greatest effect on the yield outputs. Therefore, experimental activities in the first season were targeted to examining the impacts of N application.

Of primary focus was the interaction between total N application and application timing relative to pre-emergence/postharvest applications. Secondary to assessing direct yield influences, there was also significant interest in examining the influence of the crown on both yield and nutrient management approaches. A trial was developed that explored these areas on mature rhubarb crops at two contrasting grower sites (due to climate and soil type) in the north and south of England of the 2020 season as the first of three seasonal trials of these aspects.

The outputs of the literature review were used to refine an experimental approach for the 2020 season as a preliminary step of evidence generation to update RB209. The primary focus of the 2020 season will be an accurate determination of the N requirements of commercially grown rhubarb in an established crop. N is likely to have the greatest impact on yield (both in terms of over- and under-application), and evidence needs to be generated relating to the optimisation of both the quantity and timing of nitrogen applications. Single applications may reduce labour requirements but may lead to increased leaching or oversupply at a single point at the season (depending on soil type, rainfall, rooting depth etc.), potentially reducing the impact of the crop to generate yield in a multiple pull system. Conversely, the timing of multiple applications may have an impact on the magnitude of a response – will early applications (when the crop is breaking dormancy and soil moisture likely to be at a peak) give the greatest impact, or will later applications on an emergent crop (with increased potential to absorb and use soil nutrients) give a greater response? Timings of nitrogen application may also feed forward into crop quality and scheduling potential, or complement different requirements between cultivars.

Based on the evidence outlined above, three key elements were identified that were to be prioritised for examination in the trials work in this project:

1) Nitrogen Requirements – As identified in the literature review, there is significant breadth in recommended rates of N for establishing and mature rhubarb crops. As this is likely to have the most significant impact on marketable yield, both in forced and field-grown rhubarb, this will be prioritised.
2) Timing of applications – Similarly, routine support is found for splitting applications between different periods of the season in both recommendations and current grower practice. However, the timing of such applications, and the partitioning of feed between different points in the season (e.g. pre-emergence or between harvests) is poorly documented. This will build on the outputs of 1) but allowing further optimisation of nutrient applications, particularly by
3) Fine-tuning Nutrient Applications – Considerable grower interest was seen in the potential to better manage nutrient and yield outputs, such as coupling easy-to-

measure indicators of crop condition with application, or using crop nutrition as a control mechanism for yield quality and scheduling.

Points 1) and 2) will be addressed in a single trial run over two seasons in which N application rates, and partitioning between three applications points, will be trialled. **Table 1** below summarises the initially proposed rates and timings of a variable N application trial, which are compared against recommended rates and current grower practice identified in the literature review. The total N application rates cover the range of rates discussed above, so the trial will capture the breadth of variation seen in current commercial practice, allowing closer examination of the impact of different N application rates on crop responses. It is proposed that these are applied at three timing categories (100% before emergence, a large pre-emergence application followed by two smaller applications or a smaller pre-emergence application followed by larger post-harvest applications). In this fashion the scenarios discussed will be tested in the field to allow ideal responses to be identified. It is proposed this trial design is applied to selected grower holdings to test the impact of cultivar selection, field condition and prevailing climate on optimum nitrogen response.

Table 1. Trial design nitrogen application trials to be followed in field trials. Rate category 1 represents current practice, with category 2 providing an additional 100 kg N/ha, and category 3 an additional 200 kg N/ha. Timing categories represent full application as a pre-emergence application (category 1), 60% pre-emergence application followed by two 20% further applications (before the second and third harvests, category 2) or equal applications of 30%, 35% and 35% (category 3).

Treatment Number	Timing Category	Rate Category	Application Point (kg N/Ha)			Total Applied (kg N/ha)
			Pre-Emergence	Pre-2nd Crop	Pre-3rd Crop	
1	1	1	175	0	0	175
2	2	1	105	35	35	175
3	3	1	53	61	61	175
4	1	2	275	0	0	275
5	2	2	165	55	55	275
6	3	2	83	96	96	275
7	1	3	375	0	0	375
8	2	3	225	75	75	375
9	3	3	113	131	131	375

The trial was located in a crop of Timperly Early for both trial sites; the grower hosts ensured that neither site received any N fertiliser, digestate or organic manure from autumn 2019. Site 1 (Romsey, Southampton) was on sandy clay loam, while site 2 (Redhill, Nottingham) was on sandy loam. Soil analysis were obtained for both sites (**Table 1**), and lime, phosphate and potash were applied as appropriate to ensure nutrients were not limiting. SNS indices at both sites were Index 0. The plots were marked out in January 2020 and measured 7 m x 3.8 m and consisted of four beds, with an experimental trial area of 42 m by 20 beds and a total trial area of 72 m by 28 beds. Four rows on either side of the trial area and 15 m either end act as guards to eliminate the edge effect. Callisto and Stomp were applied by the grower on the 7th of February to limit early season weed development. Site 1 applied lime at 6 t/ha and K at 150 Kg K_20/ha as recommended by RB209 across the whole site to ensure that these nutrients are not limited, and Site 2 applied K at 250 Kg K_20/ha across the trial area.

Table 1. Soil analysis and existing recommendations for rhubarb fertilisation. * This was applied in January ** taken at a depth of 0-60cm as the 60-90cm layer was too hard

		Index				Soil type
Site	pH	P	K	Mg	SMN (0-90cm) kg N/ha	
1	6.0	4	3	3	38.6**	Sandy clay loam
Amount recommended (old RB209)*	6 t/ha	0	150 kg K_2O/ha	0	-	
2	7.18	4	1	2	15.7	Sandy loam
Amount recommended (old RB209)*	0	0	250 kg K_2O/ha	0	-	

Due to COVID-19 lockdown, it was only possible to carry out the first application of N and a single harvest before subsequent work on the trial was suspended. However, crop yields, marketability and nitrogen offtake were examined from the single harvest that was possible. Significant variability was observed for crown and bud number, particularly at Site 1, which in turn produced highly variable yield outputs between plots. Gross and marketable yield showed no significant correlation with nitrogen application at either site (**Figure 1**), and there was no significant trend in any marketable quality indicators, such as stick size and color.

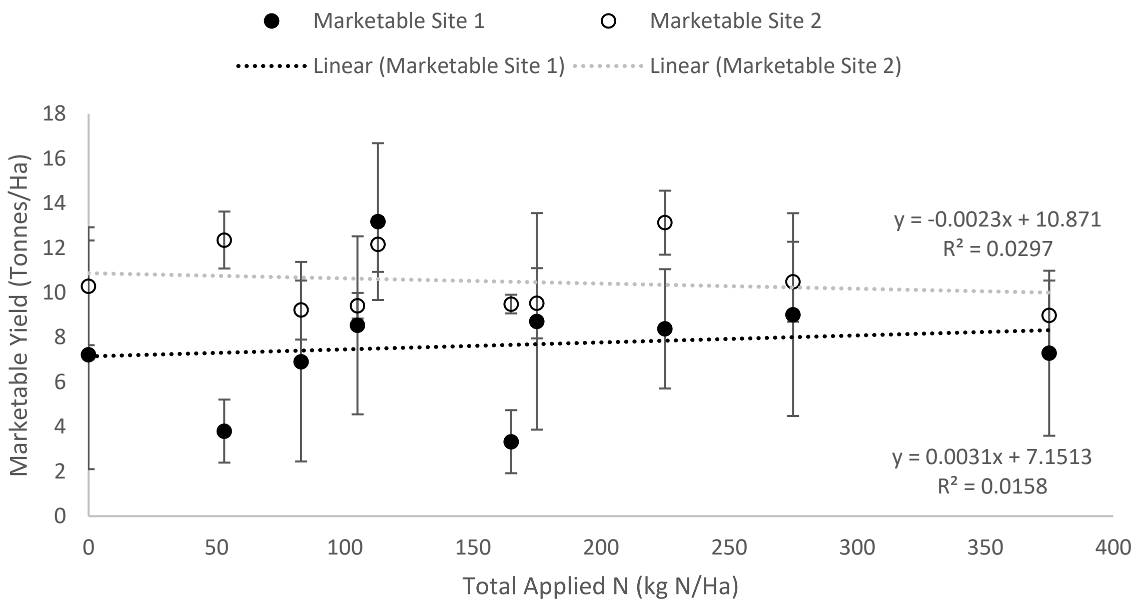

Figure 1. Marketable yield per crown per Ha (standardised to a crown density of 12.5k/Ha), averaged across plots at site 1 and site 2.

No significant differences were seen in dry matter N content in above ground biomass between N applications at either site, and this translated to a lack of any significant trend between N application and offtake at the first harvest (**Figure 2**). These results suggest that pre-emergence N application does not have a significant impact on yield or N offtake, at least during the first harvest. The older crowns at site 1 showed a greater N content (2.2%) compared with those at site 2 (1.7%), and while evidence relating to crown weights at each site prevents analysis of whole-crown N content on a per hectare basis, this may indicate that older, more established crowns may have greater N reserves than smaller crops.

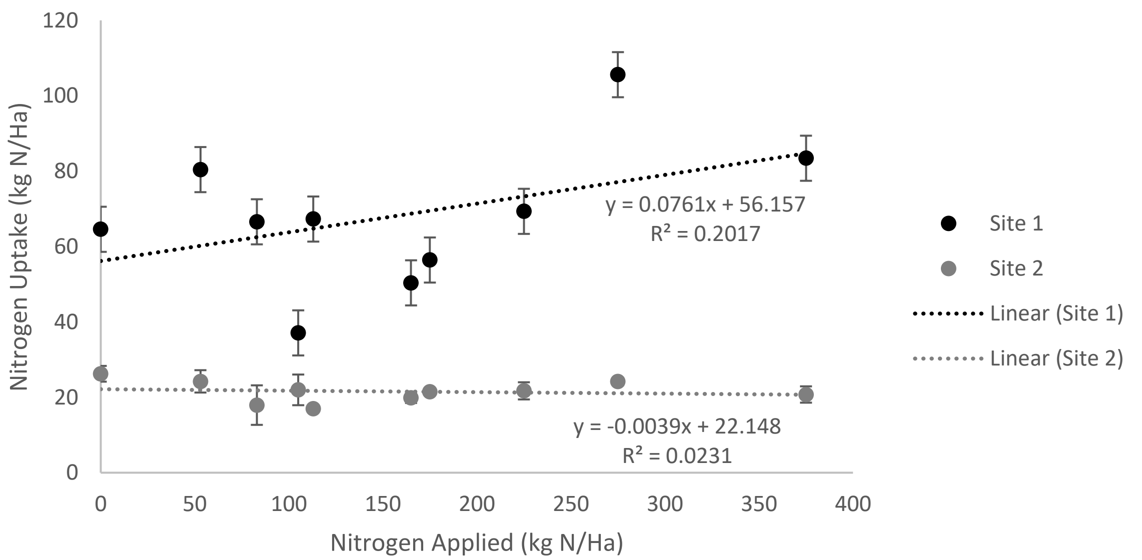

Figure 2. Nitrogen uptake per Ha based on combined leaf and stick samples.

The lack of a significant N response in the early season is likely a reflection that initial growth is dependent on the crown for both energy and nutrients, using stores that were accumulated in the previous season. This may be a favourable approach for the crown – low soil temperature, reduced root occurrence and high energy costs of absorbing nutrients may limit the ability of the crown to provide sufficient nutrients to the developing petioles. Internal sources would be used until the crown becomes fully established and is able to fully accommodate the nutrient and energy requirements of new growth and accumulate nutrients for the following season. Therefore, early N applications may be unnecessary for the crown to provide sufficient nutrients.

However, if crowns have had poor reserves from the previous season (e.g. young crowns, under application, excessive harvesting or excessive weed competition), they are less able to draw on internal resources and may benefit from early season applications.

How this interacts with consequent harvests remains to be shown. While we have been unable to fully explore N applications in rhubarb in the 2020 season, these results will enable us to review and update our approach in subsequent seasons to maximise our ability to review the nutrient in a commercial rhubarb crop.

1.4 Action points

- Consider reducing or removing pre-emergence nitrogen applications in field-grown rhubarb, and instead increase the proportion of nitrogen applied later in the season. This may increase the proportion that can be actively taken up by the crop without negatively impacting early season yields.