



Agriculture & Horticulture
DEVELOPMENT BOARD



Grower Summary

FV 418

Baby leaf lettuce: N response studies to maximise yield and manage nitrate levels

Final 2014

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HDC is a division of the Agriculture and Horticulture Development Board.

Project Number: FV 418

Project Title: Baby leaf lettuce: N response studies to maximise yield and manage nitrate levels

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Previous report/(s): None

Start Date: 01 April 2013

End Date: 31 January 2014

Project Cost: £27,000

Headline

- Mean crop nitrogen (N) offtake of baby leaf lettuce was estimated at 63 kg N/ha which should be used as a baseline guide for determining crop N requirement,
- If background soil mineral nitrogen (SMN) prior to drilling is > 60 kg N/ha, further N applications are unlikely to be necessary.

Background

Nitrate is viewed as a contaminant of leafy vegetables, and limits for its control are set in EU legislation. In northern Europe including the UK where the growing season is short and the weather is often dull during crop growth, nitrate levels tend to be higher than in southern European states. Recent work in the UK funded by HDC has examined the nitrogen (N) responses of baby leaf rocket and spinach, and led to development of N recommendations for optimising yield, and minimising tissue nitrate concentration (TNC) in baby leaf salad crops (HDC Factsheet 08/13). In addition to its effects on TNC, the recent studies showed that over-supplying baby leaf rocket and spinach crops with fertiliser N can actually cause a reduction in yield, when the crop has adequate supplies of N from the soil.

The project aims were to gather robust and independent data on nitrate levels in commercial baby leaf lettuce crops, and determine the yield response to nitrogen fertiliser, taking into account varietal types (red vs green), soil mineral nitrogen prior to drilling, soil type and previous cropping.

The objectives were to:

- quantify yield responses to N on growers sites (representative soil types across the season) and determine optimum N needed to produce a marketable crop while remaining below the proposed EC limit for TNC of 3,000 mg/kg fresh weight,
- evaluate the extent to which yield response to fertiliser N can be predicted from soil mineral nitrogen (SMN) measurements taken prior to drilling,
- critically assess N offtake as a way to measure crop N demand, and for the grower provide a better way of estimating fertiliser N requirement.

This work therefore provides a basis for recommendations for N fertiliser for baby leaf lettuce, as there are currently none in the Fertiliser Manual (RB209; Defra, 2010).

Summary

Yield response

Five sites were chosen for the N response studies to represent the geographical spread of UK baby leaf lettuce growers. Six individual N responses for red (one Red Cos and two Red Batavia) and green baby leaf (Green Cos, Green Tango and Green Batavia) lettuce varieties (three of each colour/variety type) were obtained. Sampling was carried out through the summer into early autumn, representing the full duration of the UK growing season and covering both first and second crops. Topsoil (pH, P, K, Mg) and SMN samples at 0-30 cm depth were taken prior to drilling and prior to application of fertiliser N at each site. Nitrogen fertiliser as calcium ammonium nitrate was applied at six rates of 0, 40, 80, 120, 170 and 220 kg N/ha post drilling.

Significant yield responses to applied N were only seen at two locations (Sites 13/1 and 13/2) where initial background SMN was at or below 30 kg N/ha prior to applying N treatments (Figure 1). At these two sites, further applications of N above 40 kg/ha (Site 13/1) or 80 kg N/ha (Site 13/2) had no significant effect on yield.

In the remaining four response data sets (Sites 13/3, 13/4 & 13/5) where the initial SMN was 116 – 265 kg N/ha, yield declined with addition of fertiliser N indicating that N was becoming toxic to the crop at these levels (Figure 1).

Tissue nitrate concentration

The 3,000 mg/kg limit for TNC was exceeded at a number of the sites, with modest amounts of N applied as follows:

- 40 kg N/ha applied at Site 13/2,
- 80 kg N/ha at Site 13/3,
- 120 kg N/ha at Sites 13/1 & 13/4.

Of the two sites which showed a significant yield response to applied N, Site 13/2 had the additional problem that at 40 and 80 kg N/ha applied, its TNC levels were 3,090 and 3,221 mg/kg respectively. Hence, it could not be recommended that fertiliser N be applied to this crop, given this exceedance of the legal limit.

The only site therefore at which an N application for yield could be recommended, and at which the crop would also stay below the limit for TNC, would be Site 13/1 (with 40 kg N/ha).

Differences between red and green baby leaf types

Based on the fresh weight yields at the recommended N rates for yield and TNC (recommended N rates, 40 kg/ha for Site 13/1, and zero for the remaining sites), the average yield for the red types was just under half the yield at 17.9 t/ha, of the green types at 31.6 t/ha. This average assumed only 50% of the Green tango type would have been harvested; if the gross yield of this variety was used, the average yield of the green types was 43.2 t/ha).

TNC levels were similar overall between colour types: Red; 2,549 & 2,633 mg/kg and green; 2,344 & 2,938 mg/kg, at 40 and 80 kg N/ha respectively of applied N fertiliser averaged across the six data sets. However at one site (13/5) where Green and Red varieties were grown side by side in the same experiment, the Red Cos had significantly lower TNC overall than the Green Batavia type (1,921 vs 2,547 mg/kg).

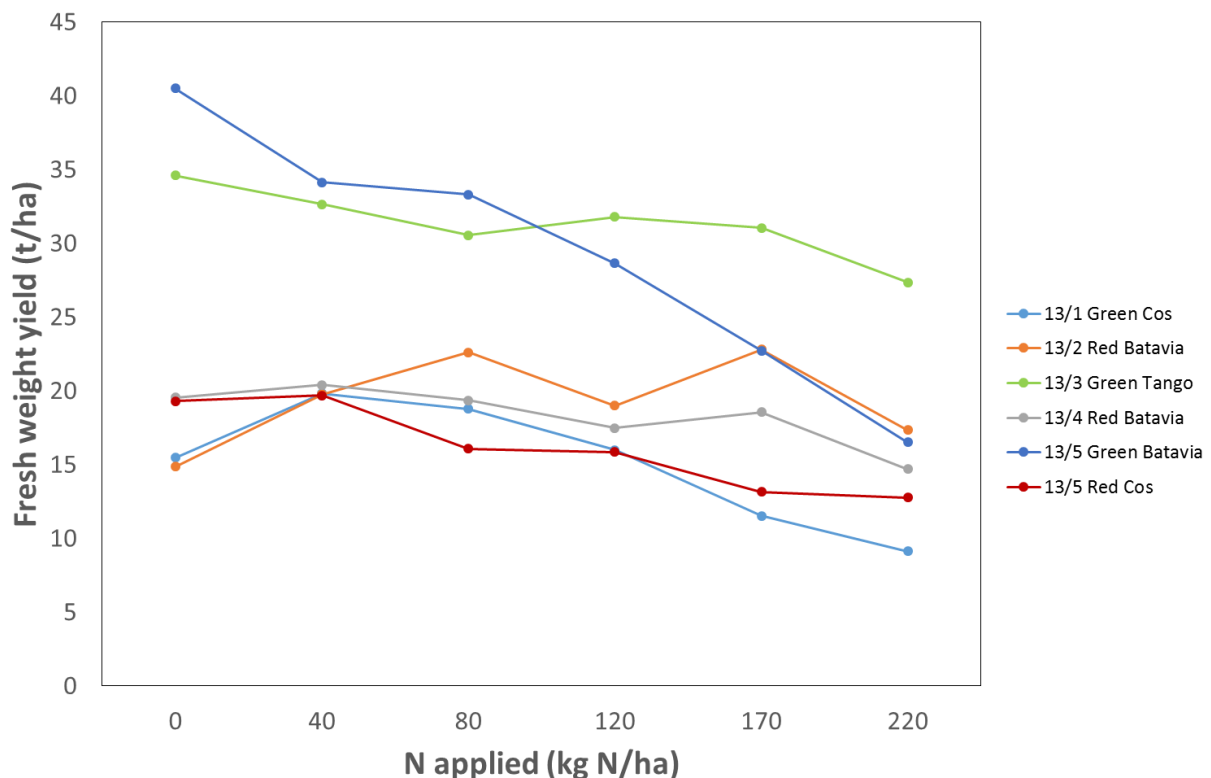


Figure 1. Effects of applied N fertiliser on fresh weight yield at four commercial production sites in 2013

N Recommendations

A key factor in determining an appropriate N recommendation is an estimate of total N uptake. Prior to this study there were no such estimates of this for baby leaf lettuce.

Across five of the data sets, based on averages of the three highest levels measured across the N rates tested, total N uptake varied between 48 and 79 kg N/ha, with an average across five data sets of 63 kg N/ha. The exception was Site 13/3, the crop of Green Tango with an N uptake of 140 kg N/ha reflecting its higher gross yield.

A total uptake of 63 kg N/ha is just over half that of the wild rocket crop, and explains in part why there was such a small response to applied N in these studies. Four of the sites had SMN (0-30 cm) at drilling greater than 100 kg N/ha, which was more than sufficient to satisfy a crop N requirement of this magnitude.

The two sites with lower SMN at drilling (27-30 kg N/ha) would be expected to require only around 55 kg N/ha as fertiliser N, assuming all the SMN was recovered by the crop, and 60% fertiliser recovery. This agrees broadly with the actual responses seen at 40 and 80 kg N/ha applied at sites 13/1 and 13/2 respectively, the early season crops.

Financial Benefits

The area of baby leaf lettuce has increased from 79 ha in 2007 to 274 ha in 2012, worth £10M at retail level and the area grown is expanding year on year. There is a requirement for continued vigilance on nitrate levels, and the industry as a whole needs to demonstrate to the Food Standards Agency and the European Commission that it is endeavouring to reduce nitrate in leafy salad crops. Failure to address the problem may result in increased losses due to rejection of crop, and potentially loss of this and other leafy salad crop species in the UK if growers cannot comply with Commission (and/or retailers) limits.

Action Points

- Baby leaf lettuce crops grown in the summer of 2013 were at risk from exceeding the limits set for TNC in outdoor lettuce of 3,000 mg NO₃⁻/kg,
- As found in previous HDC-funded work on wild rocket and baby leaf spinach, the risk was particularly high for the late season crops, when SMN builds up in the rotation due to soils warming, plus mineralization of N from soil organic matter, and residues from previous crops in the current and past seasons,
- A major finding is that with the exception of the Green Tango 'multi-leaf' type there was an average crop requirement for N of only 63 kg N/ha, approximately half that of wild rocket, meaning that recommended amounts of N for baby leaf lettuce are likely to be lower than those defined in HDC Factsheet 08/13,

- Based on such a low N requirement, in most cases, with a low SNS e.g. index zero (30-60 kg N/ha, 0-30 cm) at drilling, the crop is only like to need a maximum of 60 kg N/ha applied as fertiliser N,
- With SMN levels above 60 kg N/ha at drilling, it is likely that no further N will be required by baby leaf lettuce crops,
- Recommendations may be adjusted upwards if the grower has their own higher estimates of typical yields and N uptake for crops in their land, and can therefore justify a higher N requirement.