Grower Summary

FV 370a

Wild Rocket: N response studies to manage and reduce nitrate levels

Final 2011

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Further information

If you would like a copy of the full report, please email the HDC office (hdc@hdc.ahdb.org.uk), quoting your HDC number, alternatively contact the HDC at the address below.

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Project Leader:	Richard Weightman
Contractor:	ADAS
Industry Representative:	Graham Clarkson, Vitacress
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Headlines

- Use of high levels of nitrogen fertiliser applied to wild rocket significantly increased tissue nitrate concentration (TNC) at harvest and hence the risk of exceeding the 6,000 mgNO_3/kg limit set by the European Commission;
- Mean crop nitrogen (N) offtake of wild rocket was estimated at 110 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 > 65 kg N/ha, further N applications are unlikely to be necessary;
- In this study, at only 80 kgN/ha fertiliser applied, 25% of samples exceeded the 6,000 mgNO_3/kg limit.

Background

The preceding HDC funded project (FV 370), conducted in 2010 indicated that 25% of commercial wild rocket crops would exceed the 6,000 mg NO_3/kg limit to be implemented by the European Commission in 2012. Since there had been no scientific studies at this point to quantify the response of wild rocket to N fertiliser, work was needed to determine an optimum N rate for recommendation to growers. FV 370 also indicated that many fields had very high levels of soil mineral nitrogen (SMN) prior to sowing (>300 kg N/ha) and it was not clear to what extent these should be taken into account by growers. Estimating crop N requirements can be difficult as soil N supply is determined by a combination of soil type, previous crop and N applications to it, the amount of over-winter rainfall, mineralisation of N from soil organic matter (OM) and the amount of N applied to preceding crops and their N offtakes, and finally how much N is mineralised from crop residues within the current season.

Taking into account currently observed best practice by working with commercial growers, this project aimed to gather robust and independent data on nitrate levels in wild rocket, and how they are affected by previous crop residues, soil type and different rates of N fertiliser.

The project was divided into two specific objectives:

1. To gain information on N responses on grower's sites (representative soil types across the season) and determine optimal N to produce a marketable crop while remaining below the EC limit of 6,000 mg NO_3/kg fresh weight,
2. To determine whether residues from incorporated previous crops affect subsequent N response and to what extent this can be predicted from SMN measurements.

Summary

Yield responses

Six sites were chosen for the N response experiments to represent the geographical spread of UK wild rocket growers. 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, using a standard 12 point W-shaped sampling pattern, and soil samples were bulked to provide a single analysis for the whole trial for background SMN.

Significant yield responses to applied N were only seen at two sites (numbers 11/1 and 11/6) where initial background SMN was at or below 65 kg N/ha prior to applying N treatments (Figure 1). At these two sites, further applications of N above 40 kg/ha had no significant effect on yield.

No significant effect of N applied on leaf greenness (measured by a SPAD meter) was seen, showing that reducing application rates of nitrogen should not affect the quality of the crop in terms of colour.

Across the six sites, based on averages across the three highest levels of applied N at each site, N offtake varied between 37 and 169 kg N/ha, with an average across all six sites of 108 kg N/ha. At three of the sites (11/1, 11/3 and 11/6) there was a significant response of N offtake to applied N, broadly mirroring the trend in yield responses.

At site 11/2 the crop failed to emerge where treatment 6 (220 kg N/ha) was applied in addition to the initial background SMN of 183 kg N/ha. Higher fertiliser nitrogen treatments applied at sites 11/3 and 11/5 where initial the SMN was > 100 kg N/ha also caused a yield decrease to occur, indicating that N is becoming toxic to the crop at these levels.

In a second, separate study specifically designed to investigate the effects of incorporating residues from a previous wild rocket crop SMN was also very high and as a results there was no significant effect of applied fertiliser N, and yields apparently declined in response to increasing N (as at site 11/5).

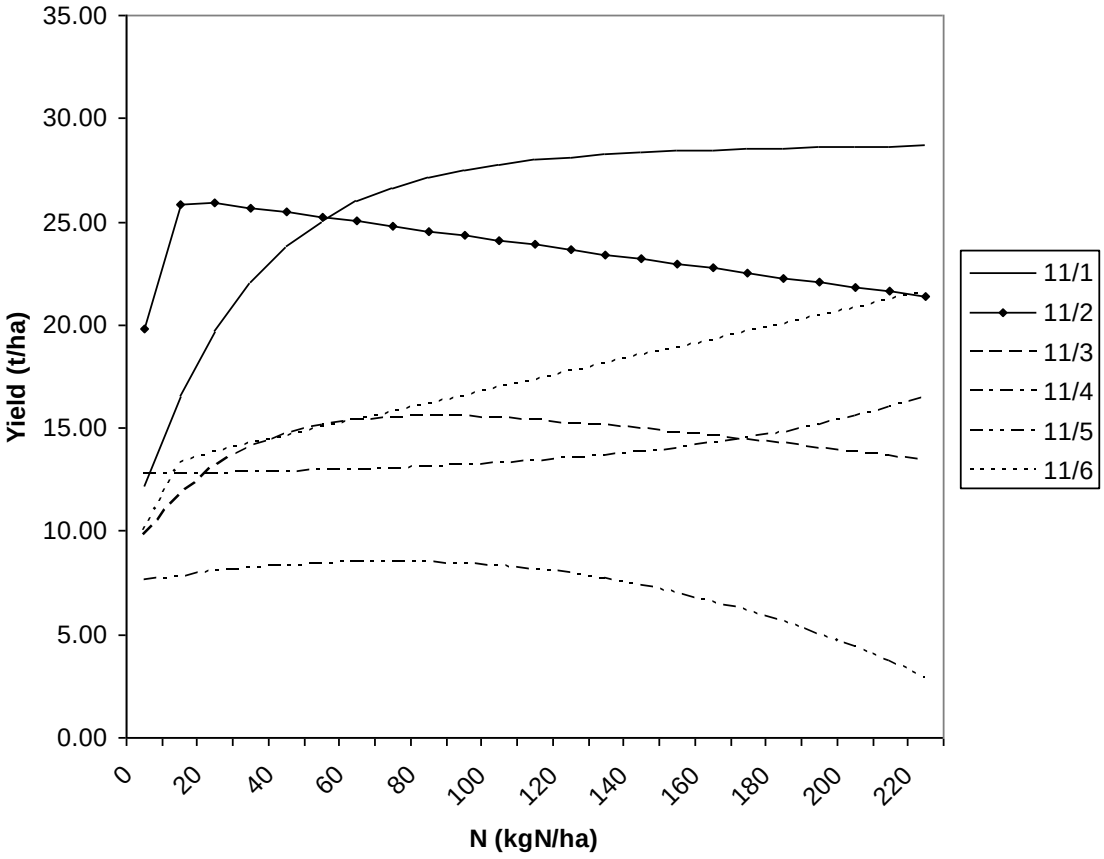

Figure 1. Effects of applied N fertiliser on fresh weight yield at six commercial production sites in 2011.

Tissue nitrate concentration

Applied N had a significant effect on tissue nitrate concentration (TNC). At five of the six sites in Study 1, mean TNC exceeded the 6,000 mg NO_3/kg EU limit at the highest levels of N applied. At three of the six sites, mean TNC exceeded the limit with 120 kg N/ha applied.

At four sites (11/3, 11/4, 11/5 & 11/6) mean TNC was within about 500 mg NO_3/kg of the limit (5,442, 6,393, 5,804 & 5,862 mg NO_3/kg respectively) with only 80 kg N/ha applied. Importantly, individual measurements of TNC from these sites showed that 25% of samples harvested exceeded the 6,000 mg NO_3/kg limit at this 80kg/ha N application rate. Furthermore, in Study 2, which had very high levels of initial SMN, all N treatments exceeded the 6,000 mg NO_3/kg limit.

Residual soil mineral nitrogen

Reflecting the relatively poor response of crop yield to applied N, at all sites a significant positive relationship was seen between N applied, the SMN remaining after harvest and also

TNC at harvest. In Figure 2, final SMN at harvest is plotted against total available N (applied fertiliser N plus initial SMN). This shows that where more than 200 kg N/ha is available to the crop, much of it remains in the soil post-harvest.

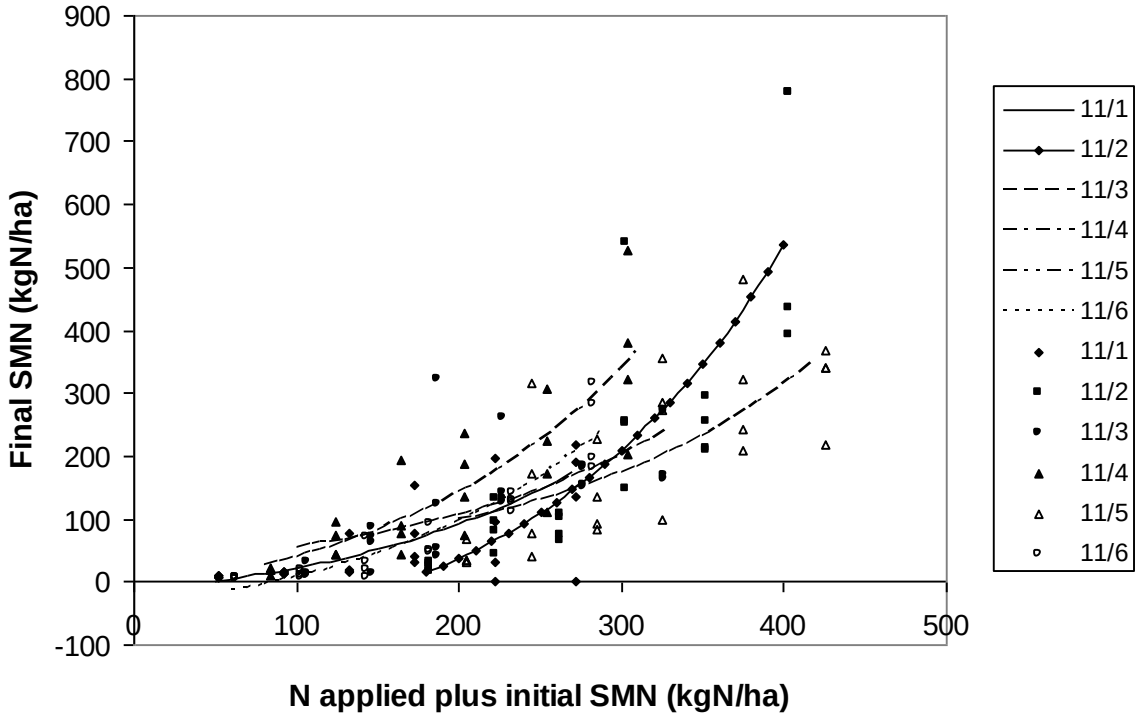

Figure 2. Effects of N fertiliser applied and background SMN, on final SMN at harvest in N response experiments at six commercial growers' sites in 2011.

Financial Benefits

The UK market for rocket is worth ca. £52M at retail level, based on the annual volume of 3,619 tonnes of crop grown in 2010.

This study suggests that current typical commercial practice of applying 120 kg N/ha may result in 50% of crops exceeding the 6000 mg NO_3/kg limit if they are managed similarly to those we looked at.

This work is therefore of major strategic importance in protecting this market, and underlines the need for a better understanding of soil N supply in soils used for fast growing leafy salad crops such as wild rocket. For growers in Nitrate Vulnerable Zones, the results also demonstrate a clear risk of nitrate pollution which could also threaten the industry with respect to the Nitrate Directive, and the need to maintain nitrate in drinking water at less than 50 mg/litre.

Action Points

- When determining fertiliser N application rates, take into account the potential background SMN from soil type, over winter rainfall and previous cropping.
- Also take into account applications of N to preceding crops within the current season, as well as mineralisation of N from soil organic matter between soils warming in spring and actual drilling of the crop.
- Where background soil mineral nitrogen (SMN) prior to drilling is > 100 kg N/ha, no further N applications are likely to be necessary.
- With SMN pre-drilling of up to 65 kg N/ha, an application of ca. 40-80 kg N/ha may be sufficient to meet crop N demand.
- At very low SMN and on light soils, with low levels of soil organic crop matter or crop residues, applications of up to 120kgN/ha may be justified for maximizing crop yield, but there may still be a risk of exceeding the limits for TNC.
- Consider recording SMN, crop yields and N offtakes for your particular location and cropping system to provide an evidence base for improved fertiliser N recommendations in the future.
- Where possible, avoid growing rocket at sites with SMN over 120-150 kg N/ha, particularly when continued mineralisation of residues is likely to contribute to soil N supply, as crops run a high risk of exceeding the TNC limit of 6,000 mg NO_3/kg.
- Avoid supplying more than 200 kg N/ha in total (SMN + fertiliser N) to the wild rocket crop, as this will significantly increasing the risk of nitrate leaching and hence environmental pollution after harvest.