Grower Summary

FV 350a

Quantifying over-winter nitrogen requirements of the leek crop

Final 2014

Disclaimer

The results and conclusions in this report may be based on an investigation conducted over one year. Therefore, care must be taken with the interpretation of the results.

Use of pesticides

Only officially approved pesticides may be used in the UK. Approvals are normally granted only in relation to individual products and for specified uses. It is an offence to use non-approved products or to use approved products in a manner that does not comply with the statutory conditions of use, except where the crop or situation is the subject of an off-label extension of use.

Before using all pesticides check the approval status and conditions of use.

Read the label before use: use pesticides safely.

Further information

If you would like a copy of this 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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GROWER SUMMARY

Headline

- Up to 100 kgN/ha of supplementary N, (in addition to RB209), applied in early autumn increased marketable crop yield.
- However, 100 kgN/ha supplementary N may leave appreciable crop residues and soil mineral nitrogen after harvest, which need to be factored in before fertilising the next crop (see HDC Factsheet 09/12 Soil Nitrogen Supply for field vegetables).

Background

In recent years, our understanding of the nitrogen (N) requirements of leeks has improved because of HDC funded work. Project FV 350 broadly validated the revised fertiliser recommendation for modern F1 hybrid leeks within the 2010 version of the Fertiliser Manual (RB209). The Manual states that no more than 100 kgN/ha should be applied in the seedbed to leek crops. The remainder of the N should be applied as a top-dressing when the crop is fully established, but recognises that an additional top-dressing of 100 kgN/ha may be required on all soils except peat, depending on the appearance of the crop, to support growth and colour. This additional 100 kgN/ha would often be applied in the autumn/winter closed period for fertiliser applications.

Under NVZ rules, no N should be applied to leeks during the closed period (1st September – 15th January) unless supported by written advice from a FACTS qualified advisor. Given the increased scrutiny of N applications under NVZ rules, and the recent setting of Nmax values for vegetables, there is a need to better understand the N requirement of leeks, particularly from October through to harvest the following spring. The information from these experiments aimed to provide guidance on how to match fertiliser applications to crop N requirements of over-wintered leeks, based on assessments of crop N status, and soil mineral nitrogen (SMN) prior to application of fertiliser.

The objectives were to:

a) establish three field experiments within commercial leek crops, representing early, mid and late maturity crops,

b) study the effects of timing and rate of N applied as well as the effect of a nitrification inhibitor during the over-winter period on leek yield,

c) measure the marketable yield, biomass and total N uptake by the three leek crops in the 2013/14 winter period,

d) measure return of N to field in non-marketable crop and hence value to following crops,

e) measure residual SMN after harvest, and hence assess use of additional nitrogen applied and its potential benefit to following crops,

f) assess the usability of crop N status and SMN measurements as tools to predict the benefits from over winter applied fertiliser N.

Summary

Materials and methods

Work was carried out in three different commercial leek crops, representing early, mid and late maturing varieties in the 2013/14 season. All crops were grown on light sand land sites in North Nottinghamshire, with low soil nitrogen supply (SNS) indices in the range 0 to 2, where positive responses to N fertiliser would be expected.

Up until the end of September 2013, and before applying any supplementary N, crops were fertilised with commercial application rates (guided by RB209). Nil N areas were also retained in each field to gain a measure of SNS during the autumn and winter periods, and at the end of the experiment.

Experimental treatments assessed responses to both the rate of supplementary N (up to 100 kgN/ha for early and mid maturity crops, and up to 150 kgN/ha for the late maturity crop) and its timing (fertiliser N applied in 50 kg/ha increments) on marketable yield, non-marketable crop fractions, and total N offtake (and hence N requirements).

Immediately before each application of supplementary N, a measurement of crop N status and SMN was made, the last being in March 2014 for the late maturing crop (subsequently harvested in April 2014). At final harvest, crops were processed into marketable and unmarketable fractions according to a commercial protocol.

It should be noted that the results are based on a single mild season, in previous work (FV 350) too much N led to an increased risk of frost damage in colder winters.

Effects of the main N application

At the early and mid maturity leek sites, the main N application (the ‘control’ application for experimental purposes) by the grower increased marketable yields by 28 and 13 t/ha respectively compared to yields of the nil N areas of the crop. These observations broadly support the recommendations given in RB209.

At the late maturity site, however, there was no increase in yield in response to the main N application. With an initial SNS index of 2, a positive response to N would have been expected. Interestingly, SMN stayed about 10 kgN/ha higher in the leek rooting zone (0-60 cm depth) in the late maturity crop compared to the early and mid crops, from the end of the summer, and through the autumn and winter period. Perhaps more significantly, the late maturity crop had a much lower total N uptake in October compared with the other two crops suggesting that its slower rate of development represented a lower N requirement early in the season. Information in the literature on patterns of growth and N accumulation in different leek maturity types remains scant. Furthermore, the leek type selected for the timing of maturity scheduling is not accounted for in RB209.

Nitrogen economy of the crop

The leek crops took up appreciable quantities of N during the autumn/winter periods, based on the measured uptakes of N in the supplementary treatments. This was also the case for the late maturity crop, which showed no yield response to the main N application. Total N uptake was significantly increased by supplementary N, and was 50 kgN/ha greater in the early and late crops, and 75 kgN/ha greater than the control in the mid maturity crop. The important question however is whether this uptake is beneficial to yield or the appearance / quality of the crop, or whether it just leads to more N in crop or soil residues; this may have deleterious effects for the environment if the following crops do not make use of it.

Effects of supplementary N application on marketable yields

Taking into account the supplementary N treatments, there was only a small effect on total fresh weight yield when the effects were averaged across the different timings and N rates, but supplementary N always increased the yield of marketable plants.

When the individual supplementary N treatments were studied in more detail, timing of application appeared to affect the proportion of marketable plants. In all experiments, the main reason for the improvements in the proportions of marketable plants was a reduction in the number of undersized plants rejected (based on shaft thickness).

Across the three crops, the results can be summarised as follows with respect to supplementary N applied during autumn/winter:

- Supplementary N in October (50 kg/ha) gave a higher proportion of marketable plants than in November,
- Where 50 kg/ha N was applied in November or later, the proportion of marketable plants decreased.

- There was no significant effect of the rate of supplementary N applied, but an indication in the late crop that 100 kgN/ha or more N decreased marketability.

- Entec (100 kgN/ha) applied at the start of autumn only showed small benefits in terms of marketable yields.

NB Control treatments (figures in parentheses show Fertiliser Manual recommendations): Early site, 202 (200) kgN/ha; Mid Site, 240 (200) kgN/ha; Late Site, 183 (170) kgN/ha.

N residues left after harvest

Supplementary N increased the N offtakes by the marketable crop, but also increased the N in the unmarketable crop fractions and residues. It also increased residual SMN left after harvest. Applying 50 kgN/ha as supplementary N left on average 45, 17 and 36 kgN/ha, whereas applying 100 kgN/ha left 210, 67 and 128 kgN/ha (0-90 cm depth) for early, mid and late maturity crops respectively, compared to the control in each experiment. This is additional to the N left in crop residues and unmarketable fractions of the crop referred to above. Clearly if this N is not taken into account when making fertiliser recommendations for the following crop, then such supplementary N treatments pose a risk of diffuse pollution on these light soils in the subsequent season, if not captured by the following crop.

The following crop can benefit directly by requiring less fertiliser N itself because of a higher SNS, or after processing vegetable wastes through an anaerobic digester, with N being returned in digestate. The gap between harvesting the leeks and establishing the future crop will dictate how much N will be of benefit on these light sands (see HDC Factsheet 09/12 Soil Nitrogen Supply for field vegetables, Rahn 2012).

Measurements of crop and soil N status

Measurements of crop N status and chlorophyll concentration index (SPAD readings) were able to detect differences between nil-N and control treatments, but were not useful for discriminating between the control and supplementary N treatments. In other words, these measures were not useful in identifying those crops which might respond to supplementary N in the autumn/winter period. This might be because even where adequate N status is measured, at a single point in time, it cannot anticipate potential growth and hence predict future crop N requirement. However where CNS is consistently high, this indicates that further N may not need to be applied. To do so may increase the susceptibility of the crop to frost damage and hence appreciable economic loss.

The leek crops did appear to have a crop N requirement (based on evidence from total N uptake) but since it did not have a significant impact on total fresh weight or marketable yield, this should be considered 'luxury' uptake.

Conclusions

Fifty kgN/ha applied in early autumn (October/November) to the early crop increased the proportion of marketable plants. There was no evidence, however, that applying this supplementary N in late winter/early spring was beneficial for this crop. There was evidence that applying 100 kgN/ha in early autumn was beneficial to marketable FW yields (but not proportion of crop harvested) in the early crop, but at such levels of application, appreciable amounts of SMN and crop residue N were left after harvest. These residues of N would need to be taken account of when fertilising the next crop.

For the mid maturity crop, the comparable supplementary N treatment actually had 90 kgN/ha applied in total above the RB209 recommendation (40 kg/ha by the grower + 50 kgN/ha supplementary N). This was beneficial to marketable yields and did not leave excessive SMN behind after harvest. The largest responses to supplementary N were seen in the mid maturity crop. However there was no benefit of supplementary N for the late crop.

These results are in line with the guidance in the Fertiliser Manual that up to 100 kg N/ha may be beneficial in the autumn. The main N application as recommended in the Fertiliser Manual is about right, but selected cropping situations warrant further study; for example, to more effectively manage N applications for the slower growing late harvested crop.

This research underlines the fact that leek growers need to take advice before applying supplementary N in the autumn, particularly in NVZ areas.

Financial Benefits

Based on an average increase in marketable yields of 12 t/ha where a yield response to 50 kgN/ha of supplementary N was seen, a price of N at £1/kg N, and trimmed produce in trays ex-packhouse at £850/t, the financial benefit would be over £10,000/ha. However, all crops clearly took up N in the over winter period, and there is a risk that the crops could be more susceptible to frost damage in a hard winter. Excess N applied in the autumn could cause a crop loss equivalent to £21,000/ha based on an average marketable yield of 25 t/ha.

Action Points

- Follow the recommendations provided in the Fertiliser Manual (RB209) when deciding on the main N application to the leek crop,
- Leeks appear to respond to up to 100 kgN/ha of supplementary N in early autumn (October/November), which can be used to increase the proportion of marketable plants and/or marketable yields,
- There is an indication that late maturing crops may not need this N until later in their growing season, so it may be sensible to delay such applications until after the main danger of frost has passed, however in this study, late applications of N appeared to reduce the proportion of marketable plants,
- There appears to be little benefit in using an N fertiliser product containing a nitrification inhibitor to provide supplementary N, as it may not release the N quickly enough to benefit the crop in October/November,
- Measurements of crop N status appear to have some potential to identify crops with no further fertiliser N requirement, but more information is needed on CNS of different maturity types in relation to their patterns of growth before they can be used as diagnostic tests to predict the benefits of applying supplementary N,
- If applying supplementary N in the closed period then a FACTS qualified advisor must provide a written recommendation,
- Despite the potential benefits, crops over-fertilised with N can become more frost sensitive. The experiments described here were carried out in a very mild winter, with no major periods of frost or snow, but if the winter had been harsh, then marketable yields could well have been lower with supplementary N,
- Take into account the N from crop residues and unmarketable plants and any residual SMN from supplementary N applications when making fertiliser recommendations for the following crop (see HDC Factsheet 09/12 Soil Nitrogen Supply for field vegetables).