Grower Summary

FV 350

Nitrogen Requirement of Leeks

Final 2011

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Headline

This project provides more relevant guidelines for fertiliser recommendations in leeks by accurately assessing the N requirements of modern F_1 hybrid leek varieties to achieve their full potential yields.

Background and expected deliverables

During 2007/08, the basis for the nitrogen (N) fertiliser recommendations for field vegetable crops in the Fertiliser Manual RB209 was made more transparent. The recommendations for leeks were revised, however, there was little evidence to support the application of nitrogen during the closed periods in Nitrate Vulnerable Zones. The Leek Growers Association recommended that research was required to support applications of nitrogen for over-wintering crops.

This project aimed to validate the revised fertiliser recommendations for modern F1 Hybrid leeks, contained within the 2010 Fertiliser Manual (Defra 2010). The work also aimed to provide a basis for improved N recommendations for leeks in future revisions of the Defra Fertiliser Manual (Defra 2010).

The work looked to provide justification of the need for supplementary N fertiliser during the (closed) overwinter period where it is necessary to comply with Nitrate Vulnerable Zone regulations. New strategies to synchronise N supply to N demand in order to make more efficient use of N, especially for crops grown on very light soils were looked at. A basis for later improvements to be made to the WELL_N model to provide more accurate fertiliser recommendations was looked at.

Summary of the project and main conclusions

- The results support the revised fertiliser recommendations published in the 2010 edition of the Fertiliser Manual - RB209 (Defra 2010)
- Where leeks are to be harvested in the autumn, the application of additional nitrogen in August and September is justified
- For over-wintered crops, when summer N requirements are met, additional nitrogen may cause reductions in yield due to frost intolerance
- It is important to make allowances for the soil N supply within rooting depth at drilling/planting

In 2009 and 2010, field trials were established to test the response of over-wintered leeks (cultivar Belton) on a sandy loam site at Wellesbourne. Table 1 contains an overview of the main trial details (full details are contained in Appendix 2 of the Science Section). The key findings from both of these experiments are presented in this summary. The full findings are contained in the Science Section in the 2010 and 2011 project reports.

Table 1. Overview of the Wellesbourne field trials.

Start date	Nitrogen treatments	Mineral N at planting (kg/ha) to 90 cm (Index)	Fertiliser recommendation, kg/ha N	Main Harvest date
1 Apr 2009	Response curve to 480 kg/ha additional N at 240 kg/ha summer N level.	54 (0)	200	2 Nov 2009
19 Jul 2010	Response curve to 500 kg/ha additional N at 150 and 200 kg/ha summer N levels.	79 (1)	190	11 Apr 2011

In 2009/10, nitrogen fertiliser, up to a rate of 360 kg/ha N, was applied (as ammonium nitrate) in late May and late June, with additional amounts of 60 kg/ha in August, September, and January, February 2010. One further treatment rate of 480 kg/ha N was used, split between May and August 2009. In 2010/11, the main dressings of nitrogen were applied in August and September, with 25 kg/ha N applied at planting and additional amounts of 50 kg/ha N applied in September, October and January, February 2011.

In the 2009/10 trial, field assessments showed that most of the growth and N uptake occurred between August and November, with little occurring beyond December, and only a

small amount in spring 2010. The crop was severely affected by frost in January 2010 and failed to produce any marketable yield at a final harvest in April 2010.

In the 2010/11 trial, most of the growth and N uptake occurred between August and December, despite a later planting date. The crop was severely affected by frost in December, resulting in the loss of dry matter, although the crop had partially recovered by the main harvest in April.

The main aim of the experiments was to test the response of a leek crop to additional amounts of fertiliser in the autumn/spring period. The main questions were:

- In 2009/10, was 180 or 240 kg/ha N the most appropriate amount? (Figures 1 & 2)
- In 2010/11, was 150 or 200 kg/ha the most appropriate amount?
- Were these amounts of fertiliser sufficient to supply the crop N requirement through to the spring without additional applications?
- Where additional fertiliser was required, how much should be applied?

Figure 1 (left): Leek crop in September 2009 where 240 kg/ha N had been applied, split equally between 2-3, 3-4 leaf stages (A nil N plot can be seen to the far right)

Figure 2 (right): Leek crop in September 2009 where 180 kg/ha N had been applied; split equally between 2-3, 3-4 leaf stages.

The results from the trials help to answer these questions (Table 2). In the 2009/10 trial where no nitrogen fertiliser was applied, crop growth was only 40% of that where 240 kg/ha N had been applied, and marketable yield from the unfertilised treatment was severely reduced. Where 180 kg/ha N was applied, crop growth up until November was almost the

same as with 240 kg/ha N. Unfortunately, the crop failed to overwinter due to severe weather, so results presented are from the November assessment of marketable yield. Marketable yield was slightly higher where 180 kg/ha N had been applied rather than 240 kg/ha N, but not as high as where 240 kg/ha N had been applied with an additional 60 kg/ha N in both August and September.

The 2010/11 trial also suffered from severe winter weather, but at an earlier stage of growth than in 2009/10, so was able to recover to produce yield of marketable quality in April. There was a clear response up to 200 kg/ha summer applied N. Fresh weight marketable yield declined when higher amounts of N were applied. Where only 150 kg/ha N had been applied in the summer there was benefit in applying an additional 50 kg/ha N. October applied N was marginally more effective than N applied in September or the spring. More than 50 kg/ha additional N was not beneficial. Where 200 kg/ha N had already been applied, there was a depression in yield where further N was applied in the autumn, and no benefit where additional N was applied in the spring. This was associated with the interaction between N in the crop and tolerance to the severe winter conditions.

Table 2. Relative marketable yields in November 2009 and April 2011. Responses to additional N applied at Wellesbourne, where sufficient summer N had been applied. Percentage of yields: relative to 28 t/ha where 240 kg/ha N was applied in 2009, and relative to 22.1 t/ha where 200 kg/ha N was applied in 2011.

Growing season	Main N amount (kg/ha)	% Yield at 200 or 240 kg/ha N	Additional N applied*					
			Aug	**Sep**	**Both**			
2009/10	nil	15						
	180	109	nd	nd	nd			
	240	**100**	116	nd	123			
	360	93						
	480	118						
			Sep	**Oct**	**Both**	**Jan**	**Feb**	**Both**
2010/11	nil	0						
	75	43						
	150	72	84	90	71	84	85	79
	200	**100**	59	74	56	82	81	83
	300	78						
	500	72						

* 60 kg/ha N was applied at each timing in 2009 and 50 kg/ha N in 2010.

nd – not determined

From the measurements of N offtake in the crop, it is possible to estimate fertiliser recovery. Within a month of establishment, recovery was less than 3% of the N applied as fertiliser. Only by September 2009 and October 2010 did recovery reach around 30% of that applied. Any excess fertiliser N would be extremely susceptible to loss whilst the crop and its roots were still poorly developed. However, even by harvest, fertiliser recovery was less than 50%, and was lower in the poorer crop in 2011 (Table 3).

Table 3. Estimated fertiliser recovery in 2009 and 2010 experiments at Wellesbourne.

Date (2009/10 trial)	% Fert. recovery	Date (2010/11 trial)	% Fert. recovery
25 Jun 2009	2		
22 Jul 2009	12		
19 Aug 2009	22	17 Aug 2010	3
22 Sep 2009	34	15 Sep 2010	13
2 Nov 2009	47	18 Oct 2010	26
14 Dec 2009	46	13 Dec 2010	41
2 Feb 2010	46	22 Feb 2011	33
6 Apr 2010	42	14 Apr 2011	37

These results help to explain why earlier experiments (Goodlass et al., 1997) showed yield responses to high levels of fertiliser nitrogen, as it is likely that the fertiliser had been applied too early for efficient utilisation by the shallow rooted leek crop.

It may be that the higher dry weight yield in the 2009/10 trial (10.7 t/ha compared with 5.6 t/ha in 2010/11) explains the difference in response to the additional 100 kg/ha N application between the two growing seasons. Furthermore, the results of the 2009/10 trial suggest that even on fertile sites, well supplied with available N (represented by the high early N plots in the experiment), there might still be a response to additional nitrogen in August and September for an autumn harvested crop. This was not supported by the results in the 2010/11 trial where additional autumn applied N led to reduced yields. However, it must be borne in mind that this crop was planted later, suffered from severe low temperatures, and produced relatively disappointing yields.

The recommendations for leeks in the Fertiliser Manual (Defra 2010) remain valid but need to be tested at a wider range of soil N supply indices. The recovery of N mineralised from soil organic matter in the leek crop was much lower than expected and also requires some further investigation.

The trials at Wellesbourne were supplemented by the monitoring of commercial crops in 2009, 2010 and 2011, at sites representing the main growing areas of leeks in England. The results of this monitoring suggest that the commercial sites were well supplied with nitrogen, with some showing 120% of the critical N level (N status = 1.2) for a given dry matter yield, even at harvest. Figure 3 compares the results at Wellesbourne with the commercial sites in the 2010/11 season. The best yields at Wellesbourne were obtained where the crop had an N status of 0.9 and 200 kg/ha N (W-200) had been applied.

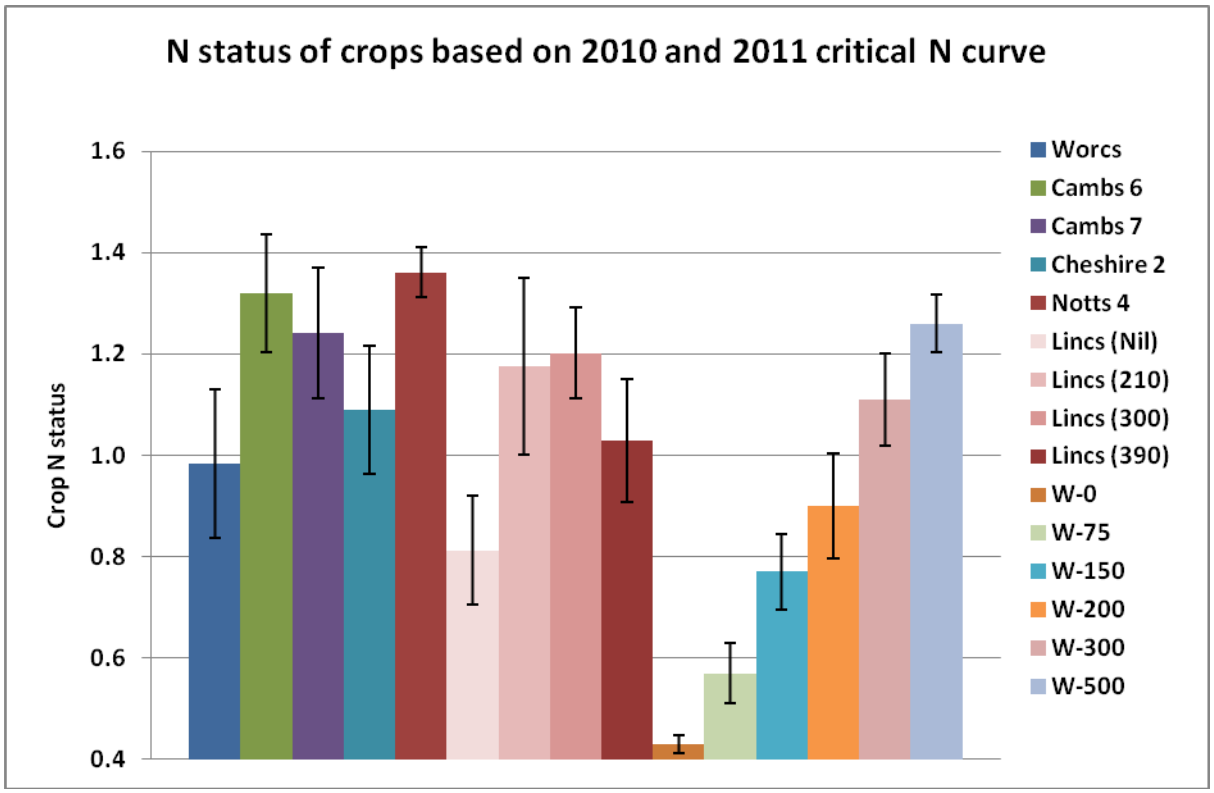

Figure 3. N status of crops in Spring 2011. Data from commercial sites with Wellesbourne (W) for comparison.

At both the commercial sites and at Wellesbourne, attempts were made to use a chlorophyll meter to assess the N status of the crops. Whilst the results indicated some differences between N treatments at a particular site, they provided no guidance on target levels that could be utilised more widely.

However, it may be possible to assess the organic N status and total dry matter yield of the crop, as illustrated above, to manage fertiliser applications. Further work is recommended to test such techniques in commercial situations, and to identify the seasons and crops in which additional N would provide the greatest benefit. This work should also include assessments of the contribution of N from mineralisation, which seems to be much lower than expected.

Financial benefits

Based on a marketable yield of 27.1 t/ha, the price of N at £1/kg N, and trimmed produce in trays ex-packhouse at £850/t, the financial effects of applying an additional 100 kg/ha N to leeks can be large.

For instance, in the 2009/10 season, there was a yield benefit of 20% at the November harvest in response to 100 kg/ha additional N applied in August and September, which

resulted in a theoretical financial benefit of £4500/ha. It should be noted that the crop failed to overwinter due to the severe winter, and in April there was no marketable crop to harvest. The benefits from the additional N were only present before the severe weather set in.

However, in the 2010/11 season, there was a yield loss of up to 20% in April where the additional N had been applied in September and October, leading to a financial detriment of up to £4700/ha. In the 2010/11 season, applications of additional N in January and February had little effect on yield where sufficient N had been supplied the previous summer.

Action points for growers

The findings support the following advice:

- It is advantageous to assess soil mineral N ahead of drilling/planting future crops.
- Consider evaluating the N status of representative crops within the holding. If the crop N status is greater than 1.4, it may be that excessive amounts of fertiliser have been applied. Where this occurs, an inventory of the supply of N from soils and fertilisers should be compared with the amount of N contained in the crop.
- Fertiliser nitrogen should be split to match the growth of the crop, as large amounts of fertiliser applied within 2 months of drilling an overwintered crop are likely to be inefficiently used, especially on light soils
- It is more beneficial to apply additional N in the summer than it is to apply large amounts to the seedbed. Note: N applied during the summer will only be available to the crop if there has been rain or irrigation to wash it into the root zone, and that additional applications of N may make the crop more susceptible to frost damage.