

Project number: 6013
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Studies on the improvement of nitrogen use efficiency in wheat



Key external stakeholders:

Cereal and crop growers; Advisers and crop consultants; Crop production industry; Other research teams.

Practical implications for stakeholders:

- The optimum rate of fertiliser N for winter wheat is very variable between sites and seasons
- Optimum fertiliser N rate is related to soil N supply and yield level
- There is no consistent effect on yield of using three splits versus two splits in winter wheat
- There is little difference in yield between crops that get their first N application as the crop approaches GS 30 compared to earlier applications.
- Winter wheat recovers little, if any, of the nitrogen from autumn applied organic manures.

Main results:

- The optimum rate of fertiliser N for winter wheat is very variable between sites and seasons and is difficult to predict
- There is no consistent effect on yield of using three splits versus two splits in winter wheat
- There is little difference in yield between crops that get their first N application as the crop approaches GS 30 compared to earlier applications.
- Crops with low plant populations do not require earlier applications of fertiliser N than crops with more normal plant populations.
- Winter wheat recovers little, if any, of the nitrogen from autumn applied organic manures.

Opportunity / Benefit:

Results from the project will allow more efficient use of fertilizer N in winter wheat production systems and have been incorporated into Teagasc fertiliser advice in the 'Green Book' and the 'Crop Report'.

Collaborating Institutions:

Reading University, UK; AFBI, Northern Ireland

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1. Project background:

Fertilizer nitrogen represents a significant input cost in cereal production. Therefore, efficient use of fertilizer N is a key requirement of modern crop production. Efficient use of fertilizer N requires that fertilizer N is applied when the crop has a requirement for fertilizer N and that N is not over supplied. Key decisions that a grower must make include the amount of fertilizer N to apply, the most appropriate crop growth stage at which to begin fertilizer N applications and the number of applications that a crop should receive. In addition to husbandry decisions the amount of fertilizer nitrogen that can be applied to a crop is limited by legislation. It is important that the amount of fertilizer allowed for each crop is based on up-to-date information. At the outset of this project there was relatively little modern information available on the response of winter wheat in Ireland to fertilizer N. There was also a dearth of information on the effect timing of fertilizer N inputs, particularly with regard to the timing of the initial application of fertilizer N on wheat crops with different plant populations, and on the optimum number of applications used to apply the fertilizer.

2. Questions addressed by the project:

- When should the first application of fertilizer N be made to winter wheat?
- Is there a benefit of using three applications compared to using two applications when applying fertilizer N to wheat?
- Should winter wheat crops with a low plant population density in spring receive the first application of fertilizer N earlier than crops with a normal plant population density?
- Does winter wheat benefit from the nitrogen contained in autumn applied slurries?

3. The experimental studies:

A series of field experiments were carried out at multiple locations in the main winter wheat growing areas of the country over four growing seasons. The experiments compared the effect of different rates of fertilizer N, ranging from sub-optimal to supra-optimal and also the number and size of applications used to apply each level of fertilizer N on grain yield and grain quality.

In addition an experiment was carried out at Oak Park Research Centre to compare the effect on grain yield of initiating fertilizer N inputs to winter wheat at different growth stages ranging from late tillering to stem extension. The effect of different times of fertilizer N application were examined at two seed rates, one representing normal commercial practice and a second lower seed rate designed to give a low plant population in spring. The effect of autumn applied cattle slurry on the nitrogen nutrition of winter wheat was also examined.

4. Main results:

The optimum rate of fertiliser N for winter wheat is highly variable between sites and seasons. The amount of nitrogen supplied from the soil had a large influence on the optimum N with higher levels of soil N supply requiring lower rates of fertiliser N. The optimum N was also linked to the yield obtained with higher yields, on average, requiring higher levels of fertiliser N.

Comparison of two-split and three-split strategies at a range of fertiliser N rates revealed no consistent differences between the two strategies in terms of grain yield. Altering the proportions of the total N applied at each application also had little consistent effect on yield.

Application of the first fertiliser N to winter wheat at the late tillering stage in early March generally gave crops that were visually denser during the stem extension phase of crop growth than crops that received the first application of fertiliser N at later dates. However, differences in yield as a result of applying N as the crop reached GS 30 compared to the earlier application were usually small and not statistically different.

The work indicated that the most appropriate growth stage at which to begin fertiliser N inputs to winter wheat was not affected by plant population density; crops with a low plant population density did not require earlier applications of fertilizer N than crops that had a normal plant population density.

Cattle slurry applied before sowing and ploughed in immediately after application had little effect on the

nitrogen nutrition of winter wheat, even where no fertiliser N was applied. This indicates that autumn application of organic manures with a high proportion of available N, such as slurries, will lead to poor efficiency of use of the nitrogen contained in these materials.

5. Opportunity/Benefit:

Growers have the opportunity of making more timely fertiliser N applications to winter wheat crops. In particular given that the timing of the first application of N to winter wheat can be made up to GS 30 the grower can wait for suitable ground conditions in March rather than feeling compelled to apply earlier when ground conditions are less favourable. Growers can avoid achieving poor efficiency of nitrogen in slurries by not applying them in autumn when crops have a low nitrogen requirement. While there was no yield advantage or disadvantage in using three splits compared to two splits, use of three splits can reduce the risk of N loss in seasons where wet weather occurs soon after application of large second splits.

6. Dissemination:

Information from the project has been disseminated to growers and advisers at a range of open days, seminars and inservice training events. Information from the project was also used to support changes in the National Action Plan governing the use of fertiliser N in crops as well as being used to update the Teagasc 'Green Book'.

Main publications:

Hackett, R. (2011). Agronomic and legislative factors influencing fertiliser decisions in 2011. Proceedings National Tillage Conference pp 36-46

Efretuei, A., Gooding, M., White, E., Hackett, R. and Spink, J 2012. Effect of nitrogen fertilizer application timing on yield of winter wheat in Ireland. In: Proceedings Agricultural Research Forum, Tullamore, March 2012 pg. 111.

Efretuei, A., Gooding, M., White, E., Hackett, R. and Spink, J 2012 Effect of nitrogen fertilizer application timing on yield of winter wheat in Ireland. In: Richards, K.G., Fenton, O., Watson, C. J. (Eds). Proceedings of the 17th Nitrogen Workshop –Innovations for sustainable use of nitrogen resources. 26th – 29th June 2012, Wexford, Ireland, pp. 411-412.

Efretuei, A., Gooding, M., White, E., Spink, J. and Hackett, R., 2016. Effect of nitrogen fertilizer application timing on nitrogen use efficiency and grain yield of winter wheat in Ireland. Irish Journal of Agricultural and Food Research.

7. Compiled by: Richie Hackett