Optimising Nitrogen Inputs for Cereals

Richie Hackett
Oak Park Research Centre

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Outline

- Background
- Conceptual framework
- Nitrogen rates
- Splitting and timing
- Fertiliser N types
Background

- Nitrogen a large cost in cereal production
- Nitrogen has potential to cause environmental issues
  - Leaching
  - GHG emissions
- Agronomic efficiency will help minimise environmental impact
- Nitrogen often gives bigger visual effects than economic effects
- Grower decisions revolve around
  - Rate
  - Timing
  - Fertiliser type
Seasonal pattern of N uptake by a cereal crop

Crop N content (kg N/ha)

- Total Crop N
- Crop N from soil

Time

Tillering GS30

GS32

GS37

GS59

GS71 GS91

Fertiliser application
N uptake by winter wheat crops

Source: Winter wheat guide
Fertiliser N requirement

- Fertiliser N requirement = \frac{\text{Crop N demand} - \text{soil N supply}}{\% \text{ recovery of fertiliser}}

- Predicting Crop N demand
  - Yield and N demand not a straightforward relationship
  - Historic yields incorporate site and management effects – no seasonal effect
  - Future use of sensors/crop models

- Predicting Soil N supply
  - Soil N index
  - Crude indicator – not very site specific
  - Soil measurement could help but expensive/laborious

- Predicting % recovery fertiliser N
  - No reliable prediction
  - Use standard value?
Determining N rates

- Current Irish recommendations based on empirical approach
- Series of N response trials at representative sites
- Calculate rate that maximises return on fertiliser investment
- Use average rate with adjustment for yield and soil N supply
Effect of N rate on spring barley yield
Effect of N rate on spring barley yield – same site over years

Yield (t/ha)

N rate (kg N/ha)

The Irish Agriculture and Food Development Authority
Effect of N rate on spring barley yield

Grain yield (t/ha) vs. N rate (kg N/ha)
Effect of N rate on spring barley yield

Increase in fertiliser N rate of ~22.5 kg N per tonne of yield (20% moisture)
How accurate do we need to be?

Small errors around optimum have only small economic effect.
N rates

• Optimum N is very variable and difficult to predict
• Taking Soil N Supply and Yield into account is important
• Small errors are not very economically significant
Timing of N

Objective

• Ensure sufficient N present to meet crops demand through season

But………

• Available N in soil can be subject to loss and/or lock-up
• Try to avoid large excesses for long periods
Seasonal pattern of N uptake by a cereal crop

- Total Crop N
- Crop N from soil

One split strategy

Crop N content (kg N/ha)

Tillering, GS30, GS32, GS37, GS59, GS71, GS91

Time

The Irish Agriculture and Food Development Authority
Seasonal pattern of N uptake by a cereal crop

The Irish Agriculture and Food Development Authority
Seasonal pattern of N uptake by a cereal crop

Crop N content (kg N/ha)

- Total Crop N
- Crop N from soil

First split
Second split

GS30 GS32 GS37 GS59 GS71 GS91

tillering

The Irish Agriculture and Food Development Authority
Seasonal pattern of N uptake by a cereal crop

- Total Crop N
- Crop N from soil

Crop N content (kg N/ha) vs. Time
Winter wheat – recent work

- Does timing of first N affect yield?
  - First split applied at
    - tillering,
    - GS30,
    - GS31,
    - GS32
  - Same total amount applied to all treatments

- Does number and size of splits affect yield?
  - Two or three split strategies compared
    - 25%:75%
    - 50%:50%
    - 25%:50%:25%
  - Each at a range of N rates
Effect of first N timing on winter wheat

Yield (t/ha) vs N regime

- 0N
- tillering
- GS30
- GS31
- GS32

Ereftei et al. 2016

The Irish Agriculture and Food Development Authority
Effect of splitting on N response in winter wheat

![Bar chart showing grain yield (t/ha) for Site 1, Site 2, and Site 3 with different N split applications.]

- Site 1: 3 split (25%-50%-25%), 2 split (25%-75%), 2 split (50%-50%)
- Site 2: 3 split (25%-50%-25%), 2 split (25%-75%), 2 split (50%-50%)
- Site 3: 3 split (25%-50%-25%), 2 split (25%-75%), 2 split (50%-50%)

The Irish Agriculture and Food Development Authority
Effect of splitting on N response in winter wheat

- Number and relative size of splits not very critical
- Large splits mean nitrogen is in soil for longer
  - Vulnerable to loss and/or lock-up
- Third splits
  - Reduce risk of loss
  - Avoid large second splits
  - Offer potential to fine-tune N inputs based on crop growth – precision ag
  - Should be considered where in excess of 150 kg N/ha is being applied
Winter barley nitrogen - recent work

- UK work indicated more N in first split advantageous
- French work suggested small benefit of delaying first N
- What about Ireland?
- 3 timings of first N
  - Early - Late Feb/early March
  - Mid – mid-March
  - Late – Late March/early April
- 3 proportions of total in first split
  - 30%
  - 50%
  - 70%
- 2 split vs 3 split strategy
Timing of first N on winter barley

2015 (medium soil)
N management in winter barley

- No yield advantage to very early N applications in winter barley
  - Usually no yield loss either – grower has flexibility
  - Aim to have first split on by GS30 (but not before late Feb)
  - Avoid large early splits – no benefit to >30%
  - Aim to have at least ~ 75% of total on at GS 31 (ie total of 1st and 2nd split)

- No yield benefit of third split in trials but
  - Reduces risk of loss
  - Avoids large second splits
  - Offers potential to fine-tune N inputs based on crop growth – precision ag
  - Should be considered where in excess of 150 kg N/ha is being applied

- Apply 3rd split between GS32 and GS37
Fertiliser type – CAN vs urea

- CAN – the predominant form in Ireland for arable crops
- Urea – less common, particularly on arable crops

- Urea advantages
  - Lower cost per unit N
  - More concentrated form of N fertiliser

- Urea disadvantages
  - Lower density than CAN – more difficult to spread evenly at wide bout widths
    - Careful set-up of machine required
    - Urea blends require particular attention
  - Potential loss of N via volatilisation
    - Risk of loss higher at high pH, drying conditions
    - Stabilised (NBPT treated) urea negates risk
Comparison of CAN, urea and stabilised urea on spring barley

**Most common scenario**

**EXP 1- 2015**

**EXP 2- 2015**
**Future directions – crop requirement**

- Potential for reflectance sensor data to guide N Inputs
- Can be satellite, drone or tractor mounted
- Need robust algorithms that work in Irish conditions
- Likely to be only of use for late season applications

**Crop requirement**

- 0 kg N/ha
- 90-240 kg N/ha
Future directions – soil N supply

• Better prediction of SNS needed

• Further evaluation of mineral N measurements required
  • Could regional measurements be useful?
  • Can a robust and reliable soil sensor be designed?
  • Potential of unfertilised areas within crops?
Summary

• Estimating crop requirement is difficult
• Estimating soil N supply is difficult
• Precise estimation of fertiliser N requirement is difficult
• Empirical work indicates N allowances for crops are satisfactory
• Timing/splitting of nitrogen for cereals is flexible