Nitrogen on Perennial Ryegrass

Key Points

- Application rates of nitrogen (N) for perennial ryegrass are based around the soil mineral N level in late winter.
- Targets of 200 kg/ha of total N (soil mineral and applied) are giving the best results when all factors are considered (seed yield, germinations and post harvest grazing).
- Economical application rates for seed production are often approximately 30 kg N below the biological optimum.
- Underestimating the applied N by 20 – 30 kg N/ha results in a 1% (99% of optimum) reduction in economic income.
- Time of lodging appears to have a large influence on the final seed yield of perennial ryegrass.
- Changes in seed head numbers are the main causes of changes in seed yield from various N treatments.
- Post harvest dry matter production increased linearly up to a plateau at approximately 200 kg total N (spring).

Background

Two seasons of nitrogen (N) trial results suggested that growers should be applying between 48 and 190 kg N/ha to perennial ryegrass seed crops (FAR Arable Update, Herbage No. 50). Further advances in the price of urea have lead to the need for further information on N application to answer two important questions, (i) how much N and (ii) when to apply N.

It is becoming increasing apparent that testing soil mineral N (ammonium and nitrate) levels in late winter is important when deciding how much “bag” N should be applied to seed crops. Seasonal variation rotation position, and variation in winter leaching, can lead to late winter mineral N levels ranging from 10-130 + kg N/ha.

This update aims to refine the information presented in FAR Arable Update Herbage No. 50.

Method

All trials have been located on arable farms within the Canterbury district where irrigation is available or in areas of reliable summer rainfall. N application levels were determined by a soil mineral N sampling in late winter with total N available to the plant ranging from 300 kg N/ha. (total N = soil mineral N + applied fertiliser N). One trial was set up to investigate the Moddus® by nitrogen rate interaction.

Results

Application Rate

The results are similar to those presented in FAR Arable Update, Herbage No. 50 for both early (Figure 1) and late cultivars (Figure 2). Total N requirements for optimum biological yield appear consistent at about 200 kg/ha N for soil mineral N values less than 80 kg N/ha (Table 1). Limited information is available for sites above 80 kg/ha but the available data sets suggest total N levels of approx 220 kg N/ha to be more appropriate under these circumstances.

Economical optimum

The economical optimum is calculated from the treatment benefit (seed revenue, minus cost of N, including application) and fitted to a N rate response model. The economical optimum was 10 to 30 kg N/ha less than the biological optimum (Table 1). In an attempt to estimate the monetary loss if the economical optimum was underestimated, the value of N which reduced the optimum by 1% was calculated. Since the optimum level of the response curves is very flat (Figure 2) a 1% reduction in economic income was equivalent to 30-40 kg N/ha (Table 1).
Lodging and solar radiation interception
The onset of severe lodging, measured as days after first anthesis to crops greater than 50% lodged, occurred between 20 and 30 days later for Moddus treated plots compared to the nil Moddus plots. At 100 kg N/ha the crop lodged within five days from the start of anthesis; but when Moddus was applied lodging was delayed until 35 days after the start of anthesis. We suggest that the seed yield response from Moddus is largely the result of delayed lodging; thus ensuring better light penetration into the canopy and delayed vegetative tiller development that is common when moisture and N are in surplus supply.

At all levels within the canopy the photosynthetically active radiation (PAR) was lower for high N treatments compared to low N treatments. When crops are standing this is associated with greater head number. Photosynthetically active radiation at flag leaf measured on two occasions during seed fill showed a strong negative relationship with increased lodging. Lodged crops have poor light penetration with PAR being distributed over less green area compared to standing crops (Figure 3).

Figure 3. Flag leaf PAR as a percent of above canopy PAR measure on two occasions in Hillary

Head number/m² and yield components
Seed head number/m² increased with increasing N rate to a plateau (Bronsyn) or declined (Bealey) above 200 kg N/ha (Figure 4). Seed yield responses were driven by changes in seed head number/m² with responses in other yield components (spikelet number, TSW, seeds/spikelet, seed yield/head) - generally non-significant.

Post harvest dry matter production
Post harvest dry matter production was assessed in Bronsyn at two grazing dates (February and March). The trial area had 130 kg N/ha applied in two 65 kg N/ha applications in February and March.

Dry matter production increased in a linear function from 3500 to 5200 kg DM/ha for 0 and 200 kg total N/ha (spring applied) respectively. Above 200 kg N/ha dry matter production was constant (Figure 5).

Figure 4. Changes in seed head number/m² for two perennial cultivars for various spring applied total N rates

Figure 5. Dry matter production post harvest as related to spring applied nitrogen, cultivar Bronsyn 2006/07, LSD0.05 = 702 kg DM/ha.130 kg N/ha applied as urea post harvest, split between February and March

Seed Germination
In two out of five nitrogen trials (2006/07 season), there was a trend for lower nitrogen treatments to have lower germinations, when compared to higher rates of nitrogen. This is likely to be attributed to blind seed disease and a more open canopy structure. See FAR Arable Update, Herbage No. 52 for further explanation on blind seed disease and canopy mass. At 200 kg N/ha (total) and above germinations were good.

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Table 1. Nitrogen responses from 2006/07 trials, Methven. Soil mineral N = 36 (Bealey) and 10 (Bronsyn). * N price $1.26/kg N; seed price $1.65/kg ($1.80 less $0.15 cleaning charge)

<table>
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<th>Cultivar</th>
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<th>Economical-Optimum</th>
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<td>$ opt (100%)</td>
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<td>2.8</td>
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<td>160</td>
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<tr>
<td>Bronsyn</td>
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</tbody>
</table>

Table 2. Nitrogen responses from 2006/07 trials, Methven. Soil mineral N = 36 (Bealey) and 10 (Bronsyn). * N price $1.26/kg N; seed price $1.65/kg ($1.80 less $0.15 cleaning charge)