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THE POTENTIAL IMPACT AND OPPORTUNITIES FROM NUTRIENT MANAGEMENT REGULATION ON THE NEW ZEALAND HERBAGE SEED INDUSTRY

Nick Pyke, Richard Chynoweth, Diana Mathers

Foundation for Arable Research
PO Box 23133, Templeton, Christchurch, New Zealand.

Abstract

New Zealand herbage seed growers will need to ensure their farm management practices do not result in nutrient losses that exceed limits. Unlike many countries New Zealand has adopted limits for nutrient loss based on outputs, with no limit on the application (input) of nutrients. As it is not currently possible to measure outputs across a number of paddocks or farms, management within the limits will rely on the use of models which accurately estimate losses for a farm system averaged over a reasonable time frame. Herbage seed crops offer both opportunities and problems to growers when minimising nutrient losses. Excellent research has provided growers with good information on the N requirements of grass seed crops to maximise productivity and, if Nitrogen Use Efficiency is high, minimising the risk of nitrogen losses through leaching or volatilisation. As grass seed production is a minor crop research has not been undertaken to measure actual losses. The Overseer® model is likely to be used to estimate nitrogen losses from the farm system and reports of losses in relation to different inputs and its applicability to herbage seed cropping systems is discussed.

Background

The major nutrient required for a high yielding ryegrass seed crop is nitrogen (N) assuming other soil nutrient levels are in the optimum range (Brown, 1980). N is also the major nutrient which can be lost though leaching to ground water or runoff in surface water. Over the last 30 years there has been a significant amount of research undertaken to determine the nitrogen requirements of ryegrass seed crops in New Zealand (NZ). Prior to 2000 research to establish the N requirements of ryegrass seed crops, e.g. responses and nitrogen use efficiency, was in the absence of the plant growth regulator trinexapac-ethyl (e.g. Moddus®). This work identified N response in relation to growth stage (Brown, 1980, Hampton, 1987). Rowarth, et al. (1998) demonstrated seed yield could be predicted by leaf N levels before stem elongation. N applications by growers increased markedly during the 1990s from rates of 80 to 120 kg N/ha to 180 to 300 kg N/ha (Rolston, et al., 2006). Other research supported increases in yield as N rates increased to 200 kg/ha (FAR 2007). In addition to increasing seed yields, higher rates of N also reduced the incidence of blind seed disease (DeFilippi, et al., 1996). Since trinexapac-ethyl became widely used by growers the optimum N rate for maximum yield in perennial ryegrass has been shown to be ~185 kg/ha made up of, on average, 40 kg N/ha as late winter soil mineral N and 145 kg of spring applied N. This is supported by 17 trials over five years (Rolston, et al., 2010) and further trials each year since (FAR, 2013).

Concerns with regard to N loss to waterways when high rates of N are used was raised by (Rowarth, 1997). Nitrogen use efficiency (NUE) in ryegrass seed crops was investigated by Cookson (1999) in a lysimeter study and showed that seed yield and NUE increased as N application rates increased to 300 kg/ha (autumn and spring applied). Within season leaching losses were minimal and the leaching losses in the winter did not differ between the control (zero applied N) and a 50 kg N /ha treatment. Williams, et al. (1997) showed that when 180 kg of N was applied as urea to a ryegrass seed crop with a seed yield of 1800 kg/ha, on average 97% of applied N was recovered; in the seed (9.3%), straw (29.3%), roots (19.3%) and top 100 mm of soil (39%) at harvest meaning losses in the growing season through either gaseous emissions or leaching were very small.

The responsibility for limit setting is at the regional, sub regional or catchment level and in Canterbury, the major grass seed production area in New Zealand, this is under the jurisdiction of Environment Canterbury. As it is not possible to measure N losses from a farm or paddock on a large scale the focus has been on the potential to use a modelled approaches and will encourage farmers to use recognised and accepted 'Good Management Practices' (GMP's).

Modelling approaches for crops under development or evaluation include Overseer, APSIM (Williams, et al., 2014) (Williams, et al., 2013) and a Matrix for Good Management (MGM) (Williams, et al., 2014) based on expected losses when GMP's are used. Overseer has received the greatest attention as a model to estimate losses. It was developed as a fertiliser budget tool for pasture systems and has undergone significant development to ensure it can be used to model losses from a range of farm systems over long timeframes (Wheeler, et al., 2003). From a grass seed production perspective, and for the wider range of arable crops, a number of deficiencies of this model were identified (Williams, et al., 2013) which are being addressed to improve accuracy. However, the accuracy of Overseer can only be verified by undertaking expensive in crop system measurements over a long time frame or by using another model which has been verified against real time measurements. Both approaches are being undertaken (Khaembah, et al., 2015, Mathers, 2015).

This paper describes the estimated losses of N from ryegrass seed crop grown in Canterbury when modelled using overseer.

Methods

This work reports on the use of Overseer to estimate N losses from a ryegrass seed crop and compares these losses with estimated losses from individual cropped paddocks on a number of cropping farms and estimated losses at the whole farm scale.

In 2014/15 season a nitrogen trial was established in a perennial ryegrass seed crop (cultivar 'Rohan') near Methven, New Zealand. The soil type was a Templeton silt loam and irrigation was applied at rates such that the soil did not drop below 50% of field capacity. The crop received other management inputs such as trinexapac-ethyl and fungicides to optimise seed yield. All plots were grazed with lambs during winter and closed from grazing in October. Nitrogen was applied at rates ranging from 0 – 230 kg N/ha with applications occurring in September at the beginning of spring growth, last defoliation (approx. Zadoks growth stage (GS) 30) and at G.S. 32 (Zadoks et al., 1974).. Seed yield and total herbage dry matter were measured at seed harvest. Overseer (version 6.2.1) was used to model N losses from each of the individual N treatments and to estimate N removal in seed and herbage.

In a separate nutrient benchmarking project, Overseer was used to estimate the N losses from a variety of arable farm systems throughout New Zealand. N losses from 429 individual crop paddocks, including some that were in ryegrass seed and white clover seed crops, were estimated and compared with the losses to the N treatments in ryegrass.

These 429 individual crop paddocks were from 25 farms so the estimate of N losses from ryegrass seed crops compared with whole farm losses for crop farms was also made.

Results and Discussion

N losses from ryegrass

The seed yields from the N trial ranged from 530 to 2120 kg/ha (Table 1). Estimates of N removal in herbage and seed by Overseer were closely related to total seed yield (Figure 1). Although seed yield varied the impact of yield when nitrogen was applied on total N removed in seed and herbage was not large. The Overseer estimate of N losses to leaching did not change by treatment but the estimate of N loss to atmosphere increased linearly as the rate of N increased (Table 1). Estimates of N loss indicate that ryegrass seed crops are not a significant contributor of N loss to water bodies. These results are as expected when N is applied to rapidly growing crops with a high demand for N to assist with the expansion and maintenance of green leaf area. However, the Overseer outputs for ryegrass seed crops have not been verified against actual measurements of N leached or against other crop based models used for this work. Although the estimated leaching losses are very low it is possible that that these are underestimated by the model. Overseer uses average weather data for a number of seasons as oppose to actual weather data, thus is a wetter than average period or season drainage, and thus leaching, will be underestimated.

When comparing 429 individual paddocks it was found that 50% of paddocks leached less than 10 kg N/ha with a range from 1 – 117 kg N/ha (Figure 2). Comparing the N losses from the seed production trial with the estimate of N losses from a range of cropped paddocks indicates that ryegrass seed production results in average N losses. Thus, the use of GMP's on ryegrass should ensure ryegrass seed production is a low risk crop for N loss in New Zealand. However, losses from white clover seed crops can be high as significant mineral N is released when white clover roots die off. Further, when losses from the ryegrass seed N trial were compared with estimates of N loss at the whole farm scale, ryegrass seed production would not be expected to increase the average estimated N loss on cropping farms.

N inputs to ryegrass seed crops have reduced in recent years and have reduced since earlier research on N losses from ryegrass seed crops (Cookson, 1999, Williams, et al., 1997)). Although N inputs to a perennial ryegrass seed crop are higher than some other crops, they are closely linked to plant growth and yield and the use of GMP's, whereby N is applied (i) in relation to either measured or estimated soil mineral N, (ii) at optimum plant growth stages during active growth, and (iii) to ensure total N available is approximately 175 kg/ha. These GMP’s will result in minimal risk of N losses to water bodies and maximise seed yield. N leaching losses from white clover seed crops could be large. These can be minimised by following GMP's which result in short fallow periods and growing subsequent crops, such as cereals, that have large N requirements.

In New Zealand limits for N loss from farm systems will be set by the regional councils. These limits may vary by catchment in relation to the risk to the receiving water body. This study indicates that the Overseer estimate of N loss from ryegrass seed production is low and that if farmers use GMP’s developed to optimise yield in relation to N use then N loss from ryegrass seed crops will be minimal.

Table 1. Observed perennial ryegrass, cultivar 'Rohan' seed yield, estimated N removed in herbage, seed and estimates of N loss to the atmosphere and leached as modelled in Overseer® version 6.2.1.

Nitrogen treatment N kg/ha	Seed yield kg/ha	Estimated N kg/ha removed in seed and herbage	Estimated N kg/ha lost to atmosphere	Estimated N kg/ha leached
0	530	217	12	9
40 kg N/ha applied Sept 15 kg N/ha applied Oct 15 kg N/ha applied Nov	1250	263	15	9
40 kg N/ha applied Sept 35 kg N/ha applied Oct 35 kg N/ha applied Nov	1645	279	19	9
40 kg N/ha applied Sept 55 kg N/ha applied Oct 55 kg N/ha applied Nov	1965	291	24	9
40 kg N/ha applied Sept 75 kg N/ha applied Oct 75 kg N/ha applied Nov	2120	298	30	9
40 kg N/ha applied Sept 95 kg N/ha applied Oct 95 kg N/ha applied Nov	2090	306	38	9

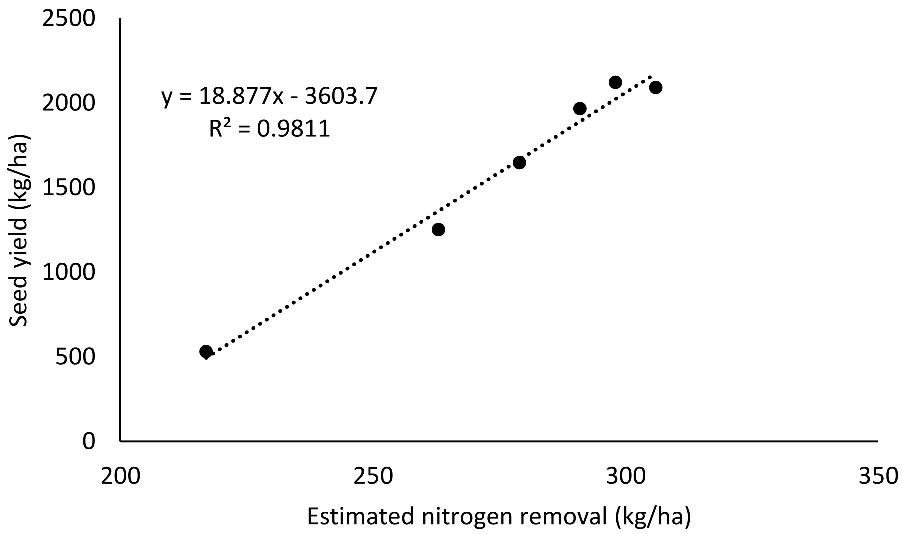

Figure 1. Relationship between machine dressed seed yield and Overseer® estimates of N removal in seed and herbage of perennial ryegrass, cultivar 'Rohan' grown near Methven, New Zealand in the 2014/15 growing season.

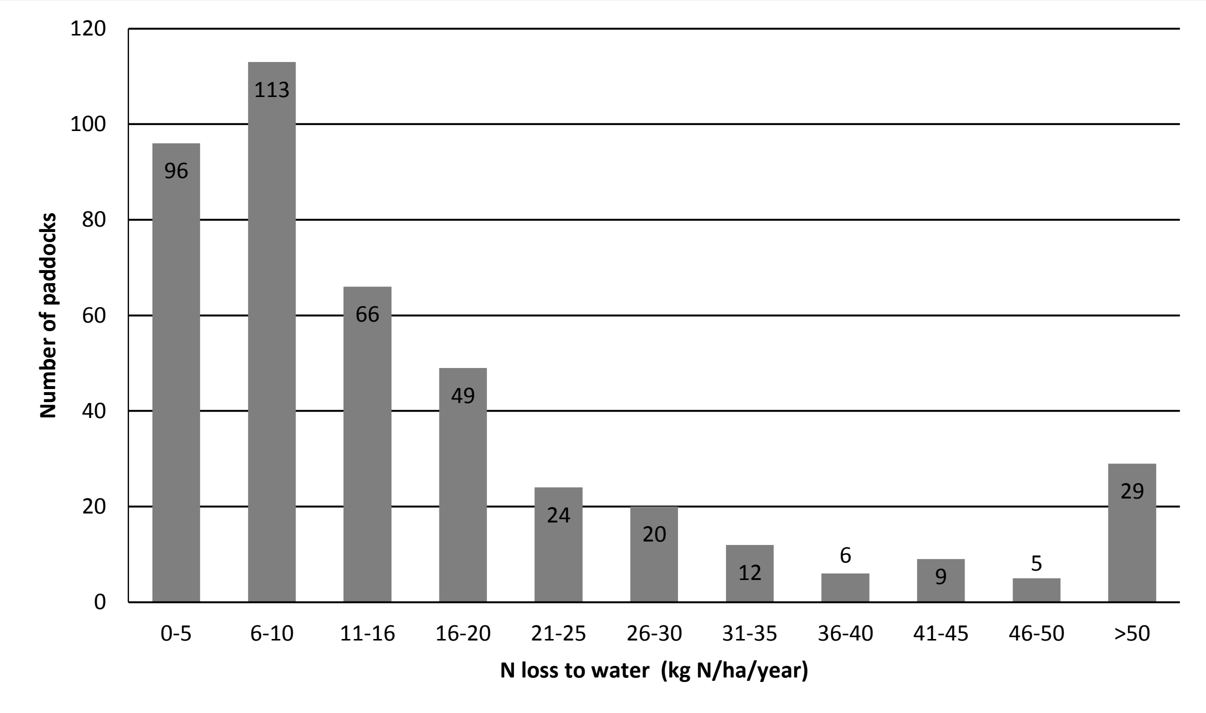

Figure 2. Overseer estimates of N leached kg/ha for 429 individual cropped paddocks located from Southland to Hawkes Bay, New Zealand.

References

Brown, K.R. 1980. Seed production in New Zealand ryegrasses. New Zealand Journal of Experimental Agriculture 8: 33-39. doi:10.1080/03015521.1980.10426229.

Cookson, W.R. 1999. Nitrogen fertiliser use efficiency in ryegrass (Lolium perenne L.) seed crops : a thesis submitted in partial fulfilment of the requirements for the degree of Doctor of Philosophy at Lincoln University. Thesis (PhD), Lincoln University, 1999.

DeFilippi, J.M., J.G. Hampton, M.P. Rolston, J.S. Rowarth. 1996. Effect of nitrogen and irrigation on blind seed disease in perennial ryegrass (Lolium perenne L.) cv. Grasslands Nui. Journal of Applied Seed Production 14: 81-83.

FAR. 2013. Cropping strategies. Issue 5, Nitrogen in Perennial Ryegrass Seed Crops. Foundation for Arable Research, Christchurch. New Zealand.

FAR. 2007. Nitrogen use on perennial ryegrass. Herbage Arable Update, No. 54. Foundation for Arable Research, Christchurch. New Zealand.

Hampton, J.G. 1987. Effects of nitrogen rate and timing of application on seed yield in perennial ryegrass cv. Grasslands Nui. New Zealand Journal of Experimental Agriculture 15: 9-16.

Khaembah, E.N., H. Brown, J. Sharp, R. Zyskowski, 2015. Soil nitrogen and soil water dynamics in crop rotations: estimation with the multiple crop single purpose model. In: Moving farm systems to improved attenuation. (Eds L.D. Currie and L.L Burkitt). http://flrc.massey.ac.nz/publications.html. Occasional Report No. 28. Fertilizer and Lime Research Centre, Massey University, Palmerston North, New Zealand. 10 pages.

Mathers, D. 2015. Rootzone reality - a network of fluxmeters measuring nutrient losses under cropping rotations. In: Moving farm systems to improved attenuation. (Eds L.D. Currie and L.L Burkitt). http://flrc.massey.ac.nz/publications.html. Occasional Report No. 28. Fertilizer and Lime Research Centre, Massey University, Palmerston North, New Zealand. 3 pages.

Pattinson, J.A.A., J.M. Pattinson. 1985. Nitrate leaching losses under a legume-based crop rotation in Central Canterbury, New Zealand. New Zealand Journal of Agricultural Research 28: 101-107. doi:10.1080/00288233.1985.10427002.

Rolston, M.P., R.J. Chynoweth A.V. Stewart. 2006. Forage seed production: 75 years applying science and technology. Proceedings of the New Zealand Grassland Association 68: 15–23.

Rolston, M.P., B.L. McCloy, R.J. Chynoweth. 2010. Predicting nitrogen requirements in perennial ryegrass seed crops. Agronomy Society of New Zealand Special publication no. 13 /Grassland Research and Practice Series No. 14: 59-65.

Rowarth, J.S. 1997. Nutrients and moisture inputs for grass seed production. Journal of Applied Seed Production 15: 103-110.

Rowarth, J.S., B. Boelt, J.G. Hampton, A.H. Marshall, M.P. Rolston, G. Sicard. 1998. The relationship between applied nitrogen concentrations in herbage and seed yield in perennial ryegrass (Lolium perenne L.) I. Grasslands Nui at five sites around the globe. Journal of Applied Seed Production 16: 105-114.

Wheeler, D.M., S.F. Ledgard, C.A.M. de Klein, R. Monaghan, P.L. Carey, R.W. McDowell, 2003. Overseer nutrient budgets - moving towards on-farm resource accounting. . Proceeding of the New Zealand Grassland Association 65: 191-194.

Williams, P.H., J.S. Rowarth R.J. Tregurtha. 1997. Influence of perennial ryegrass seed crop on soil nitrogen status. . Proceedings Agronomy Society of New Zealand 27: 15-18.

Williams, R., H. Brown, I. Brown, R. Ford, L. Lilburne, I. Pinxterhuis, M.Robson, V. Snow, K. Taylor, T. von Pein. 2015. The matrix if good management: towards an understanding of farm systems, good management practice, and nutrient losses in Canterbury . In: Moving farm systems to improved attenuation. (Eds L.D. Currie and L.L Burkitt). http://flrc.massey.ac.nz/publications.html. Occasional Report No. 28. Fertilizer and Lime Research Centre, Massey University, Palmerston North, New Zealand. 14 pages.

Williams, R., H. Brown, M. Dunbier, E. D., R. Hill, A. Metherell, 2013. A critical examination of the role of Overseer® in modelling nitrate losses from arable crops. In: Accurate and efficient use of nutrients on farms. (Eds L.D. Currie and C L. Christensen). http://flrc.massey.ac.nz/publications.html. Occasional Report No. 26. Fertilizer and Lime Research Centre, Massey University, Palmerston North, New Zealand. 8 pages.

Williams, R., H. Brown, R. Ford, L. Lilburne, P. I., M. Robson, 2014. The matrix if good management: defining good management practices and associated nutrient losses across primary industries. In: Nutrient management for the farm, catchment and community. (Eds L.D. Currie and C L. Christensen). http://flrc.massey.ac.nz/publications.html. Occasional Report No. 27. Fertilizer and Lime Research Centre, Massey University, Palmerston North, New Zealand. 8 pages.

Zadoks J. C., T. T. Chang, C. F. Konzak, 1974. A decimal code for growth stages of cereals. Weed Research, 14: 415-421.