

NITRATE LEACHING LOSSES FROM CROPPING ROTATIONS.

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Introduction

The effects of land use change and intensification on groundwater contamination by leached nitrate (NO₃) are of particular concern in New Zealand. Both farmers and policy makers need tools to be able to predict the effects of land management decisions on groundwater quality. While there are modelling tools available for predicting leaching from single crops in New Zealand conditions (Li et al. 2007), there are few models that can predict losses from cropping rotations. Furthermore, there are few New Zealand data available to validate predicted NO₃ leaching losses. Most NO₃ leaching losses from crops have been measured over the winter period. However, the increasing use of irrigation and large fertiliser inputs for growing high value crops increases the likelihood of leaching losses during other seasons. We designed a three year field experiment to quantify how NO₃ leaching losses were affected by different nitrogen and irrigation management for two cropping rotations. Results from this experiment have been used to validate components of a new cropping sequence simulation model.

Materials and Methods

A field experiment was established in spring 2004 at Lincoln, Canterbury on a well drained, intensively cropped soil with two crop rotations ([i] potatoes – winter wheat – winter fallow - potatoes, and [ii] potatoes – winter fallow - spring sown peas – winter fallow – potatoes). The experiment was a randomised block design with eight replicates. Each crop received three different rates of nitrogen fertiliser (N0, N1, N2) and two rates of irrigation (W1, W2). For each crop, N1 and W1 represented the optimum rates of fertiliser and irrigation. For each of the crops, W2 either represented a different frequency or amount of irrigation compared to W1. Solution samplers were installed in each plot (60 cm in the first potato crop; 150 cm in subsequent crops and fallow periods). Soil mineral N (0-150 cm) was measured in spring and autumn. Nitrate leaching losses were calculated from soil solution NO₃ concentrations and the amount of drainage calculated from a soil water balance.

We compared the measured leaching NO₃ losses with predictions from the LUCI (Land Use Change and Intensification) Framework Model (LFM). The LFM integrates several crop models that simulate daily plant growth response to weather, nitrogen supply and water availability, and an underlying soil model that controls the supply of nitrogen and water. The LFM is designed to run continuously for several years to simulate the effects of different cropping rotations.

Results and Discussion

Measured NO₃ leaching losses varied considerably in response to the irrigation and fertiliser treatments, crop rotation and winter rainfall. Losses during the spring and summer of 2004/05 from the first year potato crop ranged from about 10 to 106 kg N/ha, and increased with both irrigation and fertiliser application rate (Fig. 1). There was no measurable leaching loss over the winter of 2005 due to low autumn and winter rainfall. Nevertheless, the winter wheat crop reduced the amount of potentially leachable NO₃ during the winter compared with the winter

fallow. During the spring-summer of 2005/06, leaching losses from both the winter wheat and spring peas were also very small due to conservative irrigation management that year. Consequently, the amount of mineral N remaining in the soil at harvest in February 2006 varied widely between treatments.

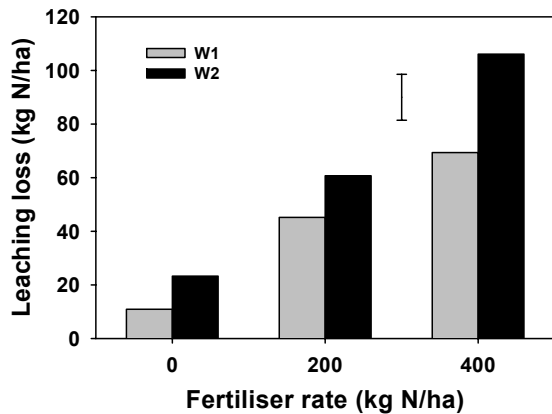


Figure 1: Nitrate leaching losses during the potato crop in 2004-05. W1 is optimal irrigation and W2 is 1.75 x optimal irrigation. The vertical bar is the LSD at P<0.05.

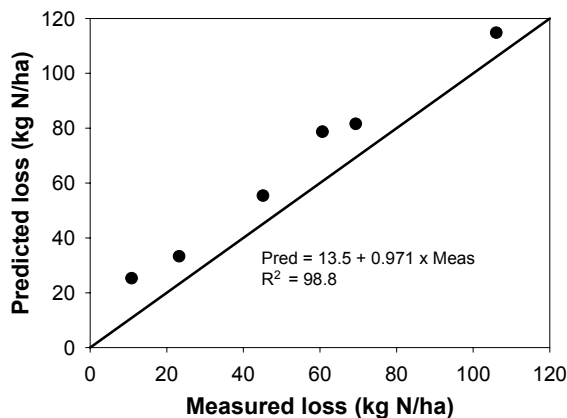


Figure 2: Comparison between measured leaching losses in 2004-05 and predicted losses using the Potato model.

Comparison of the measured and predicted leaching losses from potatoes in the first year (Figs 1 and 2) showed good agreement although the predictions were consistently greater than the measured values by about 13 kg N/ha (Figure 2). Further results of the comparison between the measured and simulated leaching losses will be presented.

References

Li, F.Y.; Jamieson, P.D.; Zyskowski, R.F.; Brown, H.E.; Pearson, A.J. 2007: The Crop Calculators - from simulation models to usable decision-support tools. *Proceedings of MODSIM 2007 International Congress on Modelling and Simulation. Modelling and Simulation Society of Australia and New Zealand, Christchurch, NZ: 128-134.*