Water quality implications of Fallow utilisation of land in the south east of Ireland

M. RYAN

Abstract

The results of a lysimeter study of nitrate (NO_3^-) leaching from a Fallow soil receiving zero inorganic nitrogen (N) fertiliser over 13 years showed high NO_3^- - N concentrations in the drainage water, especially in the early years. Concentrations declined over time but it is likely that it would take 15 years for the concentration to reach the EU MAC (maximum admissible concentration) of 11.3 mg per litre. Over the 13 years 1680 kg per hectare N was leached. The need for research into the use of cover crops is evident from the results presented.

Introduction

With its mild, moist climate the island of Ireland, 51.5° N to 55.5° N, is well suited to grass and forestry, more so than tillage crops. The cropped area only accounts for 8% of the utilised land (75% cereals) but nitrate loss from arable land is of concern.

Farmland in the south-east of Ireland, which has the lowest mean rainfall, 850-1011 mm, is utilised at a higher intensity for tillage than other parts of the island. This corresponds with the highest concentration of NO_3^- - N in rivers; there has been a doubling of highest annual maximum values in south-eastern rivers in the past eighteen years (TONER et al, 2000). Drinking water quality is of a very high standard in the Republic of Ireland (ROI) and recent measurements bear out previous assessments that the level of NO_3^- enrichment in Irish surface waters is generally low and well within the limits set for abstraction and drinking waters (LEHANE, 1999). However, NO_3^- levels are high and increasing in some tributaries in the high tillage areas. The current thrust of Public Government policy is to maintain and improve standards. Causitive factors contributing to elevated nitrate-N concentrations in water bodies are therefore studied with a view to generating remedial measures.

Fixed monolithic lysimeters, established in secure units near a laboratory, provide a very satisfactory means of sampling soil drainage water from treated experimental soils. Indeed, lysimeters are seen as the standard against which other methods of measuring leaching are tested. This paper presents results of a study carried out to assess the impact of Fallow land on NO_3^- leaching.

Materials and Methods

The lysimeters consisted of 24 concrete cylinders, 450 mm diameter and 900 mm deep which were back-filled with the local Johnstown Castle soil. They were covered with mineral felt on the outside and internally waterproofed with bitumen and pitch. The soil was a deep, well drained, coarse loamy over fine loamy brown earth which occurs within the Deerpark Variant of County Wexford soils (GARDINER & RYAN,1964)

The lysimeters were commissioned in late 1983-early 1984 from grassland and the soils were allowed to equilibrate during the preliminary year, 1984. All drainage water was collected and analysed for NO_3^- - N to test for uniformity throughout that year. Prior to establishing the treatments for the first experimental year, ground limestone, to bring the upper soil pH to 6.8, was worked into the top 50 mm of each soil on 13th of March 1985.

Commencing April 1985 and over the following thirteen years, experiments measuring leaching from fertilised barley crops and Fallow were carried out. There were three replications of Fallow lysimeters, receiving zero N fertiliser, allocated at random within the unit and in all years they only received ambient rain. Drainage water was collected annually from one sowing date to the next sowing date of the cereal crop in the other lysimeters. The water samples were analysed for NO_3^- - N concentrations in the laboratory using an auto-analyser. A one-way analysis of variance was carried out to compare leaching from the cereal and fallow treatments using the Genstat statistical package of Rothamsted Experimental Station. Eight years of this comparison has previously been reported (RYAN & FANNING, 1999; RYAN, SHERWOOD & FANNING, 2001).

Results and Discussion

Figure 1 shows the relation between rainfall and soil water drainage over the experimental period. *Figure 2* shows the effect of the Fallow treatment on nitrate-N concentration in the drainage water over the thirteen years of the experiment. Most of the values are above the EU Maximum Admissible Concentration (MAC) of 11.3 mg per l with highest values seen in the early years.

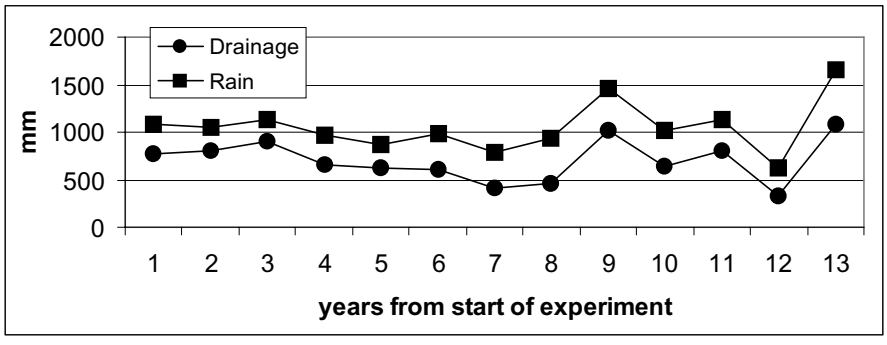

Figure 1: **Rainfall and soil drainage over time**

Autor: Dr. Michael RYAN, Teagasc, Johnstown Castle, WEXFORD, Ireland

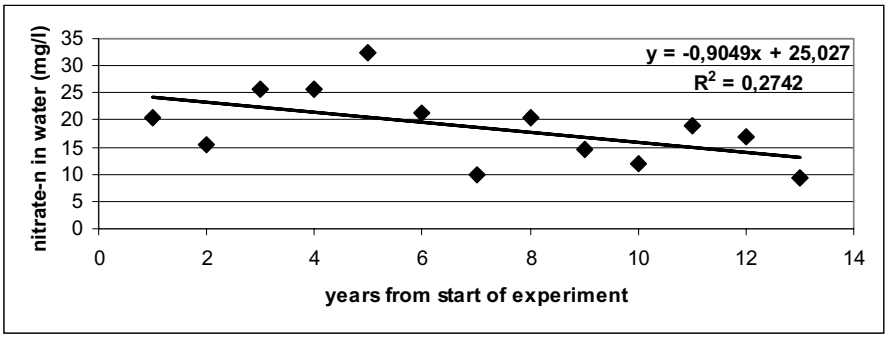

Figure 2: **Decline in mean NO_3^- - N concentration over time**

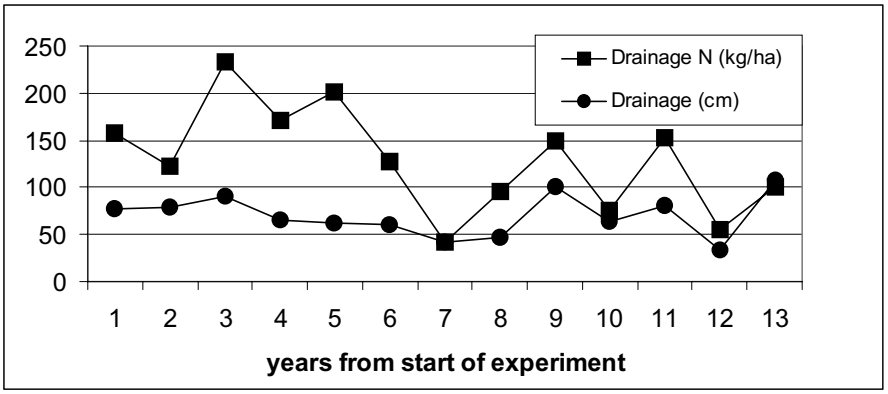

Figure 3: **Effect of drainage on N leached**

Depletion of mineralisable organic N resulted in lower values occurring over time. In the first three years, at zero N input, the mean concentration in the Fallow drainage water was 21.3 compared with 11.6 mg per l NO_3^- - N in the barley drainage water. Significant differences were noted in 8/15, 17/20 and 23/23 of the water collections in those years. By years 10-11, the Fallow concentration had dropped to 13.7, the barley water concentration was 6.5 mg per l with significant differences showing in 8/9 and 7/11 of the collections in those years. The trend line shows that it would take until year 15 for the Fallow water NO_3^- - N to be at MAC or below illustrating the importance of new research underway with cover crops, which will attempt to radically reduce nitrate leaching from Fallow.

Figure 3 shows the relationship between drainage volume and amount of N leached. It is sclear that for a given amount of drainage the tendency was for N leached to be much higher in the first 6 years of the experiment than in latter years, reflecting the mineralisation rate of organic soil N. The total N collected in the drainage water from the Fallow in the 13 years was 1680 kg per ha, illustrating a large reserve of organic N in this soil. It is anticipated that the soil would continue to release N for a further period of time, but at a decreasing rate.

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