Effects of fertilizer N and slurry on N removal in soil drainage water and herbage - a lysimeter study on 5 soils

M. RYAN

Abstract

A two year study of the effects of fertilizer nitrogen (N) (300 kg/yr) combined with pig or cattle slurry (~120 kg N/yr), applied in winter or early spring, on N removal in soil drainage water and herbage are presented. Treatment and soil type affected N removals, usually to a significant degree. Averaged over the two experimental years, N removal in soil drainage water from the treatments ranged 40.2 to 69.2 kg/ha; it ranged 18.7 to 69.8 kg/ha among soil types.

The amount of N in drainage water (pooled over soils), from fertilizer N plus winter slurry was equivalent to 14 to 17% of the total N applied; it was 10% for spring slurry plus fertilizer (Mean of two years).

Introduction

Leached N is an important component of N balance sheets and lysimeters are the standard against which other methods of measuring NO_3-N leaching are tested (GOULDING and WEBSTER, 1992). A new lysimeter unit at Johnstown Castle afforded the opportunity to measure leaching and uptake of applied N on 5 soils over two years. Details of the experiment and effects of treatments on nitrate-N (NO_3-N) concentrations in soil drainage water are available in RYAN and FANNING (1996).

Materials and Methods

Monolith lysimeters of 5 soils were sown to perennial ryegrass (*L. perenne*) *cv* Talbot. The soils consisted of two well drained, deep soils, Clonroche, (Eutric Dystrochrept) and Elton (Orthic Typudalf); one well drained, shallow soil-Oakpark (Rendollic Eutrochrept) and two poorly drained, deep soils, Castlecomer (Orthic Umbraquept) and Rathangan (Orthic Fragaqualf). Over 2 years fertilizer N (300 kg/ha) was applied incrementally during the growing season and slurry (cattle C_1, pig P_1) was applied in winter or spring (pig P_2).

Herbage was harvested 5 or 6 times in 1993 - '94; soil drainage water was collected 6, 9, 5 times in 1993, '94, '95.

Results and Discussion

The mean drainage water collected in Yr 1 (7/4/93 to 25/5/94) was 926 mm; it was 474 mm in Yr 2 (26/5/94 to 19/5/95).

Effect of treatment:

Tables 1, 2 show the main effects of treatment and soil on N removal in drainage and herbage.

Of the total N applied in Yr 1, 19, 15 and 12% was the equivalent removal in the drainage water for the C_1, P_1, P_2 treatments; the equivalent removals in Yr 2 were 9, 18 and 7%.

The higher drainage volume in Yr 1 compared to Yr 2 would be expected to give these results. Very high concentrations (~50 mg/1) of NO_3-N in the January - February drainage from the shallow, light Oakpark soil contributed significantly to the exalted (18%) removal in the drainage water for the P_1 treatment in Yr 2.

Analyses carried out, 19/4/95, showed absence of *L. perenne* from two Oakpark P, lysimeters with only sparse vegetation present. Such senescence would have meant poor uptake of N in the latter portion of Yr 2 leading to the very high NO_3-N concentrations recorded (RYAN and FANNING, 1996).

The mean (2 year) drainage water from the C_1 treatment was 691mm; the mean (2 year) amount of N removed in the drainage water was 60 kg/ha which equates to a mean NO_3-N concentration in drainage water of 8.7 mg/1. Similarly, the mean drainage water from the P_1, P_2 treatments was 703 and 706 mm, giving mean NO_3-N concentrations in the drainage water of 9.8 and 5.7 mg/1 for mean removals in the drainage water of 69.2 and 40.2 kg N/ha, respectively.

In Yr 1 the mean NO_3-N concentrations in the drainage water (pooled over soils) from C_1, P_1, P_2 treatments were 8.8, 6.7, 5.7 mg/l; they were 8.4, 16.1, 5.8 mg/1 for Yr 2. Clearly the P_1 treatment gave rise to unacceptable NO_3-N concentrations in the drainage in the second of the two experimental years which was the year with the lower rainfall (and drainage) amount.

N removals in herbage were lower for all treatments in Yr 2 compared to Yr 1.

Effect of Soils:

Of the mean total N applied in Yr 1 (424 kg/ha) the removals in the drainage water of the Castlecomer, Clonroche, Elton, Oakpark and Rathangan soils (*Table 2*) were 5, 18, 21, 14, 20%; the corresponding levels for Yr 2 were 4, 14, 10, 19, 9%.

There was a 4.4 to 4.7 fold difference between soils in N removed in drainage in Yrs 1 and 2. The difference factor for herbage N was much lower at 1.5 to 1.9. Apart from Oakpark, N removal in drainage was greater in Yr 1 than Yr 2. To-

Table 1: **Effect of *treatment (kg N/ha) on N removal (kg/ha) in drainage and herbage**

	Yr 1 C_1 (428)	Y r2 (418)	Yr 1 P_1 (422)	Yr 2 (417)	Yr 1 P_2 (422)	Yr 2 (417)	F test		s.e.d	
Drainage	80.9	39.0	62.0	76.4	52.7	27.7	NS	***	16.1	10.9
Herbage	335.8	278.5	319.9	282.0	343.5	294.7	NS	NS	22.0	12 8
Total	**416.7**	**317.5**	**381.9**	**358.4**	**396.2**	**322.4**	**NS**	**NS**	**20.1**	**17.8**

*Slurry: Cattle = 128, 118 kg N/ha (Yrs 1, 2); Pig = 122, 117 kg N/ha (Yrs 1, 2)

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

Table 2: **Effect of soil on total N removal (kg/ha) in drainage and herbage**

Mean N input 424 kg/ha (Yr 1), 417 kg/ha (Yr 2)														
Soil	Castlecomer		Clonroche		Elton		Oakpark		Rathangan		F		s. e. d.	
	Yr 1	Yr 2	Yr 1	Yr 2	Yr 1	Yr 2	Yr 1	Yr 2	Yr 1	Yr 2	test			
Drainage	20.0	17.3	76.7	57.4	87.2	43.6	58.2	81.3	84.0	38.8	**	**	20.8	14.1
Herbage	361.1	278.8	232.4	237.1	368.2	339.9	257.1	223.6	446.5	345.8	***	***	28.3	16.5
Total	**381.1**	**296.1**	**309.1**	**294.5**	**455.4**	**383.5**	**315.3**	**304.9**	**530.5**	**384.6**	***	***	**26.0**	**22.9**

tal N removals in Yr 1 were greater than in Yr 2 for all soils; these were equivalent to 90, 73, 107, 74, 125% and 71, 71, 92, 73, 92% of N applied in Yrs 1, 2 for the soils as alphabetically listed in *Table 2*. N removal in the drainage for those soils was 5, 18, 21, 14, 20% and 4, 14, 10, 19, 9% of N applied in Yrs 1, 2.

In conclusion, N removal in drainage lay in the range 17 to 20, 57 to 77, 44 to 87, 58 to 81 and 39 to 84 kg/ha for these soils receiving total N inputs of 417 to 424 kg/ha as fertilizer and slurry in years with soil drainage volumes of 474 and 926 mm.

References

GOULDING, K.W.T. and C.P. WEBSTER, 1992: Aspects Appl. Biol., 30, 63 - 70.

RYAN, M. and A. FANNING, 1996: Irish Geography. 29 (2)126-136.