

# Nitrogen leaching from effluent irrigated pasture, on a vitrand (pumice soil), taupo, New Zealand – initial results

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## Abstract

Preliminary results from the first two months of an ongoing lysimeter study located on Vitrands (Pumice Soils) in Taupo, New Zealand are presented. Nitrogen leaching and pasture uptake from a ryegrass pasture irrigated with secondary treated municipal effluent has been collected by 48 intact soil monolith lysimeters. Four treatments, nominally 650 kg N/ha/yr, 550 kg N/ha/yr, 450 kg N/ha/yr and 0 kg N/ha/yr were applied to approximately 23 hectares of the irrigation site by centre pivot irrigators. Cumulative N leached was 4.5 kg N/ha from the 650 treatment; 1.2 kg N/ha from the 550 treatment; 1.1 kg N/ha from the 450 treatment; and no nitrogen has been leached from the control over the two month period. These averages were not significantly different.

## Key Words

Wastewater, lysimeter, groundwater, sewage.

## Introduction

The Taupo District Council (TDC) operates a land treatment scheme (LTS) as the final method of treating municipal effluent from a population of about 20 000. Since 1995, TDC has irrigated secondary treated municipal wastewater to land in a cut and carry farming operation (Power and Wheeler 2007). The Taupo LTS is planted with high yielding perennial ryegrass. The ryegrass uses nitrogen and phosphorous contained in the effluent for plant growth and is harvested a minimum of five times annually. To limit the recycling of nutrients, no animal stock are held, and harvested grass is removed from site.

Nitrogen has been identified as a limiting nutrient in surface waters of the Taupo region (White & Payne 1977) and as such strict regulations govern the management of nitrogen in the greater Taupo catchment. The resource consent issued for the LTS allows 550 kg N/ha/yr to be applied, however a higher rate of application is sought by TDC. Subsequently, a trial is underway in conjunction with AWT New Zealand Ltd where up to 650 kg N/ha/yr can be applied.

The overall purpose of the study was to quantify the nitrogen leached from the soil beneath the Taupo LTS under different effluent loadings. The specific objectives were to measure:

- the amount of nitrogen applied to the land surface;
- the volume of water draining through the soil profile;
- the nitrogen concentration of drainage water; and
- the nitrogen uptake by the ryegrass pasture.

These data will be used to develop a nitrogen budget to allow TDC to determine the most appropriate effluent application rate to stay within resource consent conditions.

The trial was located 10 km north of the Taupo township, on low rolling hills and flat terraces. The soils were Vitrands (USDA Soil Taxonomy), Pumice Soils (NZ Soil Classification) formed in Taupo eruptives, predominantly Atiamuri gritty sandy loam series or Whenuaroa gravelly sandy loam series (Figure 1). Atiamuri soils were derived from flow tephra, covering the steeper slopes, while the Whenuaroa soils originate from alluvial reworked deposits. Both soils were considered well draining and had variably textured subsoils (Orbell 2007).

## Methods

Four effluent application rates (nominally 0, 450, 550, and 650 kg N/ha/yr) were applied beneath two centre pivot irrigators that span approximately 23 hectares. Forty eight intact soil monolith lysimeters (Cameron *et al.* 1992) measuring 300mm wide x 450mm deep (Figure 2), were installed with 12 replicate lysimeters in each treatment. The lysimeters feature a leachate collection compartment beneath the undisturbed soil core

and leachate is collected monthly and volumes recorded. The leachate was analysed for nitrate-N, ammoniacal-N, and TKN by a commercial laboratory, Hill Laboratories. Pasture samples were taken where total N uptake was determined by combustion using the LECO furnace and dry matter was determined by oven drying at 65°C.



**Figure 1.** Whenuaroa gravelly sandy loam covering most of the site and used in the lysimeters.



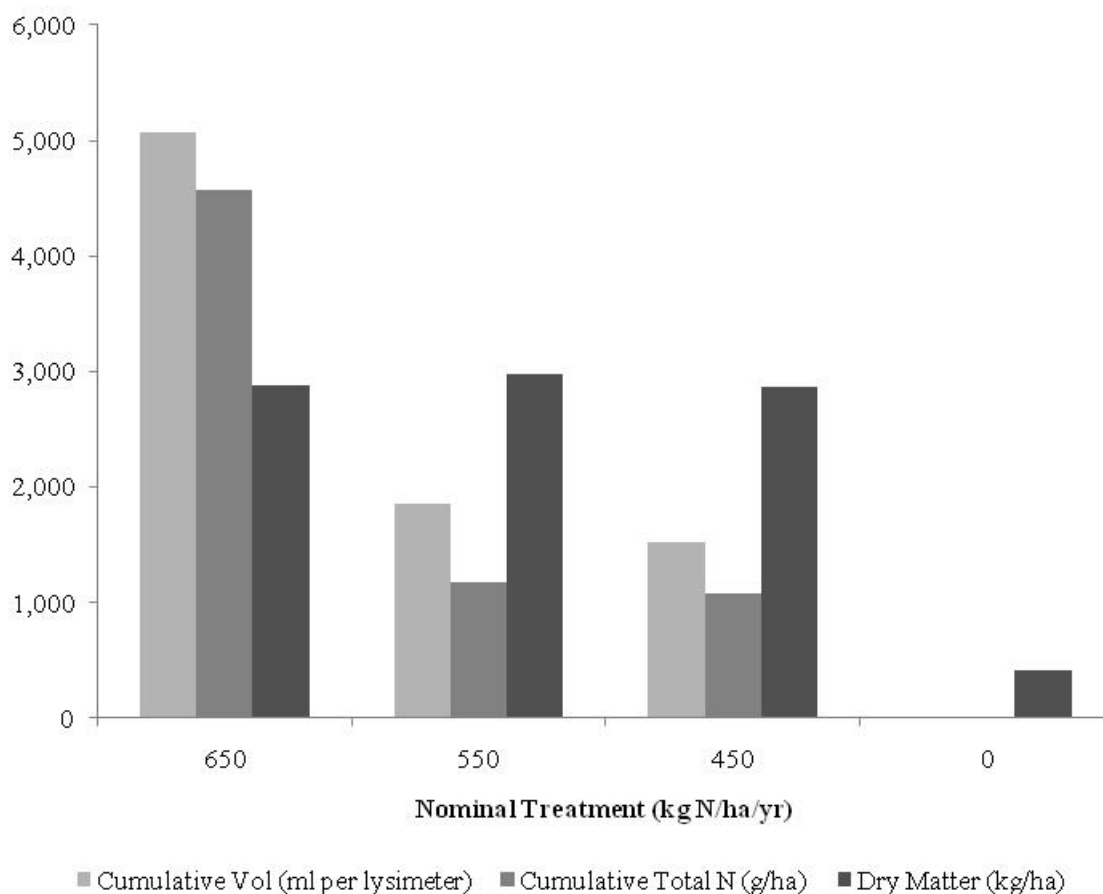
**Figure 2.** Lysimeter ready for installation, note leachate collection chamber with sampling hose.

### Initial Results

Two months (November and December 2009) of sample collection indicate higher volumes of leachate and higher total N leached from the treatment that received the greatest volume of effluent (Figure 3). Leaching volumes and N losses between treatments were not significantly different, however on average, 5100 mL of cumulative leachate per lysimeter and 4.5 kg N/ha was collected from the 650 treatment; 1850 mL of leachate and 1.2 kg N/ha from the 550 treatment; 1500 mL of leachate and 1.1 kg N/ha from the 450 treatment; and 16 mL of leachate and 0 kg N/ha from the control.

Substantially more grass was harvested from all irrigated treatments compared with the treatment receiving no irrigation, however dry matter production between irrigated treatments was not significantly different. On average; the 650 treatment produced 2.9 kg dry matter/ha; the 550 treatment produced 3.0 kg dry matter/ha; the 450 treatment produced 2.9 kg dry matter/ha and the unirrigated lysimeters produced 0.4 kg dry matter/ha. Total nitrogen uptake by the pasture for the two month period is being analysed, with additional measurements relating to effluent application rates and effluent nitrogen concentration underway. In 12 months time the amount of nitrogen entering the groundwater will be calculated.

Results generated by the study will enable TDC to determine the most appropriate effluent application rate to limit nitrogen leaching and stay within resource consent conditions. The trial will run for a minimum of four years.



**Figure 3. Cumulative volume collected per lysimeter, cumulative total N and herbage dry matter from 2 months measurement, with mean values shown. Leachate collected from the unirrigated lysimeters (0 treatment) was negligible.**

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#### References

- Cameron KC, Smith NP, McLay, CDA, Fraser PM, McPherson RJ, Harrison DF, Harbottle P (1992) Lysimeters Without Edge Flow: An Improved Design and Sampling Procedure. *Soil Science Society of America Journal* **56**, 1625-1628.
- Orbell GE (2007) *Soils of Taupo Land Disposal System, View Road*. Taupo Land Treatment Project Expansion, Appendix 3, Assessment of Environmental Effects.
- Power I, Wheeler D (2007) Soil status report for expansion of the Taupo land disposal scheme: View Road Taupo. Report prepared for Taupo District Council, Agresearch, Ruakura, New Zealand.
- White E, Payne GW (1977) Chlorophyll Production in Response to Nutrient Additions by the Algae in Lake Taupo Water. *N.Z. Journal of Marine and Freshwater Research* **11**, 501-507.