



Turfgrass Production on Sandy Soils

Nitrogen Leaching



Lysimeters being installed into plots prior to establishing turfgrass

Development and implementation of management strategies that minimise nitrogen leaching from turfgrass is essential for the sustainable development of the Australian turfgrass production industry. Nitrogen leaching is problematic as it can trigger algal blooms and compromise water quality. The University of Western Australia has evaluated the effects of irrigation and fertiliser regimes on nitrogen leaching during turfgrass production on sandy soils.

Applying nitrogen fertiliser is an integral part of turfgrass management and is needed for maintaining turfgrass growth and ensuring that the turfgrass is aesthetically acceptable.

Nowadays, people are more aware of the detrimental effects on the environment of improper use of nitrogen fertilisers. Poor nitrogen fertiliser management can cause nitrogen leaching, and increase the emissions of greenhouse and ozone depleting gases. Nitrogen leaching is problematic as it can degrade surface-water and ground-waters resulting in eutrophication and non-potable water supplies.

Nitrogen leaching is best minimised by ensuring nitrogen is applied at a rate that the turfgrass is able to utilise. The approach taken to achieve this will vary depending on the turfgrass nitrogen requirements, but also on the biological, chemical and physical attributes of the soil.

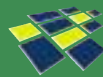
Fertiliser nitrogen can be taken up by turfgrass, denitrified or volatilised to nitrogen gases by soil microbes, or immobilised into the soil organic matter (see ATM Vol 3.4, pp 36-37). Any nitrogen not involved in these processes is likely to be leached. Additional nitrogen may also become available to the turfgrass if management practices disturb the soil and cause nitrogen to be released from soil organic matter, and if mower clippings are returned to the turfgrass.

The ability of turfgrass and soil microbes to utilise fertiliser nitrogen will also be affected by the rate that dissolved nitrogen moves through the soil profile. Plant uptake and soil biological processes often occur at greater rates in the surface soil than the subsurface soil.

So, fertiliser and irrigation management practices that maintain nutrients from the dissolved fertiliser in the surface soil should increase turfgrass nitrogen uptake and soil 'retention', and decrease nitrogen leaching. For example, irrigation rates and frequencies that do not cause water to move beyond the rooting zone have been shown to decrease nitrogen leaching.

Recommended strategies for minimising nitrogen leaching are more likely to be adopted by turfgrass producers if it is demonstrated that they do not have a detrimental effect on turfgrass growth and quality.

Consequently, the University of Western Australia, in partnership with Horticulture Australia Ltd and industry groups, have conducted a three-and-a-half-year project investigating irrigation and fertiliser management practices that maximise turfgrass growth, while



minimising nitrogen leaching from sandy, free-draining soils in south-western Australia.

This article focuses on the effects of irrigation and fertiliser regimes on nitrogen leaching from turfgrass production. Information on the effects of irrigation and fertiliser regimes on turfgrass growth and quality appeared in ATM Vol 6.2, pp 6-7.

Fertilisers and Irrigation Regimes Trialled

The study evaluated four fertiliser types (conventional (water-soluble), control-release, pelletised poultry manure and pelletised biosolids), three application rates (100, 200 and 300 kg N ha⁻¹ per 'crop'), two irrigation rates (70 per cent and 140 per cent daily replacement of net evaporation), and three replicates.

The 70 per cent rate is referred to as 'low irrigation', while the 140 per cent rate is referred

to as 'high irrigation'. The nutrient contents of the fertilisers are summarised in Table 1.

Irrigation and fertiliser treatments were applied over 16–28 weeks, after which the turfgrass was harvested and then allowed to re-grow from the remaining rhizomes.

Crop 1 was grown from 24 October, 2001 - 13 February, 2002 (16 weeks); Crop 2 from 13 February - 3 September, 2002 (28 weeks); Crop 3 from 3 September 2002 - 27 January, 2003 (20 weeks); and Crop 4 from 27 January - 19 August, 2003 (28 weeks).

Plots (10m²) were established on a free-draining soil of low chemical and biological fertility and low phosphorus retention index (PRI). Irrigation occurred daily from October–April each year; and then every second day from April–September when daily net evaporation was less than 5mm; and then

occasionally from May–August when weekly net evaporation exceeded 5mm.

Fertilisers were applied at different frequencies depending on the type. For example for the conventional treatment, 20 per cent of the fertiliser was applied at the commencement of the crop, with the remainder applied every three weeks. For the control-release, 20 per cent of the fertiliser was applied at the commencement of the crop, with the remainder generally applied every six weeks. For the two organic treatments, 70 per cent of the fertiliser was applied at the commencement of each crop, with remainder applied every four weeks.

Nutrient leaching was measured using soil lysimeters (250mm in diameter by 980mm in length) installed in the plots before the commencement of the study. The surface of each lysimeter was approximately flush with the surface of the plots, and leachate collected from a bucket under each lysimeter.

The turfgrass on the lysimeters was irrigated, fertilised, clipped and harvested at the same time as the turfgrass plots. Fertilisers applied to the lysimeters were weighed separately to those applied to the plots to ensure that the lysimeters received the correct amount of fertiliser.

Table 1. Chemical characteristics of fertilisers used during the experiment. The conventional and control-release fertiliser treatments include a combination of two fertilisers, with conventional I and control-release I only applied once at the beginning of each crop.

Fertiliser	Nitrogen (%)	Phosphorus (%)	Potassium (%)
Conventional^a			
Conventional I	4	7	7
Conventional II	34	0	0
Control-release^b			
Control-release I	26	11	10
Control-release II	25	2.2	4
Pelletised poultry^c			
Pelletised biosolid	5.5	1.5	3

^a Conventional I also contained 130 mg S g⁻¹, and 150 mg Ca g⁻¹

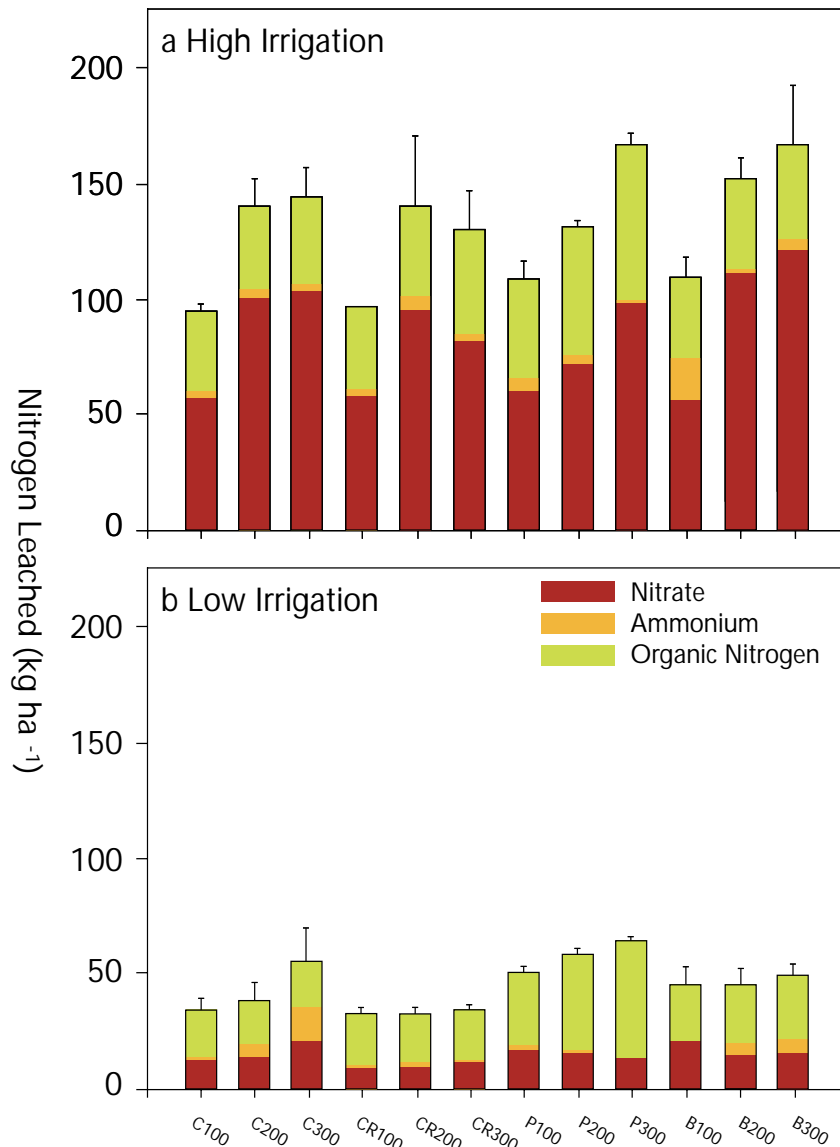
^b Control-release I also contained 100 mg S g⁻¹, and control-release II also contained 41 mg S g⁻¹, 30 mg Ca g⁻¹, 50 mg Fe g⁻¹

^c Pelletised poultry also contained 5.1 mg S g⁻¹, 19 mg Ca g⁻¹, 4.7 mg Na g⁻¹, 2.8 mg Mg g⁻¹, 130 µg Cu g⁻¹, 240 µg Zn g⁻¹, 325 µg Mn g⁻¹ and 185 µg Fe g⁻¹.



Installed lysimeter six weeks after planting

Figure 1. Proportion of nitrogen leached as nitrate, ammonium and organic nitrogen under high (a) and low (b) irrigation. Values are means of three replicates. The total height of the bar equals the total nitrogen leached after 22 months, with the error bar representing the standard error of the total nitrogen mean. Where: C is for conventional; CR, control-release; P, pelletised poultry; B, pelletised biosolids.



Proportions of nitrogen leached under low and high irrigation regimes

Total Nitrogen Leached

After 22 months, total nitrogen leaching ranged from 33-167 kg ha⁻¹ (Figure 1). Increasing the irrigation rate significantly increased the average amount of nitrogen leached from 44kg ha⁻¹ to 132kg ha⁻¹. At the high irrigation treatment, the only difference in total nitrogen leaching

between fertiliser types was between pelletised biosolids (average of 143kg N ha⁻¹ across all application rates) and the control-release (average of 123kg N ha⁻¹ across all application rates).

The total nitrogen leached represented 11-28 per cent of the nitrogen applied to the high irrigation treatments. For the low irrigation

treatment, the total amount of nitrogen leached did not differ between fertiliser treatments (types or rates), and represented less than 12 per cent of the nitrogen applied.

Forms of Nitrogen Leached

The nitrogen leached was mainly nitrate or organic nitrogen depending upon the irrigation rate (Figure 1).

For the high irrigation treatment, 55-72 per cent of the nitrogen leached was in the nitrate form, 25-42 per cent in the organic nitrogen form, while the remainder was ammonium (<5 per cent). For the low irrigation treatment, 27-43 per cent of the nitrogen was in the nitrate form, 40-78 per cent in the organic nitrogen form, and 5-20 per cent in the ammonium form.

Timing of Nitrogen Leaching

The pattern of nitrogen leaching varied with time, with large differences between the two irrigation treatments (Figure 2).

For the high irrigation treatments, 46-76 per cent of the total nitrogen leached during the first crop with fortnightly nitrogen losses as high as 50kg ha⁻¹. For the low irrigation treatments fortnightly losses of nitrogen were less than 9kg ha⁻¹, with the greatest losses occurring during the second winter (June 2003) of the study.

For the high irrigation treatment, increased nitrogen losses were associated with nitrate leaching, while for the low irrigation treatments, increased nitrogen losses were associated with organic nitrogen leaching.

Turfgrass Growth and Quality

The effect of irrigation and fertiliser treatments on turfgrass growth and quality has been presented previously (ATM Vol 6.2, pp 6-7). Briefly, we found that the low irrigation regime not only maintained turfgrass growth, but maximised water use efficiency.

Furthermore, the high irrigation rate was detrimental to turfgrass growth and colour during turfgrass establishment. For turfgrass produced on a sandy soil, conventional (i.e., water-soluble) and control-release fertilisers produced better growth and colour than pelletised poultry manure and pelletised biosolids at nitrogen application rates of 100-300kg ha⁻¹ per crop.

Concluding Comments

Nitrogen leaching from turfgrass production systems on sandy soils will be low if irrigation regimes supply sufficient water for turfgrass growth without causing excess water to move beyond the rooting zone.

Furthermore, under optimised irrigation regimes we expect nitrogen leaching to be low

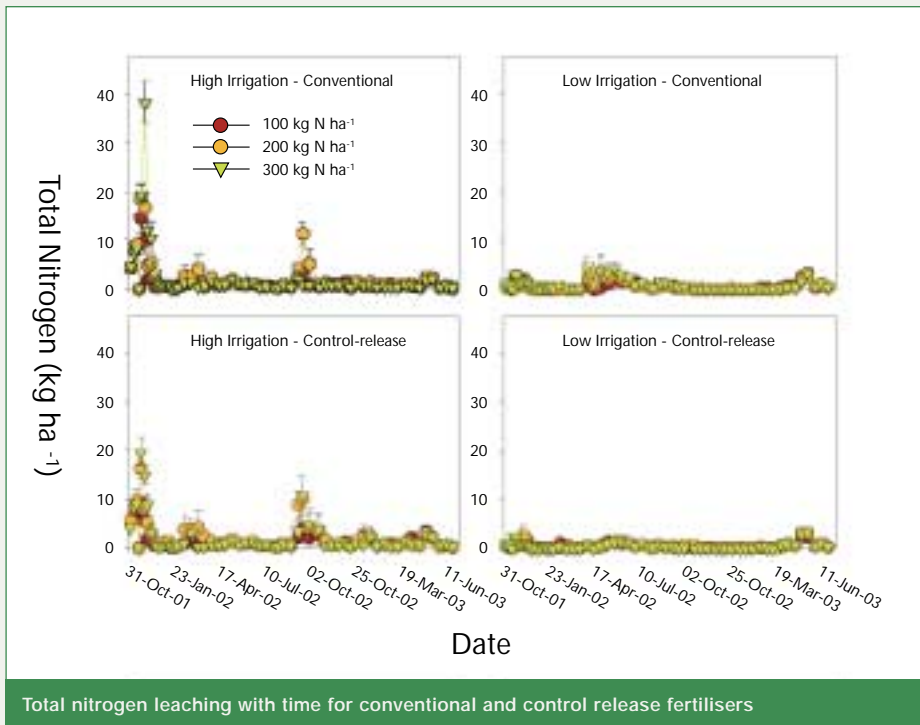


Figure 2. Total nitrogen leaching with time for the conventional, control-release, pelletised poultry and pelletised biosolids at three nitrogen application rates, and under high and low irrigation. Values represent means (\pm standard errors) of three replicates.

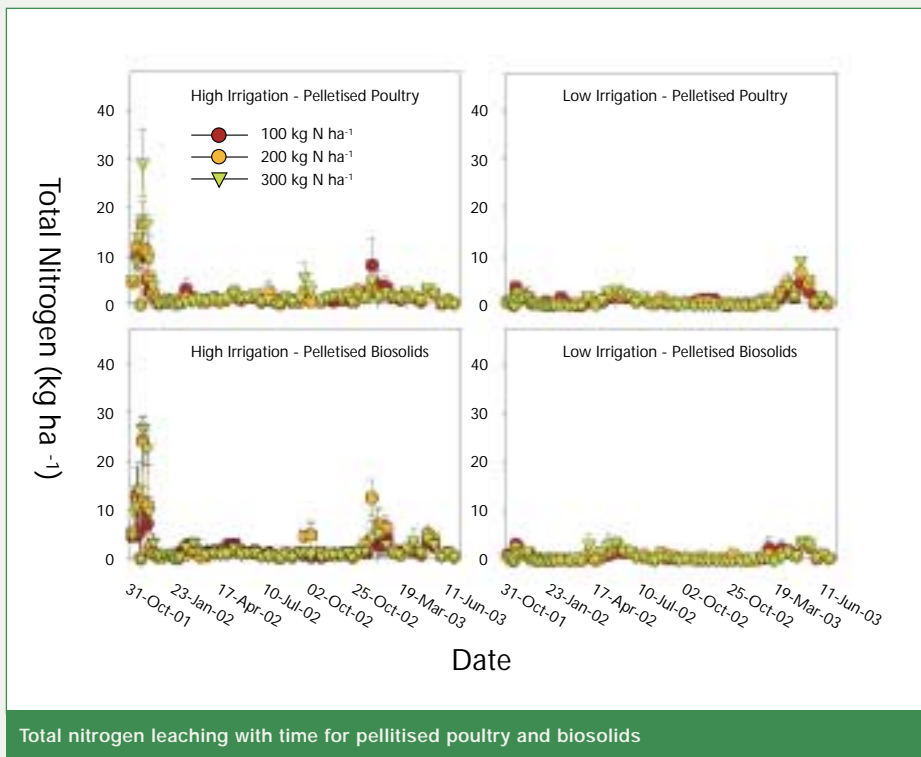
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from all fertiliser types as long as nitrogen is applied at a rate and frequency that matches turfgrass requirements.

The risk of nitrogen leaching is greatest during the establishment of the turfgrass, and to lesser extent following harvests of sod (i.e., turfgrass rolls). Furthermore, the irrigation and fertiliser management practices that limit nitrogen leaching can also benefit turfgrass growth and quality.

We recommend that total nitrogen, in addition to mineral forms of nitrogen, should be measured when assessing the influence of management practices on nitrogen leaching from turfgrass, as significant proportions of the nitrogen leached under turfgrass in our study was in the organic nitrogen form.

Total nitrogen leaching with time for conventional and control release fertilisers

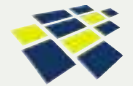


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<http://www.fnas.uwa.edu.au/turfresearch/index.htm>



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