

# Effects of nitrogen fertiliser on nitrate leaching and production of autumn-sown Italian ryegrass in a double-cropping system on a New Zealand dairy farm

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**Introduction** On intensive dairy farms in New Zealand, winter Italian ryegrass crops are combined with summer maize silage crops in double-cropping systems. Limited data (Davies & Neilson, 1975) showed variable ryegrass yield responses to nitrogen (N) fertiliser when grown after maize. Nitrogen leaching losses were not measured in this experiment but Ledgard *et al.* (1988) showed that late autumn/early winter N applications are vulnerable to leaching. Different rates of N fertiliser were applied to Italian ryegrass grown after maize to assess yield responses and levels of nitrate leaching.

**Materials and methods** Two experiments were conducted at Dexcel (37°47'S, 175°19'E, 40 m a.s.l.) on a free-draining Horotiu silt loam soil (Umbric Vitrandept). Italian ryegrass was drilled (20 kg/ha) into maize stubble in mid April of Years 1 and 2 in areas double-cropped for three years out of pasture. Treatment plots (5 x 2m) were arranged in a four replicate randomised block design. Plots received totals of 0, 40, 100, 160 and 220 (Year 2 only) kg N/ha as urea (46% N) in equal split applications at 24, 40, 90 and 109 d after drilling. Plot herbage was cut 80, 135 and 170 d from drilling and a sub sample was analysed for dry matter (DM) and N contents. Porous ceramic leachate collectors (3/plot) were inserted 60 cm below the soil surface and leachate was sampled 6-8 times throughout the winter drainage period. This was analysed for nitrate and ammonium-N by high-pressure liquid chromatography. Drainage was estimated using lysimeters containing intact soil cores.

**Results** Strong linear yield responses to N fertiliser occurred at all harvests in Year 1 up to 160 kg N/ha and in Year 2 up to 100 kg N/ha. Cumulative yields were 2.7, 3.5, 4.2 and 4.8 t DM/ha (SED=0.3) for 0, 40, 100 and 160 kg N/ha in Year 1; comparable Year 2 data were 3.9, 4.5, 5.9 and 5.9 t DM/ha, with plots receiving 220 kg N/ha yielding 6.2 t DM/ha (SED=0.3). Most (>94 %) of the total inorganic N leached was as nitrate-N (Table1).

**Table 1** Nitrate-N leached over the total drainage period

kg N/ha	Year 1		Year 2	
	kg/ha	mg/l	kg/ha	mg/l
0	20.6	6.5	14.0	6.6
40	30.9	9.8	22.2	11.3
100	15.7	5.0	34.5	17.5
160	31.7	10.1	35.3	18.0
220	-	-	41.5	21.0
Average	6.2	2.1	12.1	6.1
SED				

In both years there were high inorganic-N levels in soil (85 and 93 kg N/ha, respectively) before the first N application. Year 1 June drainage was >2 times higher than that in Year 2, with reduced leaching losses for the 0N treatment in Year 2. A significant ( $p<0.05$ ) increasing trend in nitrate leaching occurred as N fertiliser increased in Year 2, but not in Year 1. Average nitrate-N concentrations in the leachates were above the recommended drinking water threshold (11.3 mg N/l) at the three highest N rates in Year 2 but, possibly because of lower annual (310 vs 198 mm/yr, respectively) drainage, exceeded it only in the 160 kg N/ha treatment during Year 1. In Year

1, herbage nitrate-N concentrations in the 100 and 160 kg N/ha treatments were near the critical animal health threshold (0.21 % of DM) at the first and second harvests. In Year 2, this was the case for all N treatments at harvest 1, the three highest N rates at harvest 2, but only the highest rate at harvest 3.

**Conclusions** Large improvements in winter yield of Italian ryegrass occurred in response to N fertiliser, although in Year 2 it was near maximum with  $\leq 100$  kg N/ha. Responses ranged from 13-20 kg DM/kg N and were higher than in typical local perennial ryegrass-based pastures. However, the high rates coincided with high nitrate-N concentrations in grass and drainage and highlight the conflict between production and environment.

## References

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