Enhancing water use efficiency on irrigated dairy pastures with nitrogen fertiliser

F.R. McKenzie, J.L. Jacobs and G.N. Ward
Department of Primary Industries, 78 Henna Street, Warrnambool, Vic 3280, Australia, Email: frank.mckenzie@dpi.vic.gov.au

Keywords: dry matter, perennial ryegrass, urea

Introduction Low summer rainfall in southwest Victoria, Australia, restricts pasture growth and limits milk production. One fifth of dairy farmers in the region have some capacity to irrigate during summer. Irrigated dairy pastures are relatively poor utilisers of water with water use efficiencies (WUE) of about 1 t DM/ML water (Ward *et al.* 1998). Using nitrogen (N) fertiliser may increase dry matter (DM) yields for a given amount of water. Data on N response efficiencies from irrigated pasture in southwest Victoria are lacking. Two experiments determined the potential of N fertiliser to maximise the conversion of irrigated water to pasture DM.

Materials and methods Experiments ran from mid-October 2003 to the end of April 2004 on commercial farms. Farm 1 (38°28'S, 142°45'E) was under fixed sprinkler irrigation and Farm 2 (38°27'S, 142°42'E) under centre pivot irrigation. Perennial ryegrass dominated (84 to 88%) both experimental sites. Soil tests (0 to 10 cm) in October 2003 revealed: 26 and 28 mg/kg P (Olsen method), 120 and 230 mg/kg K (Skene method), 19 and 24 mg/kg S (CPC method) and $pH_{(water)}$ 6.7 and 6.0 for Farms 1 (dark-grey sandy loam) and 2 (dark brown-grey loam) respectively. Following each grazing 0, 25, 50, 75, and 100 kg N/ha (urea, 46%N) was applied to 12m x 24m plots, replicated three times in a randomised block design. Weekly neutron probe measurements determined irrigation scheduling and quantity. During the experiment there were nine and seven grazings for Farms 1 and 2 respectively. Three applications of a P, K and S blend (each equivalent to 8 kg P/ha, 27 kg K/ha and 8 kg S/ha) were applied at six-week intervals to both sites. Pasture DM consumed was measured as the difference between pasture DM before and after grazing using a calibrated rising plate meter (Earle and McGowan 1979). An analysis of variance (GenStat Committee 2000) with significance declared if $P<0.05$ was conducted.

Results Multiple N applications of 25 to 100 kg/ha increased ($P<0.05$) DM consumed at both sites by a total of between 1.7 to 5.3 t/ha for the summer irrigation period (Table 1). While the improvements in WUE were greatest (68 to 69% and 33 to 40% for Farms 1 and 2 respectively) with N at 75 to 100 kg/ha, the corresponding N response efficiencies were lower than when 25 kg N/ha was applied.

Table 1 Effect of treatment (kg N/ha/grazing), total pasture consumed (t DM/ha), extra pasture produced (t DM/ha), nitrogen response efficiency (kg DM/kgN), water use efficiency (t DM/ML) and improvement in water use efficiency (%) for Farms 1 and 2

Treatment	Total N applied		Total consumed		Extra produced		N response efficiency		WUE		Improvement in WUE	
Farm	1	2	1	2	1	2	1	2	1	2	1	2
0	0	0	7.7	9.1	-	-	-	-	0.85	1.34	-	-
25	225	175	10.3	10.8	2.6	1.7	11.6	9.7	1.14	1.59	34	19
50	450	350	11.5	11.5	3.8	2.4	8.4	6.9	1.27	1.69	49	26
75	675	525	13.0	12.8	5.3	3.7	7.9	7.0	1.44	1.88	69	40
100	900	700	12.9	12.1	5.2	3.0	5.8	4.3	1.43	1.78	68	33
l.s.d. ($P<0.05$)	-	-	1.34	1.27	-	-	-	-	-	-	-	-

Total water (irrigation plus rain) from mid-October 2003 to 30 April 2004: 905 and 681mm/ha for Farms 1 and 2

Conclusions Pasture DM consumed increased with N fertiliser. While 75 to 100 kg N/ha resulted in the highest WUE, applications of 25 kg N/ha following each grazing gave best N responses (10 to 12 kg DM/kgN). Nitrogen fertiliser improved the conversion of a fixed amount of water (irrigation plus rain) into pasture DM.

References

Earle D.F., & A.A. McGowan (1979). Evaluation and calibration of an automated rising plate meter for estimating dry matter yield of pasture. *Australian Journal of Experimental Agriculture and Animal Husbandry*, 19, 337-43.

Genstat 5 Committee (1997). 'Genstat 5.41 Reference Manual'. Oxford Science Publications, Oxford, UK.

Ward G, S. Burch, J. Jacobs, M. Ryan, F. McKenzie & S. Rigby (1998). Effects of sub-optimal irrigation practices on dairy pasture production in south west Victoria. *Proceedings of the Ninth Australian Agronomy Conference*, 254-257.