Influence of nitrogen on the yield, water use and water deficits of wheat grown in a Mediterranean climate

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In water-limited environments it is generally considered that high dry matter production prior to flowering reduces the water supply available for post anthesis growth and grain filling, leading to lower grain yields (1). This has led to low planting densities and conservative use of nitrogen fertiliser in water-limited environments. This paper reports results from a study of the interaction of water and nitrogen use of wheat grown on a duplex soil in a Mediterranean climatic zone in a dry year.

Methods

Wheat (Triticum aestivum L.) cv. Gutha was sown at 50 kg/ha on 14 June 1985 in 4 replicated plots at the Merredin Research Station that had grown either Gutha wheat or lupins (Lupinus angustifolius L. cv. Yandee) in 1984. Zero or 30 kg N/ha as ammonium sulphate was broadcast on the plots immediately after sowing. The yellow duplex soil had a clay content of 9% at the surface increasing to 33% at 1 m. Annual rainfall was 70% of the long term average, with a growing season (June to October) rainfall of 164 mm. Dry matter, leaf area and soil water content were measured every 14 days; profile root length densities and leaf water potentials were measured at anthesis; and grain yield and its components were measured at maturity.

Results and discussion

Table 1. Influence of nitrogen fertilser on some characteristics of Gutha wheat grown after wheat or lupins. Values are means t s.e.

	Wheat after Wheat		Wheat after Lupins	
N fertiliser applied	0 kg N/ha	30 kg N/ha	0 kg N/ha	30 kg N/ha
Dry matter (t/ha)	2.90±0.16	3.76±0.20	4.13±0.10	4.29±0.12
Grain yield (t/ha)	1.32±0.07	1.77±0.30	1.93±0.09	2.00±0.06
Head number (no/m^2)	126±6	153±6	169±6	175±4
Total water use (mm)	160±10	163±3	178±2	173±3
Leaf area index (m^2/m^2)	0.76±0.04	1.43±0.10	1.71±0.13	1.83±0.10
Water potential (MPa)	-2.12±0.08	-2.83±0.12	-3.01±0.16	-

Table 1 shows the well-documented increase in dry matter production and grain yield commonly found in wheat grown after lupins. In this study 30 kg N/ha of fertiliser applied to wheat after wheat gave 10% smaller (statistically insignificant) yields to those following lupins. The wheat in the more fertile soils grew significantly faster in the first 60 days after sowing and this differential was maintained until anthesis. While this led to greater water deficits at anthesis, a greater number of fertile tillers were produced in the wheat in the fertilised soil leading to the higher grain yields. Grain yield was linearly related to head number: grain number per head and grain size were unaffected by the level of nitrogen. Total water use was 8% greater when nitrogen came from lupins than from fertiliser, leading to a greater water use efficiency in the fertilised plots on a total dry matter basis (17 kg DM/ha/mm at 0 kg N/ha and 22-25 kg/ha/mm in the fertilised soil) and on a grain yield basis (8 and 11 kg/ha/mm, respectively). Despite the very dry year, nitrogen (both from lupins and fertiliser sources) increased yields due to its influence on early growth and fertile tiller development and this benefit was not reduced by the water deficit at anthesis.

1. Fischer, R.A. 1979. J. Aust. Inst. Agric. Sci. 45, 83-94.