Response of wheat yield to preceding crop and fertiliser nitrogen

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Abstract

In a rotation trial at Roseworthy, wheat yields were always higher when following either medics or faba bean than when following barley grass in 1995 and 1996. Application of nitrogen (N) at 0, 50, 75 and 100 kg/ha to wheat failed to increase wheat yield in all the treatments. This response was consistent in both years, despite rainfall being close to seasonal average. These results were associated in part with haying-off at high rates of N, and probably with adequate availability of native N in the soil for the rainfall received in the two seasons.

Key words

spring wheat, rotations, pasture legumes, nitrogen, haying off, grazing

Rotation of cereals with legumes, mostly pastures, is a major feature of cropping in the Australian cereal belt. Studies have shown increases of up to 100 % in grain yield and up to 50 % in protein for the cereal crop following legumes, and are often associated with residual nitrogen (N) fixed, but not completely utilised, by the preceding legumes (1, 4). However, it is still debatable whether the residual N from legumes is adequate for achieving potential yield for the following wheat in any given environment, and additional N fertilisation of up to 80 kg/ha has been found to further increase wheat yield after pasture by about 50 % (3). In the current study, wheat yield response to preceding legumes and to supplementary fertiliser N in the cropping season was evaluated.

Materials and methods

Two phases of rotation were started with the pasture course in 1994 (Phase I) and 1995 (Phase II). The treatments consisted of medics (Medicago truncatula cv. Praggio), faba bean (Vicia faba cv Fiord) and barley grass (Hordeum leporinum), and were assigned to 0.5 ha plots arranged in a randomised complete block design with three replications. Thus, the first wheat season was in 1995 for Phase I and 1996 for Phase II. For Phase I, wheat cv Janz was sown on 30 June 1995, while for Phase II, herbicide and flooding damaged the first sowing in June, and so seeding was repeated on 15 August 1996 using cv Exculibur. At wheat sowing, four strips of 70 m by 2.4 m were marked out in each plot and were supplied with fertiliser N at rates of either 0, 50, 75 or 100 kg/ha. Dry matter (DM) accumulation by wheat and soil water and nitrogen were monitored during the season. At harvest, grain and above-ground DM and yield components were determined. In this report, the results are presented for wheat yields, harvest indices and grain weight following either faba bean or grazed medics or barley grass. Data on soil water and N have been reported (2). No symptoms of disease and/or nematodes infestation (CNN, take-all, rhizoconia and pratylechus) wereN, take-all, and pratylenchus) were observed during this study.

Results and discussion

The growing season rainfall (May to November) was 294 mm in 1995 and 355 mm in 1996. In both years, the wheat yields was in the following order faba bean > medics > barley grass treatments (Table 1); the difference in wheat yields following the two legumes being significantly higher than when following barley grass. These increases in wheat yield following legumes were consistent with increases of 70 % in inorganic N and 10 % in water in the soil profiles under medics compared to those under barley grass at the start of the wheat season (2). Late sowing in 1996 reduced wheat yields in all treatments compared to

1995 season, with largest fall (33 %) produced by the medic treatment and the least (19 %) by barley grass treatment.

Fertiliser N did not produce any significant increases in wheat yield in any treatment. In both years, the yield differences amongst N treatments were within 10 % of each other (Table 2). In 1996, there was a progressive decline in wheat yield with increasing rates of N leading to an almost 9 % fall in yield at 100 kg N ha-1. Surprisingly, wheat after barley grass also failed to produce significant increases in grain yield with fertiliser N (data not presented). Reasons for the lack of yield increase with N application could be due in part to haying off at high levels of N availability. Generally, less dry matter was accumulated after anthesis by wheat fertilised with N compared to the non-fertilised treatment which increased its DM by up to 11 % in 1996. Most of the post-anthesis assimilates could have been partitioned to the ears thereby marginally increasing both the harvest index and grain weight (Table 2). These results are consistent with a premature depletion of soil water and reduced grain yield by spring wheat supplied with 67 kg N/ha on a red brown earth in the dry wheatbelt of Western Australia (5).

Table 1: Response of grain yield and harvest index for wheat to previous season?s cropping

Treatments	Grain yield(kg/ha)		Harvest index	
	1995	1996	1995	1996
Faba bean	3381	2592	0.41	0.44
Medics	3354	2306	0.42	0.40
Barley grass	2726	2206	0.38	0.43
P(SE)	0.00 (61.4)	0.00 (100.1)	0.45 (0.017)	0.07 (0.023)

Table 2: Response of grain yield and yield components for wheat to fertiliser N

Fertiliser N(kg ha^{-1})	Grain yield (kg/ha)		Harvest index		Mean grain weight (mg)	
	1995	1996	1995	1996	1995	1996
0	3362	2474	0.44	0.44	na	34.2
50	3267	2474	0.42	0.42	na	34.2
75	3199	2430	0.40	0.42	na	33.8
100	3223	2262	0.40	0.38	na	33.8

P(SE)	0.12 (50.1)	0.26 (81.7)	0.016 (0.014)	0.21 (0.190)	-	0.06 (0.36)

na=data not taken

Thus, higher N availability increased the yield of wheat following legumes compared to when following barley, because the former also had more residual soil water. While without additional soil water, fertiliser N failed to improve wheat yield. However, since wheat following barley grass also failed to increase yield with N application, suggested probable adequate supply of N in the soil to attain potential yields in the two seasons. This was likely since the site was under pasture legumes for several seasons prior to the commencement of this trial. Analysis of yield with French & Schultz model (3) showed that 94 % of potential yield was achieved for the 1995 season and 45 % for the late sowing in 1996. This study shows the importance of determining N at the start of the season to achieve the best fertilisation practice. This project was funded by GRDC, and we thank Messers Ian Trigg and Tim Prior for their technical support.

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