Optimum management of N fertiliser for wheat growing on alkaline soils

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Abstract

In 14 experiments in western Victoria on alkaline soils with hostile subsoils, application of urea to wheat by mid-row banding (MRB) gave yield responses similar to those from split top-dressing, and significantly greater than the standard application method of incorporation by sowing. The advantages of both banding and topdressing are because nitrogen is kept separate from the salt, sodicity and boron in the subsoil. Grain growers prefer MRB to topdressing because of lower cost and because it is not dependent on rain for effective nitrogen incorporation.

The appearance of nitrate, ammonium and nitrite was measured at two-weekly intervals from near the bands and away from the bands in 3 experiments. Peak ammonium concentrations were found 45 days after sowing (DAS), while nitrate concentrations were maintained until 75 DAS. High levels of nitrite (≈20 mg/g) were found near the bands 45 DAS, apparently because the transformation of nitrite to nitrate was slow in the high-pH conditions induced by the urea. From the results at hand, the advantages of MRB do not appear to be outweighed by the risk of nitrite toxicity.

Keywords

Nitrate, nitrite, ammonium, nitrogen management.

Introduction

Urea toxicity in field crops is particularly associated with high pH soils (1), which occur across much of the southern wheat belt in Australia. To overcome this effect, options such as predrilling, banding or post-seeding topdressing applications are often used. Banding the urea near the seed is a lower cost operation than topdressing because the latter involves an additional pass over the paddock. Similarly, pre-drilling also requires an extra machine operation before seeding. Placing the fertiliser with the seed, or banding near the seed reduces the need for the extra pass, although care needs to be taken with seed being placed in close association with urea due to high pH, toxic ammonia levels and osmotic effects on germinating seed (1, 2).

The higher concentration of urea in banded placements slows the rate of nitrification (3), and N supply to the roots is thus lower early in the season, but continues for a longer period into the growing season. Our research has investigated the option of banding urea in between every second seeding row, termed mid row banding (MRB). In 14 experiments in western Victoria on alkaline soils with hostile subsoils, the application of urea to wheat by mid-row banding (MRB) gave yield responses similar to those from split dressings, and significantly greater than the standard application method of incorporation by sowing (4). The advantages of both banding and topdressing are because nitrogen is ‘trickled on’ and kept separate from the salt, sodicity and boron in the subsoil. This paper reports on the presence of high levels of nitrite adjacent to the mid-row bands of urea and discusses the possible implications of the levels observed.

Methods

Results are presented from three field experiments that were established in the southern Victorian Mallee to investigate a range of N strategies, including MRB, on high pH soils with high sodicity, salinity and boron levels in their subsoils. These experiments were sown on May 26 (Beulah sites) and June 13 (Warracknabeal). The results presented here are from MRB treatments with 80 kg N/ha applied as urea. Within each plot three subsample cores were taken with a thin walled tread sampler between the sowing rows to a depth of 10 cm into the urea bands (A) and between adjacent seeding rows where there was no fertiliser placed (B). Samples were taken at three times, approximately 45, 60 and 75 days after sowing and analysed for ammonium, nitrate and nitrite, measured colourimetrically in a segmented flow analyser. Levels of the ions are expressed as mg N per kg of soil.

Results

Table 1 shows the mean levels for the ions in these samples at three sites at three times. As expected, high levels of ammonium and nitrate were found in the bands, and nitrate levels continued at relatively high levels in the bands for the duration of the measurements. Of particular interest were the levels of nitrite detected near the urea bands at the first sampling time on both of the sites at Beulah. None of the sites were significantly waterlogged, which could contribute to higher nitrite levels (1). The relative levels of ammonium and nitrate suggest that urea hydrolysis was occurring faster than nitrification of nitrite to nitrate, which would then lead to a build up of nitrite (1). At Warracknabeal, the nitrite level was slower to increase, possibly due to later sowing at that site and cooler temperatures reducing the rate of hydrolysis and nitrification.

While it is recognised that nitrite can be taken up and metabolised by wheat in neutral soils (5), inhibition of root growth has been reported in solution culture with nitrite concentrations around 40 mg/l (6). While the recorded nitrite levels are at the lower end of the range expected from crop toxicity (5, 6), it is likely that roots would avoid these bands and so crop effects would be expected to be minimal.

Table 1: Nitrate, ammonium and nitrite levels at three sites in the Mallee within the mid row urea band (A) and between the drill rows (B)

Site	DAS	Nitrate N mg/kg		Ammonium N mg/kg		Nitrite N mg/kg	
		(A)	(B)	(A)	(B)	(A)	(B)
Beulah Flat	46	153?37	6?2	133?68	<1	19?4	<1
	60	62?11	8?1	7?1	6?1	<1	<1
	75	61?9	10?1	6?1	6?1	<1	<1
Beulah Ridge	46	53?10	3?1	110?19	<1	13?3	<1
	60	29?21	13?11	28?21	20?20	<1	<1
	75	28?9	4?2	8?4	5?0.3	<1	<1
Warracknabeal	42	43?8	46?31	11?8	19?18	1?2	<1

57	90?33	13?3	32?11	6?1	7?3	<1
75	73?16	6?1	8?3	6?1	<1	<1

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