Innovative Deep Nutrient Application with Fluid Fertilisers

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Key Points

- High-pressure injection shows promise as an alternative method for applying fertiliser into the soil.
- Deep banding fluid fertilisers with extra long knife points is another option which also showed promise.
- This research is still in its early days.

Why do the trial?

To identify suitable machinery for deep nutrient placement with economic and practical potential. To evaluate the potential of injecting fluid fertilisers into soil using high pressure. Refer to Subsoil Nutrition articles in the "Soils" section in previous Eyre Peninsula Farming Systems summaries.

For several years massive yield increases have been achieved by deep tillage and nutrient application in infertile sand over clay soils. The largest yield increases to date have occurred when multi-nutrient fluid fertilisers with phosphorus, nitrogen, zinc, copper & manganese are placed pre sowing throughout the profile to a depth of 40 cm or between 20 cm to 40cm below the surface. Despite the spectacular increases in cereal yields, this practice has not been adopted because deep tillage is slow, expensive and traction is a problem on sands, fluid fertilisers are expensive and application volumes exceed 500 l/ha.

How was it done?

High-pressure injection and other methods were evaluated in a pilot trial to assess whether they could be used to place multi-nutrient fertilisers at depth more easily but still produce yields similar to deep tillage with fertiliser placement to 40 cm. The methods tested were:

- Deep ripping with nutrients (control) - Deep rip tines working at 40 cm deep fitted with four spray jets equally spaced down the trailing edge (Figure 1). To reduce application volume and improve practicality, speed was increased to 7.5 km/hr from 5 km/hr as used in past years. This is the standard treatment used in all previous deep placement trials.
- High-pressure injection - Each deep rip tine was fitted with a solid stream nozzle on the foot pointed downwards (Figure 2). This system uses a combination of tillage and the penetration of high pressure to apply fertiliser at depth. Injection pressures used were 345 bar (5000 psi) and 86 bar (1250 psi) at tillage depths of 10 & 30 cm.
- Deep coulter banding - 76 cm Yetter coulters fitted with a rear knife and fluid tube operating at 30 cm. Fluid fertiliser was placed in a band from a single outlet at low pressure (1 bar) fixed to the bottom of the knife.
- Deep knife banding - 225 mm knifepoints were fitted to Ausplow DBS seeding tines. A fluid delivery tube was fixed to

the rear of the knife, banding fluid at the working depth of the knifepoint, approximately 200 mm below the surface.

• No deep nutrients (district practice). Deep placed nutrients were applied well before sowing (2-4 weeks) except with 'deep knife banding' where subsoil nutrients were applied during seeding. Nutrients applied at depth were 12 kg P/ha, 25 kg N/ha, 2.25 kg Mn/ha, 1.5 kg Zn/ha & 0.75 kg Cu/ha from phosphoric acid, urea and zinc, manganese and copper sulphates. The row spacing for deep rip tines and coulters was 50 cm. DAP was applied at 60 kg/ha with seed during sowing for all treatments. Shorter 150 mm knife points were used to sow the trial compared to those used in 'deep knife banding'. Frame wheat was sown on June 17.

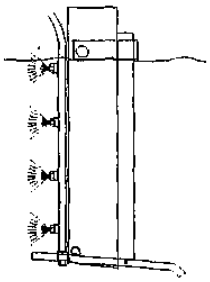

Figure 1: Deep ripping tine diagram showing position of fluid nozzles. Benchmark system for maximum yield used for past 2 years.

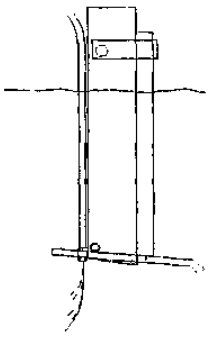

Figure 2: Deep ripping tine diagram showing position of high-pressure nozzle.

What happened?

The trial was intended as a first step in identifying ways to make deep placement of nutrients more practical and economic and test high pressure as an option to achieve this goal. Grain yield results from 2003 (Table 1) indicated that the method which applied nutrient the deepest tended to produce the highest yields. This is consistent with past work at several sites.

High-pressure injection - Higher yields were achievable by reducing tillage depth and using high pressure to apply nutrients deeper. At 5000 psi and tines at 30 cm yields were better than deep ripping to 40

cm with nutrients, the consistently highest performer previously. However there was no difference in yields between 88 and 345 bar pressure at either depth. This is important from a practical point of view because high pressure requires a high power input (approximately 4 hp/nozzle @ 5000 psi). Reducing pressure to a medium level of 1250 psi reduces power input and application volume by approximately half each. There hasn't been any accurate assessment of penetration distance from the nozzle. However from observation 100 - 150 mm seems achievable, possibly more in the sands. Deep ripping unfortunately causes considerable soil surface disturbance which often requires levelling or firming with a light roller before sowing can occur, particularly when sowing with knife points. Deep coulter banding was considered as an alternative to high pressure. The first advantage observed from coulters was the minimal soil disturbance. In these sandy soils coulters were also able to reach maximum depth without extra weight to aid penetration. They also yielded very well.

Deep knife banding was included as a one-pass seeding and deep fluid banding system. In this system deep nutrients were applied at the same row spacing as seed (225 mm). We can't say from the trial whether this is an advantage or not. Yields under this system were less than the best treatment but still yielded 20% more than district practice. Because district practice received a lower amount of nutrients than the deep placement treatment, we are unable to determine whether the yield increase is from nutrients at depth, increased nutrient input or a combination of both. However in past trials on these soils, increasing nutrients in the top 5 cm hasn't increased yields to the same magnitude as placing some nutrients deeper. The extra length knife points did not cause excessive soil throw or seedling establishment problems. In the interim this method would be worth considering on a larger area until we know more about the other alternatives.

Table 1: Yield and protein from alternative methods of deep placed nutrient application at Wharminda, 2003. Note: district practice received lower P, N and micronutrient inputs.

	Application Volume	Grain Yield		Protein	
	L/ha	t/ha		%	
Deep ripping to 30 cm + fluid injection @ 5000 psi	653	1.90	a..	9.7	ab...
Deep ripping to 30 cm + fluid injection @ 1250 psi	316	1.82	ab.	9.5	.bcd.
Deep ripping to 10 cm + fluid injection @ 5000 psi	653	1.81	ab.	9.6	.bc.
Deep ripping to 40 cm + fluid sprays on trailing edge	361	1.78	.b.	9.5	.bcd.
Fluid banding @ 30 cm with large coulters	200	1.78	.b.	9.4	..cd.
Knife banding @ 20 cm with DBS while sowing	200	1.75	.b.	9.3	..cd.
Deep ripping to 10 cm - fluid below @ 1250 psi	316	1.73	.b.	10.0	a....
District practice - Nil deep fertiliser	**Na**	1.47	..c	9.3	...d.
F pr.		>0.001		>0.001	

What does this mean?

This trial has shown that fertiliser application with high pressure injection from shallower working tines and banding from coulters or long knife points have potential to improve the economic viability of deep nutrient placement. Further research is required to overcome the limitations of deep tillage to 40 cm (high application

volumes, power & fertiliser costs) and identify methods with similar benefits. Future research will concentrate on:

- Measuring yield response to various pressure and tillage depth combinations.
- Adapting high pressure to coulters.
- Using suspension fluid fertilisers, which are cheaper to purchase.
- More accurate input power estimates to estimate real costs.

Acknowledgements

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Category:
"Searching for answers" - we know what the problem/issue is and we're trying to find out what we can do about it.

Location: Wharminda
Closest town: Arno Bay
Co-operator: John Masters
Group: Wharminda
Rainfall
Av. Annual total: 274 mm
Av. Growing season: 204 mm
Actual annual total: 291 mm
Actual growing season: 236 mm
Yield
Potential: 2.8 t/ha
Actual: 1.55 t/ha
Paddock History
2002: Grass free pasture
2001: Excalibur wheat
2000: Grass free pasture
Soil
Major soil type description: Sand over Clay
Plot size
Dimensions: 2 x 20 m
Other factors
Severe sand blasting at 2-4 leaf stage