Liquid P and Micronutrients in the Mallee

Aim

On sandy soils in the Mallee to test the efficiency of granular versus liquid P fertilisers and determine the impact of zinc and copper on crop performance.

Summary

- Granular and liquid fertilisers were equally effective in terms of grain yield for wheat.
- The addition of zinc and copper had no effect on crop performance.
- Liquid P produced more dry matter production at the 5-leaf stage than granular P.
- More P was taken up by the crop as a liquid rather than as a granular.

Background

Liquid P has proven to be advantageous on alkaline calcareous soils, particularly in South Australia on the Eyre Peninsula. "Liquid" fertilisers, or "fluid P" which has become the more commonly used term is relatively new in its development and farmer interest in Victoria is relatively new. The lack of production facilities within Australia means the per unit cost of fluid P is greater than the granular alternative. In addition, the costs associated with change-over, such as storage and handling can reach up to $70,000 as a one-off capital investment but can be much cheaper.

Trial work has been conducted over several years in Victoria with mixed results. It should be noted that the majority of these years were drought years and so differences may not have been as pronounced. On the other hand, responses to P fertiliser are often larger in drought years (in relative terms) and you could argue that under drought conditions, fluid P may have an advantage. The biggest responses to fluid P on upper Eyre Peninsula, SA, have been under dry conditions with mean yield less than 1 t/ha.

When granular fertilisers are applied to a soil, moisture is required to move into the granule to dissolve it. The resultant solution will slowly diffuse away from the site of fertilisation and become available to the plant. Previous work has shown that the granules may not completely dissolve and become fixed to the soil.

The principal difference between granular and liquid fertilisers is the initial distribution of the fertiliser in the soil and the movement away from the fertiliser band. The movement is governed by the osmotic pressure endured from the addition of water. In fluids, greater diffusion away from the fertiliser band occurs allowing greater uptake by the crop.

Reasons for this further diffusion are unknown. Currently there has been no conclusive evidence to suggest any direct relationship between fluid P response and soil properties, other than pH and calcium content. P responses are still being found on soils which have been identified as high P using Colwell P test. Indicating that the test can overestimate the amount of plant available P and is not a true indicator of what is actually available.

One of the benefits of using fluid P fertilisers is the compatibility it has with micronutrients. Many farmers in the Mallee will apply zinc at seeding each year. Zinc deficiency can occur with clear symptoms but deficiencies are often noticed too late. Losses of up to 30% in yield have been reported, with marked reduction in root growth and a strong interaction with root disease.

Methods

Trial site:	Sea Lake	
Replicates:	4	
Plot Size:	2m x 25m	
Variety:	Annuello	
Sowing Date:	June 6 2005	
Seeding Density:	175pl/m2	
Seeder:	Incitec Pivot Seeder – narrow points, press wheels, 202cm row spacing	
Herbicide:	7/6/05	Triflur X (0.6L), Logran (15g)
	12/8/05	Ally (4g), MCPA LVE (350ml), Lontrel (100ml) + wetter (0.1%)
	5/9/05	Stripe rust control - Propiconazole (Bumper) (250ml)
Soil Type:	Mallee Sand overlying a sandy clay at depth (calcarosol)	

Treatments are presented in Table 1.

The fertilisers used in this experiment were:

Mono-ammonium Phosphate, MAP (N10-P22-K0-S1): a commonly used granular fertiliser in the Mallee (granule).

Technical Grade Mono-ammonium Phosphate, TGMAP: same formulation as MAP (with less purity) but mixed with water before application (fluid).

Table 1: Treatments used in this experiment

Treatments	P Rate /ha	Micronutrients Rate /ha	Application Method
Control	0kg P	0	
MAP	12kg P	0	Banded
TGMAP	12kg P	0	Dribble Band
TGMAP + Zn	12kg P	1kg Zn	Dribble Band
MAP + Zn	12kg P	1kg Zn	Banded, IBS
TGMAP + Cu	12kg P	0.5kg Cu	Dribble Band
MAP + Cu	12kg P	0.5kg Cu	Banded, IBS
TGMAP + Cu, Zn	12kg P	0.5kg Cu, 1kg Zn	Dribble Band
MAP + Cu, Zn	12kg P	0.5kg Cu, 1kg Zn	Banded, IBS

Results

Dry matter production was measured at the five leaf stage, to assess any difference in early vigour between the treatments. Figure 1 shows the marked differences between the liquid and granular treatments compared to the control. TGMAP at 12kg P resulted in nearly 80% greater dry matter than the control, whereas the MAP at 12kg P only improved dry matter by 20%.

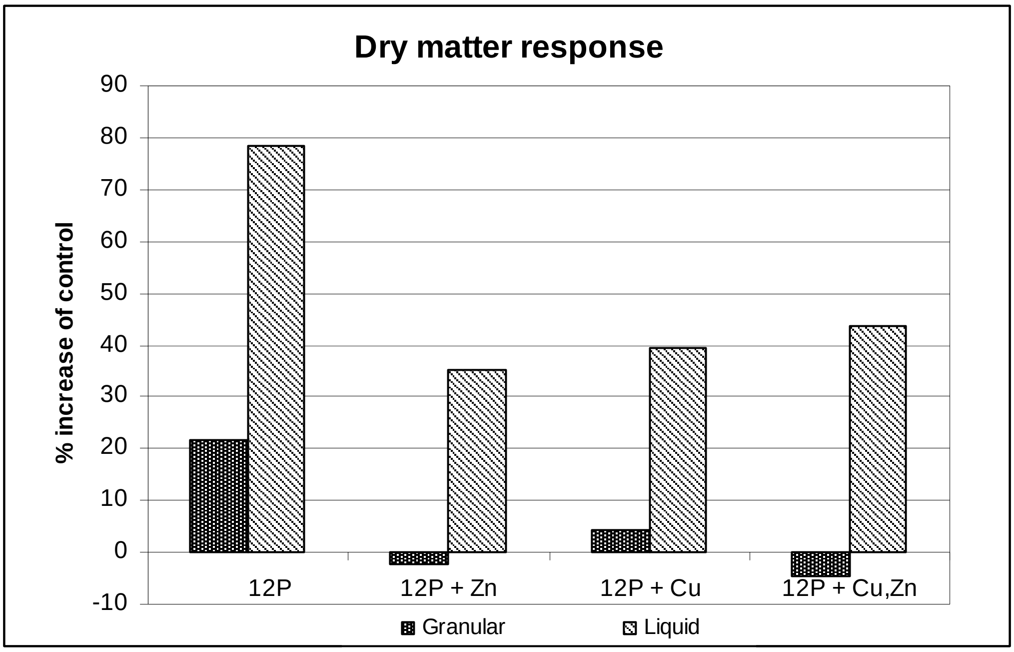

Figure 1: Total dry matter production at the 5-leaf stage of wheat expressed as a % of control

Establishment was relatively even across the site, although from the plant counts made at 3-4 leaf stage, TGMAP 12P had greater plant numbers compared to MAP 12P (Table 1). As a result of fewer plants/m2, MAP 12P produced significantly more tillers than the control. This may not only be a competition effect but P deficiency is also known to cause reduced tillering. Neither of the two indicators, plant population or tillers (m2), related to an increase in head counts at maturity.

Total P uptake (5-leaf) in all the liquid treatments were significantly greater compared to the control.

Table 2: The effect of liquid and granular phosphorus with the addition of micronutrients on performance of wheat.

Treatment	Plant Counts (m^2)	Tiller Counts at GS30 (m^2)	Head Counts (m^2)	Dry Matter at 5-leaf (kg/ha)	Total P Uptake at 5-leaf (kg P/ha)	Yield (t/ha)	Protein %	Screenings %
Control	141	420	295	281	1.02	4.7	11.7	3.8
TGMAP	167	497	298	500	2.00	4.8	11.9	3.6
MAP	134	560	316	342	1.37	4.6	11.6	3.5
TGMAP + Zn	124	504	298	378	1.43	4.2	11.6	4.1
MAP + Zn	124	518	297	274	1.12	4.4	11.5	3.7
TGMAP + Cu	165	592	296	390	1.63	4.4	11.6	3.9
MAP + Cu	135	641	318	293	1.19	4.5	11.8	3.8
TGMAP + Cu, Zn	161	626	316	402	1.57	4.3	11.4	3.1
MAP + Cu, Zn	121	441	300	268	1.09	4.3	11.7	3.5
Significant Difference	**P<0.05**	**P<0.05**	**NS**	**P<0.05**	**P<0.05**	**P<0.05**	**P<0.05**	**NS**
L.S.D 0.05	**27**	**131**	**-**	**78**	**0.36**	**0.4**	**0.4**	**-**
CV %	**7.9**	**27.8**	**3.1**	**6.1**	**6.8**	**3.7**	**1.5**	**8.9**

There was no difference found when applying the two formulations of P on this particular soil type and no benefit from applying micronutrients or in applying P in the first instance. There was an unusual response where TGMAP without micronutrients had a significantly higher yield compared to TGMAP with micronutrients. This difference is not conclusive, despite being consistent with dry matters, and will be investigated further next year.

Table 3 shows the grain content of P, Zn and Cu. No differences were observed between any of the treatments. The adequate concentration for P in grain is 3050mg/kg ±160 of which all the treatments were well above. This was also the case for Cu, with all the treatments containing above the adequate concentration for Cu (4.2mg/kg ± 0.5). Zinc concentrations for all treatments however, were below the adequate level (18mg/kg ± 1.5). It is doubtful that this indicates a deficiency under the conditions of the trial as there was little improvement when Zn was applied.

Table 3: Grain analysis chemical composition

Treatment	P mg/kg	Zn mg/kg	Cu mg/kg
Control	3550	15.8	5.0
MAP	3725	15.0	4.9
TGMAP	3475	15.9	4.6
TGMAP + Zn	3625	15.2	4.8
MAP + Zn	3600	15.1	4.5
TGMAP + Cu	3525	15.1	4.7
MAP + Cu	3625	15.3	4.9
TGMAP+Cu,Zn	3600	15.6	4.5
MAP+CuZn	3575	15.3	4.7
Significant Difference	**NS**	**NS**	**P<0.05**
LSD 0.05	**-**	**-**	**0.4**
CV%	**3.0**	**1.0**	**4.7**

Interpretation

There was a clear response in early vigorous growth to P (and P uptake) when supplied as a liquid rather than as a granule. Total P uptake was calculated using the P concentration in the youngest emerged leaf (at 5-leaf stage), multiplied by the DM production.

The liquid treatments matured earlier than the granular. The reason why the early vigour and hence maturity didn't translate into yield was most likely attributed to the late October rains, when over 50 mm had fallen. The later maturing granular P treated plots would have benefited from this moisture to catch up to the liquid treatments.

Commercial Practice

While the most important result in this trial should be yield, there are many factors which could have changed the results. From the early assessments it was clear that the crop had improved growth from applying P as a liquid. This would be fantastic in an average or above average rainfall year. Although it would increase the crop's demand for moisture and may place it under stress in drier years.

Based on this data alone it is not cost effective for liquid P fertilisers to be viable on this soil type at the Sea Lake site in 2005. However neither was it cost effective to use a granular fertiliser. It is important to continue investigations so that if it does become economical we are aware of all the advantages and disadvantages for changing over.