3.4.4 PHOSPHORUS AND TRACE ELEMENT FOR MAXIMUM WHEAT PRODUCTION IN THE HIGH RAINFALL ZONE (GNARWARRE, HAMILTON & LAKE BOLAC)

Researcher:
Andrew Speirs, *HiFert,* ph 0428 685 172
Wes Arnott, Una Allender, Steve Holden, *SFS Ltd.*

Locations: Gnarwarre
Lake Bolac
Hamilton

Background:
Raised bed technology has removed one of the major limitations to grain yield in Southern Victoria. With increasing yields, phosphorus nutrition needs to be assessed for crops yielding greater than 6 tonne per hectare. As yields increase, it is possible that other nutrients may become limiting and in several areas of South West Victoria, both copper and zinc nutrition have been found to be important.

Aim:

- To develop a phosphorus response curve for wheat in the high rainfall zone of South West Victoria.
- Investigate responses to zinc and copper individually as well as in combination.
- Evaluate several R and D products which may improve phosphorus and nitrogen efficiency.

Table 30: Treatment Details

Treatment	Sowing	Pre Sowing	Nutrients applied (kg/ha)				
			N	P	S	Zn	Cu
1	Nil	Urea	60	0	0	0	0.00
2	DAP	Urea	60	15	1	0	0.00
3	DAP	Urea	60	25	2	0	0.00
4	DAP	DAP/Urea	60	35	3	0	0.00
5	DAP	DAP/Urea	60	50	4	0	0.00
6	DAP Zinc cote 2.5%	Urea	60	25	2	3.2	0.00
7	DAPS	Urea	60	25	17	0	0.00
8	DAP Cu cote 1 %	Urea	60	25	2	0	1.26
9	DAP Cu cote 2.5 %	Urea	60	25	2	0	3.22
10	DAP Cu/Zn cote 2.5 %	Urea	60	25	2	3.40	3.40
11	MAP	Urea	60	25	2	0	0.00
12	DAP RB 1	Urea	60	25	2	0	0.00
13	DAP FS	Urea	60	25	164	0	0.00
14	MAP impreg S	Urea	60	25	9	0	0.00
15	DAP impreg S	Urea	60	25	12	0	0.00

Gnarwarre

Annual Rainfall mm: 532 Growing Season Rainfall (Apr-Nov) mm 381
Paddock History: 2001 Pasture

Table 31: Last Soil Test Results

Test	Org. C %	P[12] mg/kg	K mg/kg	S mg/kg	pH H_2O	pH $CaCl_2$	Cu DTPA mg/kg	Zn DTPA mg/kg
Result	1.90	9.5	412	16.1	5.8	4.9	0.83	0.24
Status	High	Marginal	High	Adeq	Mod Acid	Mod Acid	Adeq	Low
Test	**CEC meq/100 mg**	**Ca %**	**Mg %**	**Na %**	**S 0-60**	**SALT dS/m**	**N (kg/ha) 0-10**	**N (kg/ha) 0-30**
Result	19.2	49	42.3	2.8		0.15	57	180

Phosphate buffering Index 81

[12] *P test is Olsen, Colwell 27 0-10cm nitrate 29 and Ammonium 28*

A fully randomised complete block design, 3 replicates 15 treatments

Urea was deep banded under all treatments to balance the total nitrogen input to 60 kg/ha. The additional P applied above 25 P was pre drilled .

Table 32: Calendar of Events and Observations[13]

Growing Season Rainfall: 33mm

Date	Event	Comments[14]
30/5/2002	Sowing	Sown into moist soil beds quite cloddy
19/6/2002	Baited	Site inspection P response evident 40 P plots looking better
25/7/2002	Sprayed	Broadleaf spray Tigrex
15/8/2002	Tissue tests taken	Crop looking well
24/8/2002	Site inspection	Some plots not looking as good possible crown rot
7/11/2001	Field day held	Soil dry cracking rust on 2nd and 3rd leaf from the flag
11/01/2003	Harvested	Crown rot clearly visible esp in reps 2 and 3.

[13] *Record of trial management activities or events that may affect the trial.*
[14] *Note observations relevant to effects of events on trial outcomes.*

Table 33: Actual Rainfall Recorded Total: 452mm

J	F	M	A	M	J	J	A	S	O	N	D
24	59	2.5	20	33	61.5	61	52	43	39	43.5	13.5

Results :

Table 34: Yield and Protein

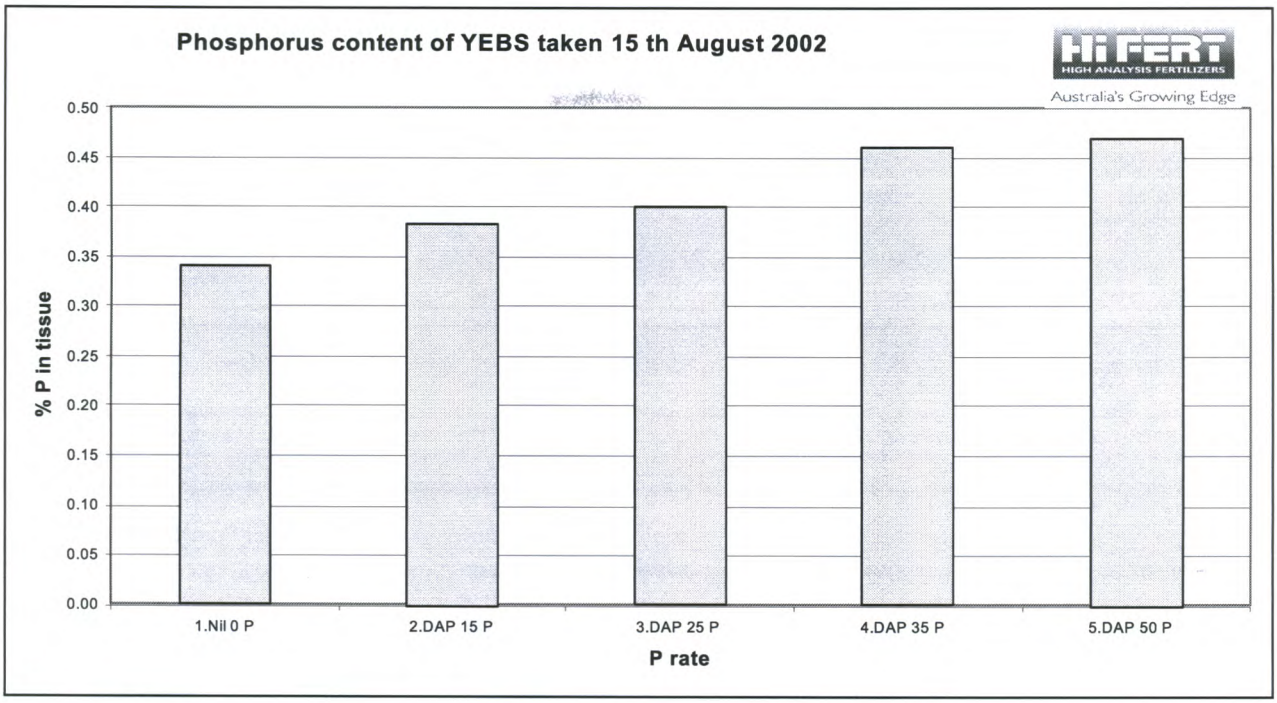
Treatment	Product	Yield (t/ha)	Yield % of Nil	WUE[15] (kg/mm)	Protein[16] (%)
1	Nil	3.29	100	14.07	10.3
2	DAP	3.98	113	15.85	9.37
3	DAP	3.92	119	16.74	9.83
4	DAP	4.07	120	16.82	9.27
5	DAP	3.79	111	15.64	9.33
6	DAP Zinc cote 2.5%	4.24	121	16.96	9.27
7	DAPS	3.70	104	14.66	9.43
8	DAP Cu cote 1 %	3.90	110	15.51	8.77
9	DAP Cu cote 2.5 %	4.31	123	17.27	9.1
10	DAP Cu/Zn cote 2.5 %	4.17	118	16.66	8.47
11	MAP	3.98	113	15.85	9.5
12	DAP RB 1	3.68	104	14.57	9.37
13	DAP FS	3.89	110	15.49	8.7
14	MAP impreg S	4.56	134	18.92	9.3
15	DAP impreg S	4.13	117	16.49	9.3
LSD 5 %		**0.82**			**1.6**
CV %		**13 % high**			**13% high**

[15] *Water Use Efficiency = (0.5 * (March + April) + GSR (M-N) – 110 mm) x 0.02*
[16] *Proteins are variable and low due to crown rot.*

Table 35: Tissue Test Results YEBS 15th August 2002

Treat	Product	N%	P%	K %	S%	Cu ppm	Zn ppm	Ca%	Mg%	Na%
1	Nil	5.89	0.34	4.37	0.48	6.61	24.89	0.20	0.20	0.06
2	DAP	6.00	0.38	4.40	0.46	8.27	22.91	0.22	0.22	0.06
3	DAP	5.98	0.40	4.30	0.45	6.29	25.32	0.22	0.21	0.07
4	DAP	6.20	0.46	4.20	0.48	6.46	25.08	0.24	0.23	0.07
5	DAP	5.59	0.47	4.20	0.45	6.26	23.14	0.22	0.22	0.06
6	DAP Zinc cote 2.5%	5.88	0.40	4.33	0.45	7.90	22.80	0.21	0.20	0.05
7	DAPS	6.36	0.42	4.30	0.47	6.83	23.58	0.24	0.23	0.07
8	DAP Cu cote 1 %	5.73	0.39	4.30	0.44	6.96	22.27	0.24	0.22	0.07
9	DAP Cu cote 2.5 %	5.83	0.41	4.30	0.45	6.83	23.61	0.24	0.23	0.06
10	DAP Cu/Zn cote 2.5 %	5.92	0.38	4.17	0.44	9.18	22.89	0.19	0.20	0.08
11	MAP	5.95	0.44	4.30	0.46	7.29	24.08	0.23	0.22	0.05
12	DAP RB 1	5.83	0.36	4.33	0.46	8.80	22.50	0.21	0.22	0.07
13	DAP FS	5.74	0.43	4.20	0.46	6.92	23.78	0.22	0.21	0.05
14	MAP impreg S	5.88	0.40	4.40	0.44	6.20	22.68	0.24	0.21	0.05
15	DAP impreg S	6.01	0.42	4.40	0.47	6.92	24.26	0.21	0.22	0.07

Figure 8: Phosphorus Content of YEBS at Rates of P



Trial Summary:

Main Findings:

- Phosphorus (P) responses were visual and evident from 3 leaf stage until the end of September with the 50 of P treatments being well ahead of the nil P.
- The 15 P plots also were visibly behind.
- There was a strong trend to increased yield with increasing rate of P applied, however this was not significant due to the high CV as a result of crown rot.
- The zinc and copper cote treatments performed better than most treatments and were significantly better than the nil P treatment, but not significantly better than the straight 25 P treatment as DAP.
- Grain proteins were lower than expected with a very high CV 13%, usually grain protein CV's are about 2 – 3% showing that there was a dramatic effect of possibly crown rot in the site.
- The site had been in barley the year prior which is the best cereal host for carry over of crown rot and a dry finish makes the crown rot worse.

Hamilton

Annual rainfall: 532mm
Growing Season rainfall (Apr-Nov): 381mm
Soil Type: Sandy Loam
Paddock History: 2001 Pasture

Table 36: Latest Soil Test Results

Test	Org. C %	P[17] mg/kg	K mg/kg	S mg/kg	pH H_2O	pH $CaCl_2$	Cu DTPA mg/kg	Zn DTPA mg/kg
Result	3.73	7.2	281	11.1	5.3	4.8	1.0	0.57
Status	High	Marginal	Adeq	Adeq	Mod Acid	Mod Acid	Adeq	Marg
Test	**CEC meq/100 mg**	**Ca %**	**Mg %**	**Na %**	**S 0-60**	**SALT dS/m**	**N (kg/ha) 0-10**	**N (kg/ha) 0-60**
Result	9.5	67.1	17.6	4.4		0.15	57	NA

Phosphate buffering Index 254

[17] *P test is Olsen, Colwell 27 0-10cm nitrate 29 and Ammonium 28*

A fully randomised complete block design, 3 replicates 15 treatments, 100 kg/ha Kellalac wheat

Urea was deep banded under all treatments to balance the total nitrogen input to 60 kg/ha. The additional P applied above 25 P was pre drilled .

Table 37: Calendar of Events and Observations[18]

Growing Season Rainfall: 380mm

Date	Event	Comments[19]
24/5/2002	Sowing	Sown into moist soil beds perfect conditions
24/5/2002	Sprayed	Pre emergent application of Dual and Tristar
6/5/2002	Baited for slugs	Crop just coming through
25/7/2002	Sprayed	Broadleaf spray for seedling sorrel and capeweed
14/8/2002	Tissue tests taken	Crop looking well
24/8/2002	Site inspection	All looking well P response still visible
15/11/2002	Field day held	Some rust on 2nd and 3rd leaf down
14/01/2003	Harvested	All reps harvested well

[18] *Record of trial management activities or events that may affect the trial.*
[19] *Note observations relevant to effects of events on trial outcomes.*

Table 38: Actual Rainfall Recorded Total: 532mm decile 1

J	F	M	A	M	J	J	A	S	O	N	D
23	19	20	42	41	71	74	39	49	55	52	47

Results :

Table 39: Yield and Protein

Treatment	Product	Yield (t/ha)	Yield % of Nil	WUE[20] (kg/mm)	Protein[21] (%)
1	Nil	6.11	100	20.23	10.60
2	DAP	7.03	115	23.29	10.20
3	DAP	7.21	118	23.89	10.33
4	DAP	7.60	124	25.17	10.30
5	DAP	7.58	124	25.10	10.17
6	DAP Zinc cote 2.5%	6.96	114	23.03	10.37
7	DAPS	7.44	122	24.63	10.23
8	DAP Cu cote 1 %	7.17	117	23.74	10.20
9	DAP Cu cote 2.5 %	7.37	121	24.41	10.93
10	DAP Cu/Zn cote 2.5 %	6.97	114	23.09	10.67
11	MAP	7.40	121	24.51	10.50
12	DAP RB 1	7.01	115	23.21	10.40
13	DAP FS	7.12	117	23.58	10.33
14	MAP impreg S	7.45	122	24.67	10.87
15	DAP impreg S	6.99	114	23.14	10.43
LSD 5 % P Rate			0.39		
LSD 5 %		0.49			0.63
CV %		4.1			3.60

[20] *Water Use Efficiency = (0.5 * (March + April) + GSR (M-N) – 110 mm) x 0.02*
[21] *Proteins are variable and low due to crown rot.*

Table 40: Tissue Test Results YEBS 14th August 2002

Treat	Product	N%	P%	K %	S%	Cu ppm	Zn ppm	Ca%	Mg%	Na%
1	Nil	6.14	0.31	4.13	0.45	9.22	24.72	0.42	0.17	0.042
2	DAP	5.88	0.34	4.23	0.45	7.17	23.70	0.40	0.16	0.038
3	DAP	5.97	0.39	4.50	0.46	6.37	22.84	0.30	0.15	0.037
4	DAP	6.13	0.41	4.33	0.47	6.27	24.08	0.32	0.16	0.039
5	DAP	6.14	0.41	4.33	0.46	5.86	24.12	0.43	0.18	0.041
6	DAP Zinc cote 2.5%	5.97	0.37	4.33	0.46	7.09	26.01	0.38	0.17	0.037
7	DAPS	6.29	0.37	4.23	0.47	6.92	25.19	0.42	0.19	0.055
8	DAP Cu cote 1 %	6.13	0.36	4.53	0.46	7.24	24.14	0.38	0.17	0.038
9	DAP Cu cote 2.5 %	5.69	0.37	4.40	0.44	7.36	25.33	0.41	0.17	0.039
10	DAP Cu/Zn cote 2.5 %	5.94	0.40	4.40	0.47	7.00	27.28	0.34	0.16	0.039
11	MAP	5.73	0.36	4.37	0.45	8.01	23.57	0.39	0.17	0.040
12	DAP RB 1	5.84	0.36	4.33	0.45	6.88	23.19	0.30	0.15	0.041
13	DAP FS	5.63	0.37	4.50	0.46	7.17	24.07	0.36	0.18	0.046
14	MAP impreg S	5.95	0.36	4.37	0.45	6.60	23.59	0.35	0.16	0.044
15	DAP impreg S	6.35	0.32	3.83	0.44	7.09	24.54	0.56	0.20	0.051
LSD 5%		**ns**	**0.061**			**ns**	**sig**			
CV %			**9.8**							

Figure 9: Phosphorus Content of YEBS at Various Rates of P

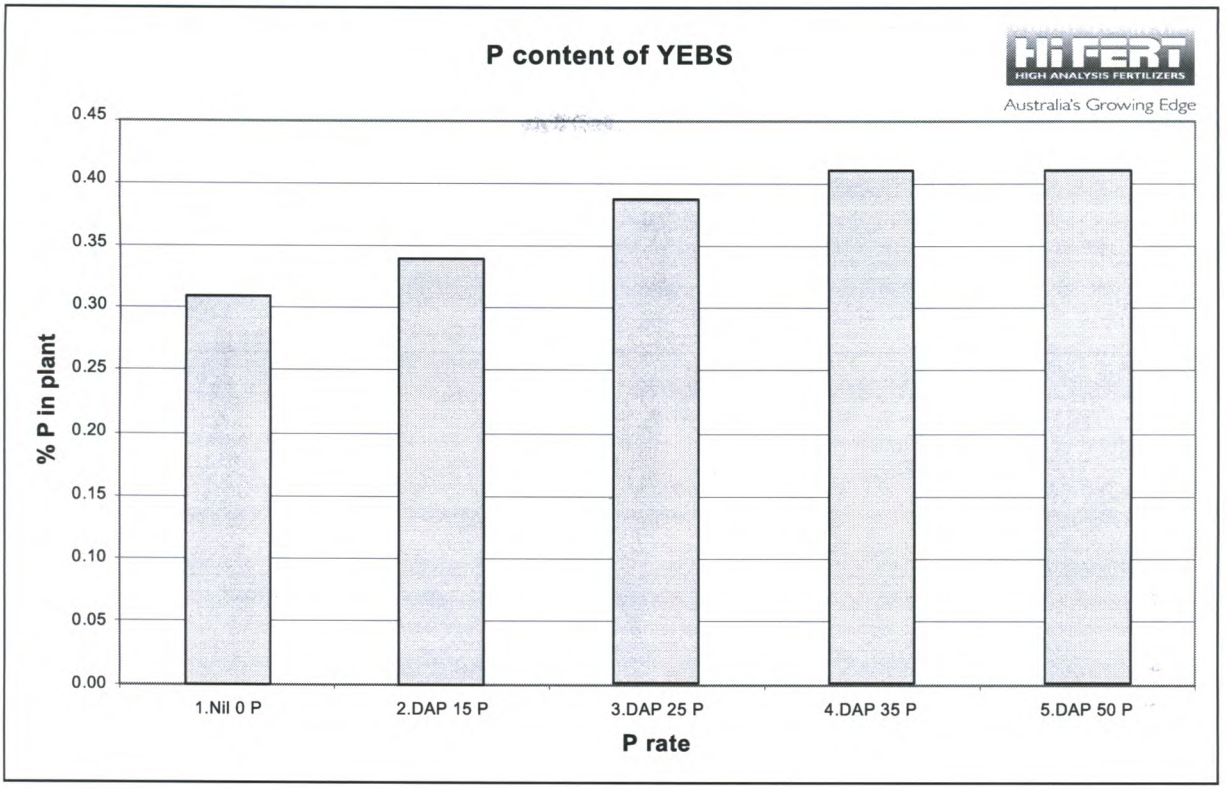
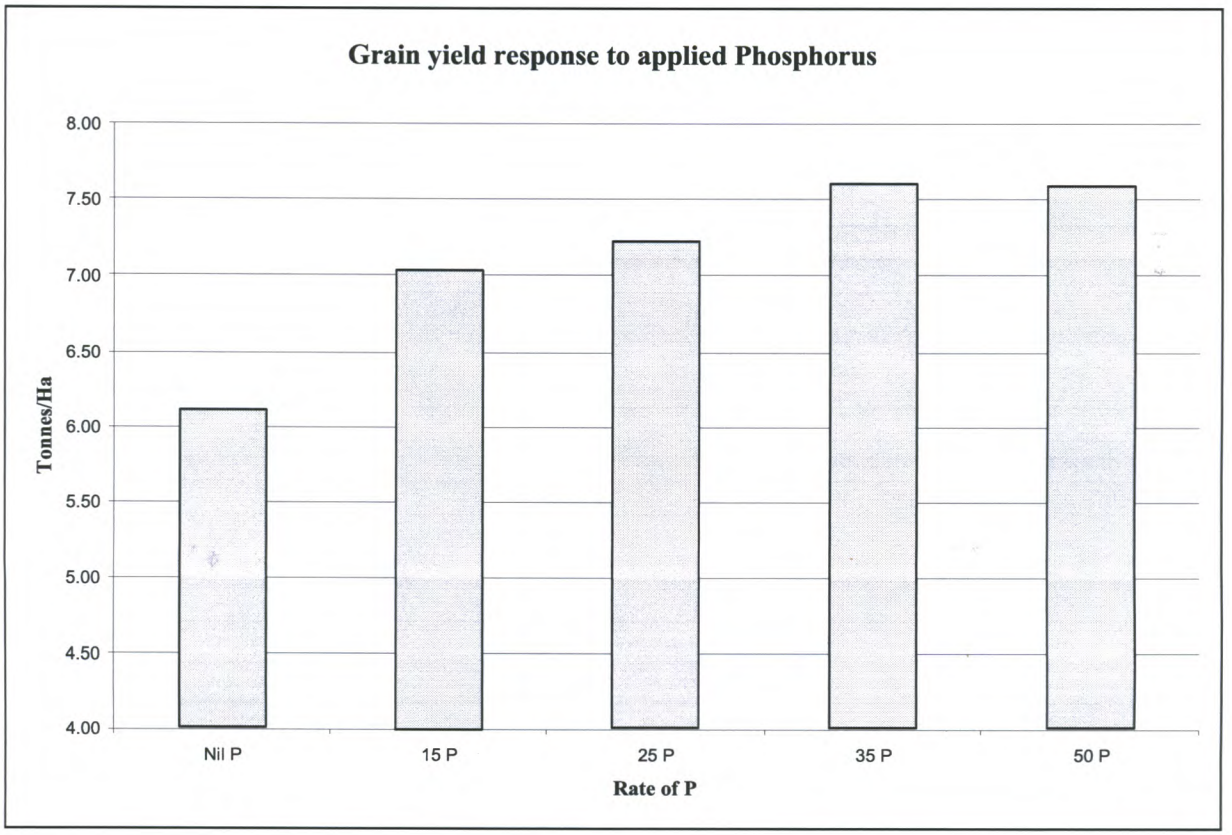


Figure 10: Yield Response to Applied P



Trial Summary:

Main Findings:

- Phosphorus (P) responses were visual and evident from 3 leaf stage until mid August with the 50 of P treatments being well ahead of the nil P.
- There was a significant response to applied P with 15 P being significantly higher yielding than nil P.
- There is a trend for increasing yield with increasing P rate above this (35 P yielding 7.60 tonnes) but it was not significant.
- There was no significant grain yield attributed to applied zinc, copper or sulphur when compared to 25 kg P applied per ha.
- There was a significant lift in tissue P levels with rate of P applied, with 15 P being significantly higher than nil P applied.
- Grain proteins were all around 10% and there was no significant difference between treatments. Treatments 12 and 13 performed no better than straight products, hence their improved performance in highly calcareous is not evident in these acid soils.
- This site performed very well with the average yield at the site being 7.16 tonne per hectare again showing cropping can be very profitable in South West Victoria. To maintain soil P levels 20 – 25 kg of P needs to be applied (7 tonne * 3.5 kg P tonne grain = 24.5 kg P), this does not allow for any soil build up.

Lake Bolac

Annual rainfall: 407mm
Growing Season rainfall (Apr-Nov): 275mm
Soil Type: Loam
Paddock History: 2001 Pasture

Table 41: Latest Soil Test Results

Test	Org. C %	P[22] mg/kg	K mg/kg	S mg/kg	pH H_2O	pH $CaCl_2$	Cu DTPA mg/kg	Zn DTPA mg/kg
Result	2.07	6.7	273	9.6	6.2	5.7	0.75	0.53
Status	High	Marginal	Adeq	Adeq	Mod Acid	Mod Acid	Adeq	Marg
Test	**CEC meq/100 mg**	**Ca %**	**Mg %**	**Na %**	**S 0-60**	**SALT dS/m**	**N (kg/ha) 0-10**	**N (kg/ha) 0-60**
Result	10.7	81.3	9.2	2.4		0.255	136	NA

Phosphate buffering Index 89

[22] *P test is Olsen, Colwell 20 0-10cm nitrate 124 and Ammonium 12*

A fully randomised complete block design, 3 replicates 15 treatments

Table 42: Calender of Events and Observations[23]

Growing Season Rainfall: 320mm

Date	Event	Comments[24]
6/6/2002	Sowing	Sown into moist soil beds perfect conditions
6/6/2002	Sprayed	2 lt Roundup pre sowing
6/6/2002	Sprayed	Telstar and Dual post sowing
25/7/2002	Sprayed	Broadleaf spray for seedling sorrel and onion weed
27/8/2002	Tissue tests taken	Crop looking well
20/9/2002	Site inspection	All looking well P response still visible
15/11/2002	Field day held	Plots still looking well but dry
6/01/2003	Harvested	All reps harvested well

[23] *Record of trial management activities or events that may affect the trial.*
[24] *Note observations relevant to effects of events on trial outcomes.*

Table 43: Actual Rainfall Recorded Total: 407mm

J	F	M	A	M	J	J	A	S	O	N	D
20.4	51.8	7.6	29.4	37.4	47	42.6	20.8	42.2	38.8	46.2	23

Results :

Table 44: Yield and Protein

Treatment	Product	Yield (t/ha)	Yield % of Nil	WUE[25] (kg/mm)	Protein (%)
1	Nil	1.794	100	7.32	14.10
2	DAP	4.217	235	17.21	13.37
3	DAP	4.900	273	20.00	13.13
4	DAP	5.011	279	20.45	13.60
5	DAP	5.097	284	20.80	13.57
6	DAP Zinc cote 2.5%	4.522	252	18.46	13.47
7	DAPS	4.572	255	18.66	13.63
8	DAP Cu cote 1 %	4.761	265	19.43	13.53
9	DAP Cu cote 2.5 %	4.364	243	17.81	14.17
10	DAP Cu/Zn cote 2.5 %	4.364	243	17.81	13.53
11	MAP	4.972	277	20.29	13.40
12	DAP RB 1	3.947	220	16.11	13.60
13	DAP FS	4.725	263	19.29	13.50
14	MAP impreg S	4.772	266	19.48	13.43
15	DAP impreg S	4.642	259	18.95	13.77
LSD 5% P rate 1 -5		**0.58**			
LSD 5 %		**0.66**			
CV %		**8.9**			

[25] *Water Use Efficiency = (0.5 * (March + April) + GSR (M-N) – 110 mm) x 0.02*

Photo 4: Andrew Speirs showing response to phosphorus in wheat trial at Lake Bolac

Table 45: Tissue Test Results YEBS 14th August 2002

Treat	Product	N%	P%	K %	S%	Cu ppm	Zn ppm	Ca%	Mg%	Na%
1	Nil	4.98	0.22	3.70	3.70	6.32	21.79	0.420	0.11	0.03
2	DAP	5.55	0.31	4.17	4.17	5.58	22.22	0.370	0.12	0.03
3	DAP	5.46	0.34	4.37	4.37	5.69	21.68	0.360	0.12	0.03
4	DAP	5.88	0.36	4.40	4.40	6.10	22.77	0.427	0.13	0.03
5	DAP	5.95	0.38	4.53	4.53	6.05	22.50	0.463	0.14	0.03
6	DAP Zinc cote 2.5%	5.54	0.30	4.30	4.30	5.14	21.70	0.387	0.12	0.03
7	DAPS	5.52	0.32	4.33	4.33	5.73	21.22	0.387	0.13	0.03
8	DAP Cu cote 1 %	5.58	0.30	4.43	4.43	5.74	21.92	0.393	0.12	0.03
9	DAP Cu cote 2.5 %	5.50	0.33	4.30	4.30	5.85	22.11	0.410	0.12	0.03
10	DAP Cu/Zn cote 2.5 %	5.41	0.31	4.33	4.33	5.42	22.00	0.360	0.12	0.03
11	MAP	5.43	0.32	4.37	4.37	5.83	22.75	0.463	0.13	0.03
12	DAP RB 1	5.06	0.27	3.95	3.95	5.79	18.95	0.355	0.12	0.03
13	DAP FS	5.36	0.30	4.27	4.27	5.64	21.12	0.387	0.12	0.03
14	MAP impreg S	5.52	0.31	4.20	4.20	5.87	21.74	0.450	0.13	0.04
15	DAP impreg S	5.56	0.33	4.37	4.37	5.58	22.92	0.413	0.12	0.03
LSD 5%		ns	sig	ns	ns	ns	ns	ns	ns	ns

Figure 11: Phosphorus Content of YEBS at Various Rates of P

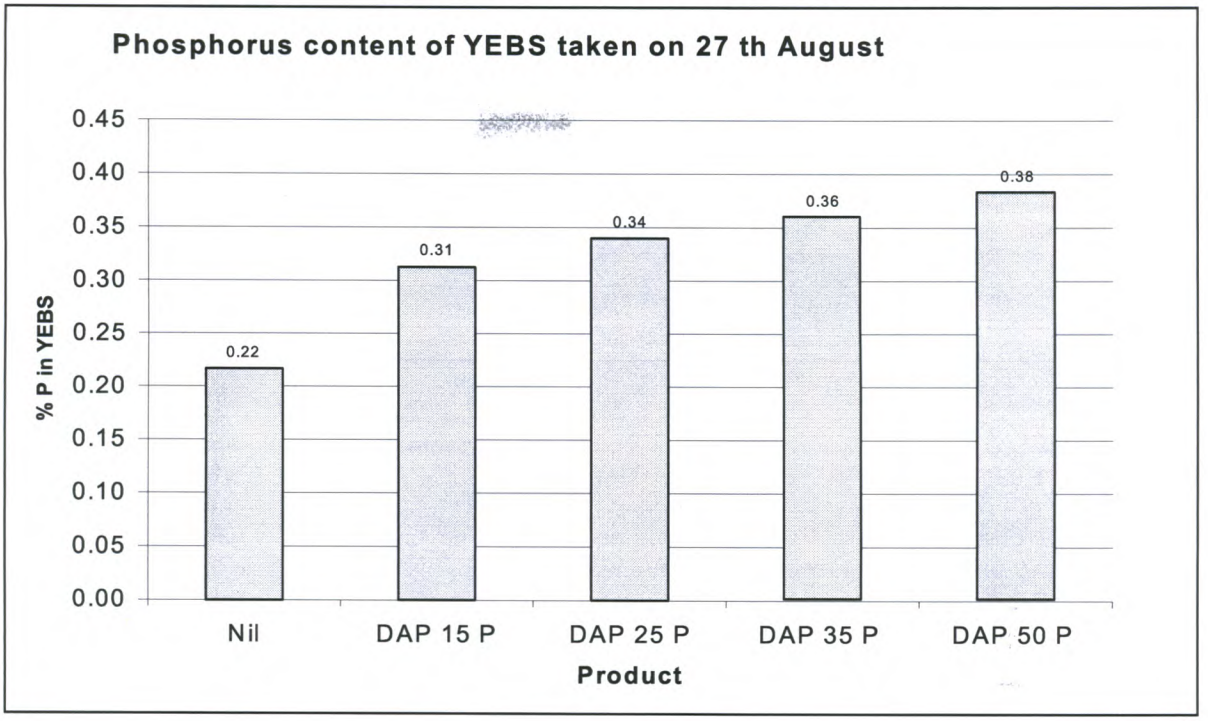
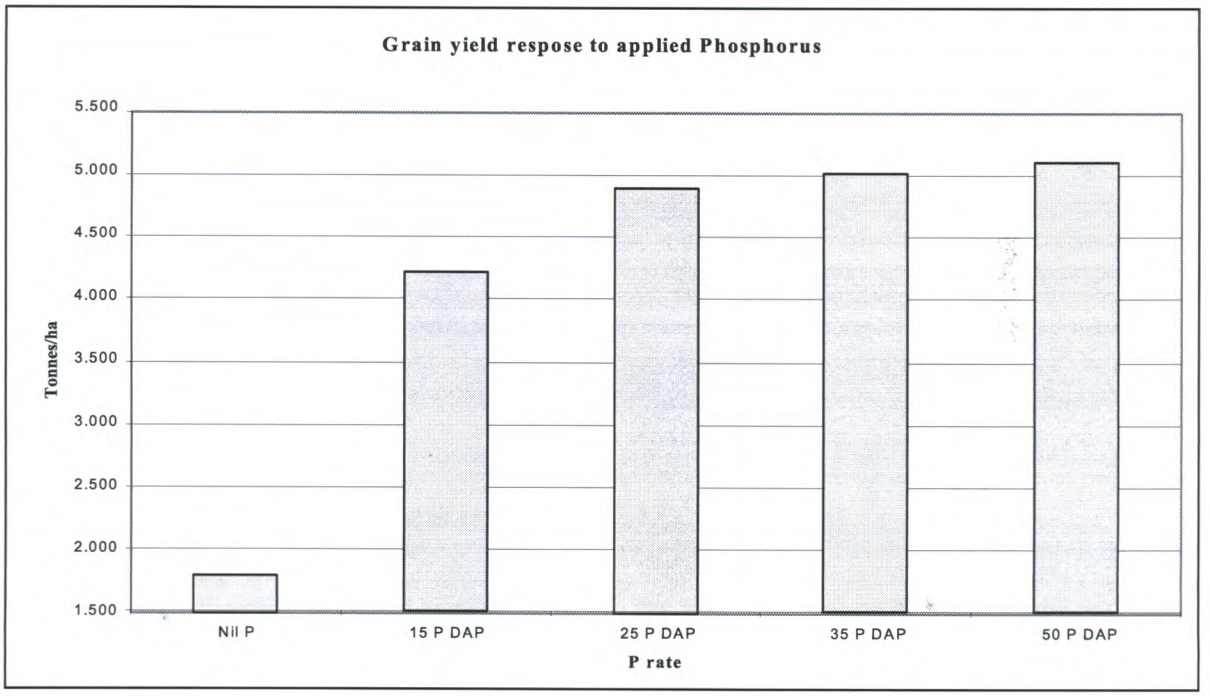


Figure 12: Yield Response to Applied P



Main Findings:

- Phosphorus (P) responses were visual steps in drymatter growth from nil, 15 P to 25 P to 35 P to 50 P from 3 leaf stage until head emergence.
- This site was strongly P responsive with a significant P response to 25 kg of applied phosphorus. Response above this rate may have been limited by moisture.
- There was no significant increase in grain yield to applied sulphur, copper or zinc this may have been masked by the fact that there was such a dramatic response to applied P.
- In cases of low soil P like this the plant analysis of YEB's (youngest fully emerged blades) at mid tillering was a reliable indicator of P deficiency.
- Treatment 12 performed significantly worse than some of the other 25 of P treatments, hence its ability to supply N and P more effectively in calcareous soils doesn't hold true for acid soils.