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Sulphur nutrition of pastures. Potassium nutrition of high rainfall pastures on deep sands

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Department of Agriculture
Western Australia

Summary of Experimental Results 1984

Sulphur Nutrition of Pastures
Potassium Nutrition of High Rainfall Pastures on Deep Sands

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- C. Potassium (4054EX)
 - 1. Sources, rates, time of application of potassium on high rainfall deep sand pastures. 80AL3, 80AL6

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General Aims

The work summarized here is part of two programs.

- (1) General research in sulphur requirements of crops and pastures in Western Australia.
- (2) The nutrition of leaching sands.

The sulphur source work is aimed at quantifying the current and residual value of superphosphate as an S source and the relative effectiveness of alternative S sources with various solubility characteristics. The work is of particular relevance to soils with a sulphur requirement but where current P requirement is low because P levels have risen from the residual value of past superphosphate applications.

In these situations, alternative sources of S (to super) are required to reduce fertilizer costs, and so called 'slow release' sources are of potential benefit in the high rainfall areas.

Potassium source work was initiated to examine the potential for 'slow release' K on the leaching sands as part of the project on mobile nutrients on legume pastures.

These programs are part of a larger pasture program with the ultimate aim of integrating information on the behaviour of various sources of the 'leaching nutrients' into a mechanistic model, to be able to make integrated P, S and K recommendations for specific situations.

General Results and Conclusions of 1983 Work

A. Sulphur - High Rainfall Pastures

1. Sources of sulphur

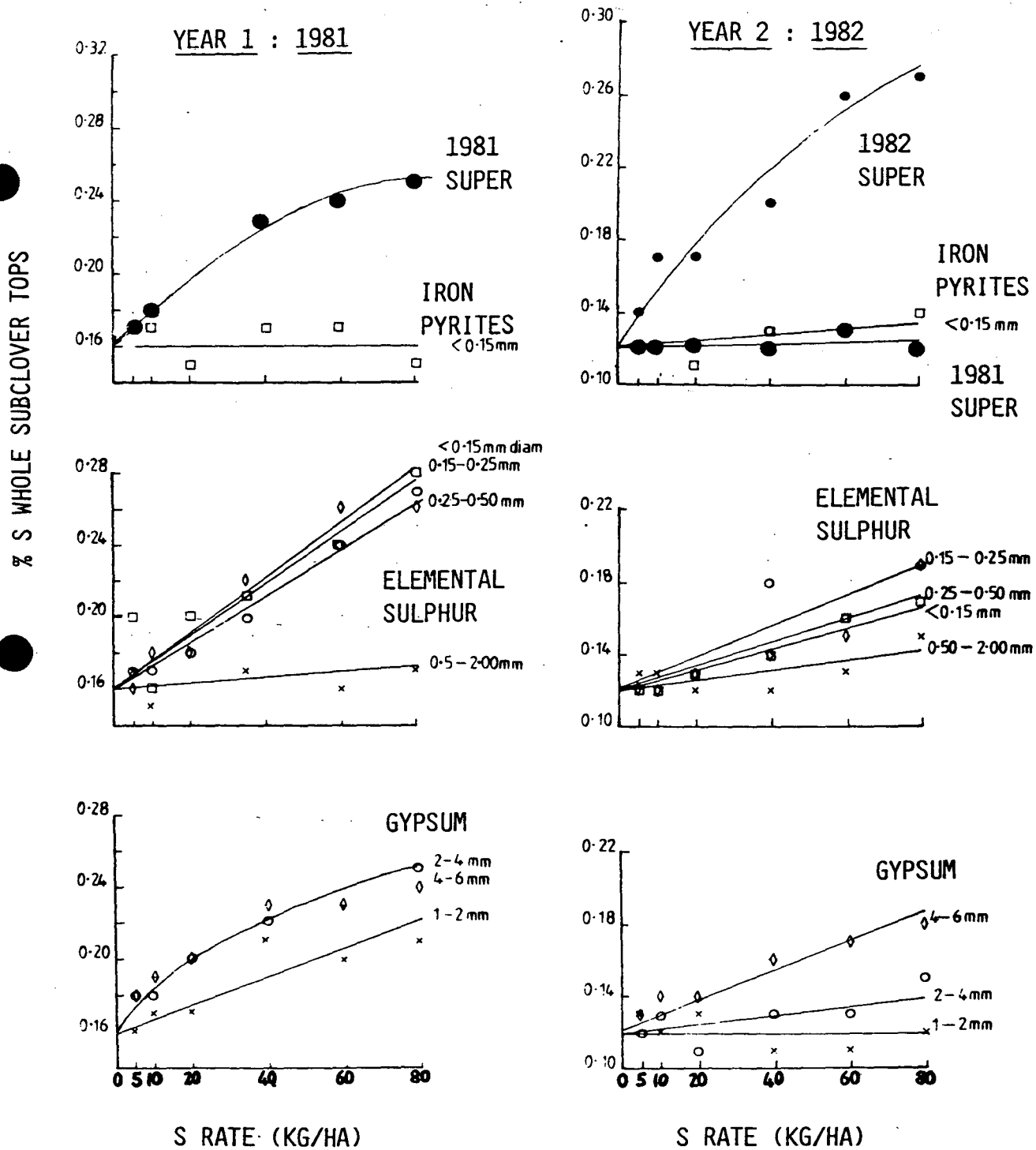
Trial 80AL1 continued to respond only sporadically to sulphur, presumably due to the efficiency of sulphur cycling through organic matter. Comparison of sources of S must necessarily be made using S uptake data on this site.

Trial 80AL4 (1980) has shown that sulphur as elemental S (in SF25, SF45) has some residual value three years after application, in contrast to other sources used. In 1983 both super and AS3 (see below) were effective sources of S, with maximum growth achieved at about 30 kg/ha S, though the small responses on this site in 1983 make this estimate subject to considerable error.

Trial 80AL4 B (established 1983) was designed to estimate the current and residual value of various particle sizes of elemental sulphur and gypsum, in addition to AS3 and ordinary superphosphate. Though yield results were rather variable, data shows ES in the particle size range < 0.15-0.25 mm, gypsum 2-6 mm, and super to be most effective per unit of applied S and ES 2-5 mm least effective, confirming past data (see S uptake from terminated trial 81AL4, Figure 1). This trial will be continued for several years to obtain residual value data.

Based on 1983 and past data, commercial production of AS3 ("new coastal superphosphate") as a slow release source of S (and P) has been undertaken by CSBP (see Technote 4/84).

FIG 1. EFFECT OF 1981 AUTUMN APPLIED SULPHUR SOURCES ON SPRING SULPHUR CONTENT OF WHOLE LEGUME TOPS IN 1981 AND 1982. SIZES REFER TO PARTICLE SIZE RANGES OF THE SULPHUR SOURCES.



Sources used in the sulphur sources work were:

Super	Ordinary superphosphate
LBCG	Lake Brown gypsum (coarse mixed particle sizes)
NW	Wyalkatchem fine gypsum
KS	Potassium sulphate
SF25	Coarse elemental S and superphosphate 25% S ("sulphur fortified super")
SF45	Coarse elemental S and superphosphate 45% S ("sulphur fortified super")
ES	Elemental sulphur (< 0.15 mm where particle size not specified; mixed particle sizes (0.15-2.00 mm) were ES(M))
AS1	ES(M) 33%, superphosphate 33%, ground rock phosphate 33%
AS3	ES (0.15 - 0.50 mm) 33%, superphosphate (= new coastal super) 33%, ground rock phosphate 33%

2. Sulphur nutrition of pastures

One trial (83PE36) was conducted to compare AS3 and ordinary super as sources of S. Data showed differences in S release patterns (as measured by % S) but poor yield data were collected. This site will be cross-stripped with S in 1984 to measure S residual from super and AS3.

B. Sulphur - Low Rainfall

1. Sulphur on pastures

Trial 82AL9 gave no response to S, despite being on a sandy soil and of low extractable S and (the nil plots) receiving no S for two years. This site highlights the difficulty of predicting S responses even on soils most prone to deficiency development.

Trials 80JE16/17 and 82KA4 had very poor pasture; the former because of poor seasonal conditions and the latter because of an apparent nodulation failure in the subclover (site previously cropped for 7 years -- ?). 82KA4 will be limed and reseeded in 1984 with additional trace elements; 80JE16/17 is to be terminated. Neither trial responded to S in 1983.

Potassium

Potassium chloride (KCL) and sulphur coated KCL (SCK) have been compared as sources of K on deep sand pasture on two sites near Albany since 1980. The trials have been marked by small or no responses to K, despite generally low soil tests at the start of the trial, and high removal of K in clippings. This is believed due to some redistribution of K by sheep grazing on the trials during periods of the year, and to residual value of K being appreciable on these soils (grey sands, organic layer on surface: 3-4% organic carbon).

Some comparisons between sources and years of application can be made using K uptake data, but generally the work has highlighted the need for a more detailed investigation of the current and particularly residual value of K on these soils.

From available data, both sources of K have similar effectiveness and residual value.

Title: Sulphur on absorbing soils receiving no current S input.

Aims: To investigate current sulphur responsiveness of sulphur absorbing soils which have received no fertilizer sulphur input for at least five years.

To follow soil sulphate levels over time on these soils on plots receiving nil and high rates of recently applied S.

Trials:

Trial	Location	Soil
80BY1/2684EX	Forrest, Lowden	0 > 50 cm loam, gravelly clay loam

Basals: Nil 1983.

Treatments: Fine gypsum (1980)

Management: Grazed by sheep

Results: 80BY1
Trial not assessed

1983: Trial to be continued.

Title: Sources, rates, time of application of sulphur to legume pastures.

Aims: To generate response curves for sulphur sources on legume pastures.

To assess the effect of time of application (within one year) on the response curve for superphosphate.

To assess the residual value of the sulphur sources in the second and subsequent years after application relative to currently applied superphosphate.

Trials:

Trial	Location	Soil
80AL1/4054EX	Turner, Narrikup	0-10 cm grey sand 10-80 cm white sand 90 cm coffee rock
80AL4/4054EX 80AL4B/4054EX	Anderson, Cuthbert	0-10 cm grey sand 10 > 80 cm white sand

Basals: 80AL4B: Calciphos 500 (1 t/ha), aerophos (300 kg/ha, split application), KCL (100 kg/ha, split application)
80AL1, 80AL4: nil basals.

Management: Flash grazing with sheep (all trials).

80AL1
Results: 1. DM yield (kg/ha) 15/6/1983. Mean of 3 reps. 90% clover.

S rate (kg/ha)	Superphosphate applied				AS3*	ES(M)*	LBCG*	SF25*	SF45*	ES*
	5/80	3/81	2/82	3/83						
0	1040									
5		1140	1170	1070	1040	1100	970		1150	1190
10	1160	1040	1180	990	1050	1010	1170	1010	1110	930
20	990	1140	1110	1300	1050	990	1170	1110	1120	1190
40	1010	1180	1210	1140	1180	1140	1060	1000	1040	1180
80	1230	1080	1060	1280	1180	980	1140	1020	1120	970

* See introduction for key to abbreviations

2. DM yield (kg/ha) 10/8/1983. Mean of 3 reps. 90% clover.

S rate (kg/ha)	Superphosphate applied				AS3 3/83	ES (M) 5/80	LBCG 5/80	SF25 5/80	SF45 5/80	ES 5/80
	5/80	3/81	2/82	3/83						
0	1630									
5	-	1620	1600	1740	1640	1760	1640	-	1580	1660
10	1680	1690	1800	1840	1660	1700	1630	1680	1580	1500
20	1600	1720	2000	1930	1680	1500	1670	1690	1790	1680
40	1820	1780	1990	1920	1780	1810	1660	1860	1750	1610
80	1720	1790	2010	1990	1060	1780	1600	1750	1780	1700

3. DM yield (kg/ha) 13/10/1983. Mean of 3 reps. 90% clover.

S rate (kg/ha)	Superphosphate applied				AS3 3/83	ES (M) 5/80	LBCG 5/80	SF25 5/80	SF45 5/80	ES 5/80
	5/80	3/81	2/82	3/83						
0	3030									
5		2960	3130	2750	2930	3030	2910		2800	3000
10	2910	2890	2980	3100	2720	2900	3330	3700	3070	2780
20	3070	3130	2810	3480	2970	2630	3290	3140	2880	3180
40	3010	3310	2940	3110	3140	3100	2920	2900	2840	2770
80	3200	2940	2980	3520	2960	3110	3270	3230	3280	2280

Summary:

1. Small early response to S.
2. Despite no S on some plots since 1979, sulphur deficiency occurs only spasmodically on this high rainfall site -- ?
3. Sources to be compared by S uptake.

1984

Trial to be continued. Trial to be terminated at the end of 1984.

80AL4

Results:

1. DM yield (kg/ha) 15/6/1983. Mean of 3 reps. 90% clover.

S rate (kg/ha)	Superphosphate applied				AS3* 3/83	LBCG* 5/80	SF25* 5/80	SF45* 5/80	ES* 5/80
	5/80	3/81	2/82	3/83					
0	1066								
5	-	1080	1260	1290	1440	-	-	-	-
10	-	1190	1330	1180	1050	-	1140	-	1460
20	-	1170	1540	1140	1340	1140	1340	1010	1280
40	1100	1300	1500	1240	1380	1120	1470	1260	1290
80	1140	1300	1510	1240	1400	1400	1380	1330	1330

* See introduction for key to abbreviations

2. DM yield (kg/ha) 10/8/1983. Mean of 3 reps. 90% clover.

S rate (kg/ha)	Superphosphate applied				AS3 3/83	LBCG 5/80	SF25 5/80	SF45 5/80	ES 5/80
	5/80	3/81	2/82	3/83					
0	3.5								
5	-	4	5	8	6	-	-	-	-
10	-	3.5	5	5.5	5	-	3	-	2.5
20	-	5.5	9	7	6.5	2.5	3.5	4.5	6.5
40	3	6	11	10.5	8.5	5	6	6	6
80	3	4	12	12.5	13	5	7.5	6	5.5

3. DM rate (1-5) 23/9/1983. Sum of 3 reps. 90% clover.

S rate (kg/ha)	Superphosphate applied				AS3 3/83	LBCG 5/80	SF25 5/80	SF45 5/80	ES 5/80
	5/80	3/81	2/82	3/83					
0	5								
5	-	5	7	11	7.5	-	-	-	-
10	-	6.5	7.5	10.5	6.5	-	5	-	5
20	-	4.5	11.5	9.5	8.5	3	7	4	7
40	4	7.5	12.5	11	12.5	6	8.5	7.5	5.5
80	6	5.5	11.5	11.5	12	7	9	8.5	8

4. DM yield (kg/ha) 10/10/1983. Mean of 3 reps. 90% clover.

S rate (kg/ha)	Superphosphate applied				AS3 3/83	LBCG 5/80	SF25 5/80	SF45 5/80	ES 5/80
	5/80	3/81	2/82	3/83					
0	1500								
5	-	1600	1670	1890	1810	-	-	-	-
10	-	1520	1610	1870	1650	-	1510	-	1660
20	-	1610	2140	1980	1870	1950	1650	1330	1550
40	1700	1540	2020	2100	2210	1540	1770	1660	1440
80	1510	1470	2120	2400	2230	1660	1870	1850	1870

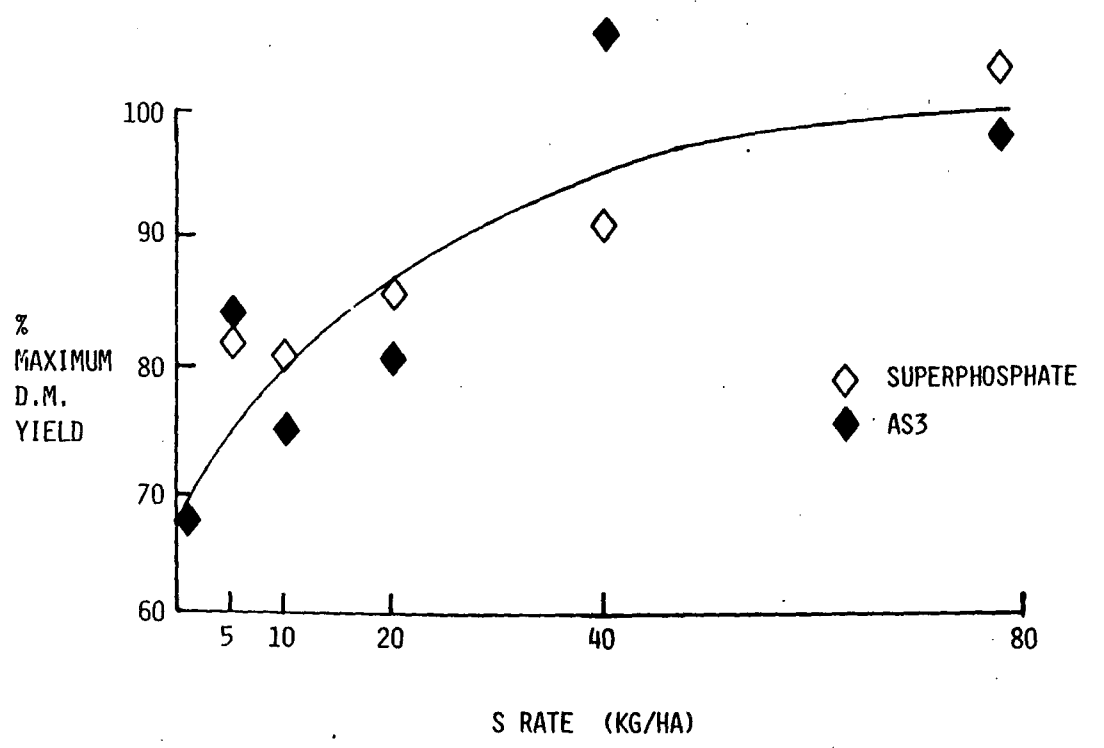
Summary:

1. Very useful site. Data shows 1980, 1981 applied super had no residual value in 1983. 1982 super had some residual in this dry year. SF45, SF25 had some residual.
2. 1983 super and AS3 had similar effectiveness late; super > AS3 early (ratings).
3. Sulphur deficiency less severe in 1983 (dry year) than other years. Early response small.

1984

Trial to be continued.

FIGURE 2: EFFECT OF S RATE ON DRY MATTER PRODUCTION AT 10/10/83 ON TRIAL 80AL4



80AL4B

Results: 1. DM rate (1-5) 23/9/1983. Sum of 3 reps. All treatments applied 4/84. 70% clover.

S rate (kg/ha)	Super AS3	ES*	ES*	ES*	ES*	ES*	GYP*	GYP*	GYP*	GYP*	GYP*	
	Particle size range (mm)						< 2	2-4	4-6	6-10	< 20	
		< 0.15	0.15- 0.25	0.25- 0.50	0.5- 2.0							
0	5											
5	10.5	5.5	7.5	6	5	4	5	8	7	9.5	6.5	4
10	7.5	9	12	9.5	4	5	5	8.5	12	9.5	9	6.5
20	14	9.5	14	12.5	8.5	6	4	10.5	13	12	8.5	6
40	13	12	13	13.5	8	7	8	9	13.5	12.5	9.5	8.5
80	11.5	11.5	10.5	12	13	9.5	8	10	15	11	11.5	13

* See introduction for key to abbreviations

2. DM yield (kg/ha) 10/10/1983. Mean of 3 reps. 80% clover.

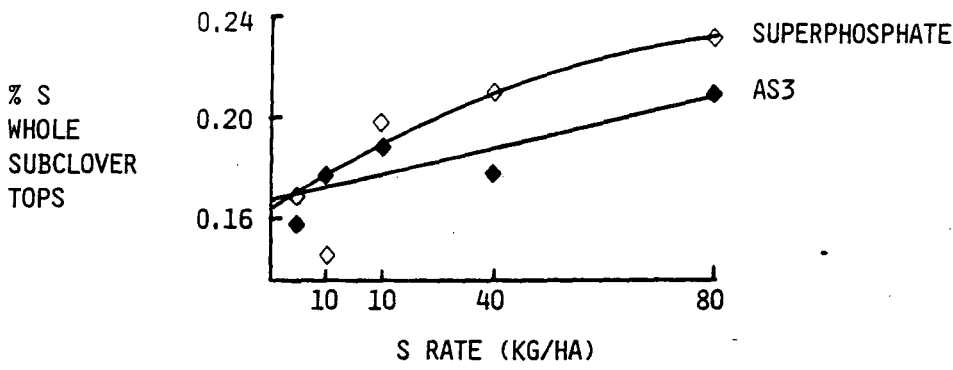
S rate (kg/ha)	Super AS3	ES	ES	ES	ES	ES	GPY	GPY	GYP	GYP	GYP	
	Particle size range (mm)						< 2	2-4	4-6	6-10	10-20	
		< 0.15	0.15- 0.25	0.25- 0.50	0.50- 2.0							
0	1420											
5	1760	1490	1650	1470	1640	1450	1500	1790	1470	1910	1600	1390
10	1730	1720	1920	1690	1550	1690	1420	1630	2000	1730	1670	1570
20	1960	1620	2030	1990	1650	1580	1550	1770	1850	1780	1690	1540
40	1950	1780	1950	1920	1740	1420	1600	1820	2050	1850	1900	1790
50	1950	2020	1830	1910	2010	1810	1610	1830	2140	1850	1970	2120

- Summary:
1. Some problems with capeweed and variation in 1983 (first year of trial).
 2. Fine elemental sulphur, gypsum, super effective as S sources in year 1, but some variation (data from S uptake to confirm yield data).
 3. Dry year in 1983 (see comments under 80AL4).

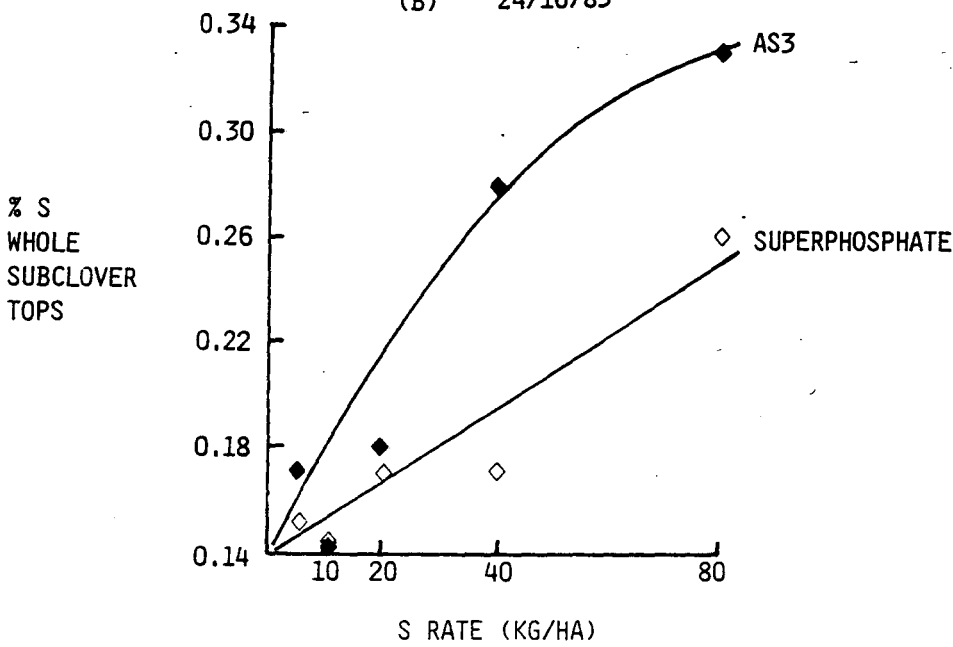
1984 Trial to be continued.

FIGURE 3: EFFECT OF S RATE ON % S IN WHOLE SUB CLOVER TOPS ON TRIAL 83PE36

(A) 15/9/83



(B) 24/10/83



Title: Sulphur nutrition of pastures.

Aim: To compare superphosphate and AS3 (= new coastal super) as sources of sulphur in the year of application and one year after application.

Trials:

Trial	Location	Soil
83PE36	Dawe, Nth Dandalup	0-10 cm grey sand 10-50 cm sandy clay > 50 cm mottled clay (Coolup sand)

Basals: 200 kg/ha aerophos, 200 kg/ha KCL (split autumn and spring)

Management: Mowing and removal of clippings

83PE36

Results: 1. DM rate (1-5). Sum of 3 reps. 70% clover.

S rate (kg/ha)	Superphosphate		AS3	
	2/8/1983	17/8/1983	2/8/1983	17/8/1983
0	6	8		
5	7	7	9	8
10	10	10	9	8
20	8	8	8	5
40	7	8	7	7
80	9	8	8	7

2. D.M. yield 15/9/1983. Mean of 3 reps. 70% clover.

S rate (kg/ha)	Superphosphate	AS3
0	2600	
5	2660	2650
10	2640	2750
20	2580	2850
40	2750	2560
80	2780	2850

3. Rate (1-5) 7/10/1983. Sum of 3 reps. 70% clover.

S rate (kg/ha)	Superphosphate		AS3	
	DM	Colour*	DM	Colour*
0	5	4		
5	7	5	8	6
10	8	7	10	10
20	10	10	9	7
40	14	13	12	11
80	12	9	14	13

* 1 = pale yellow
5 = dark green

4. S content (%) whole tops.

S rate (kg/ha)	Superphosphate		AS3	
	15/9/1983	23/10/1983	15/9/1983	23/19/1983
0	0.17	0.16		
5	0.17	0.15		
10	0.15	0.14	0.18	0.14
20	0.20	0.17	0.19	0.18
40	0.21	0.17	0.18	0.28
80	0.23	0.26	0.21	0.33

Summary:

1. Small early responses to sulphur (15/9/1983).
2. Trial hayed off before late assessment (rated only).
3. From S uptake data super more effective than AS3 at 15/9/1983, but AS3 > super at 23/10/1983.

1984

Trial to be continued. Maximum S strip to be cross plotted.

Title: Rates of application of sulphur as superphosphate to pastures - low rainfall areas.

- Aims:
1. To generate response curves on pasture for currently applied and residual sulphur.
 2. To generate data for use in predicting sulphur responsive situations in low rainfall areas.

Trials:

Trial	Location	Soil
80JE16/17/4067EX	Parsons, Nth Fitzgerald	0-35/35 cm coarse grey/white sand (variable) 35 cm gravelly clay
82AL9/4067EX	Miles, Sth Stirlings	0-60 cm grey/white sand > 60 cm gravelly clay
82KA4/4067EX	Eckersley, Woodanilling	0-50 cm grey white sand > 50 cm gravelly clay

Basals: Aerophos (300 kg/ha) KCL (100 kg/ha)

Treatments: Superphosphate applied 1983

Management: 80JE16/17, 82KA4 Ungrazed
82AL9 Grazed by sheep

Results: 80JE16/17
Trial not assessed.

1984 Trial to be terminated (major composition problems).

Results: 82KA4
Trial not assessed. Clover failed to nodulate.

1984 Trial to be continued after reseeding.

82AL9

Results: 1. DM yield 9/8/1983 (kg/ha). Mean of 4 reps. 70% clover.

S rate (kg/ha)	Superphosphate applied	
	3/83	3/84
0	1450	
5	1470	1450
10	1450	1450
20	1470	1460
40	1350	1500
80	1520	1420

2. DM rate (1-5) 20/10/1983. Sum of 4 reps. 60% clover.

S rate (kg/ha)	Superphosphate applied	
	3/83	3/84
0	7	
5	9	8
10	6	6
20	4	8
40	6	5
80	5	5

Summary: 1. No response to S on this sandy soil (no S on nil plots since 1981). S uptake data indicates high soil S levels.

1984 Trial to be continued.

Title: Sources, rates, time of application of potassium fertilizers to legume pastures on sandy soils of the high rainfall area.

Aims: To generate response curves for two potassium sources on pasture.

To assess the effect of time of application (within one season) on the response curve for KCL.

To assess the residual value of the K sources in the second and third year after application, relative to currently applied KCL.

Trials:

Trial	Location	Soil
80AL3/4054EX	Turner, Narrikup	0-10 cm grey sand 10-80 cm white sand > 90 cm coffee rock
80AL6/4054EX	Anderson, Cuthbert	0-10 cm grey sand 10 > 80 cm white sand

Basals: Superphosphate (200 kg/ha) split application.

Management: Flash grazing by sheep.

Results: 80AL3
1. DM yield (kg/ha) 15/6/1983. Means of 3 reps. 90% clover.

K rate (kg/ha)	KCL applied						SCK* 5/80
	5/80	7/80	9/80	3/81	3/82	3/83	
0	970						
25	1040	1160	1020	1080	940	-	960
50	1040	1060	1180	1050	990	1010	1090
100	1390	990	1035	1010	970	1129	930
200	1010	1130	-	1180	1140	1063	810

* Sulphur coated KCL (31.5)

2. DM yield (kg/ha) 10/8/1983. Means of 3 reps. 90% clover.

K rate (kg/ha)	KCL applied						SCK 5/80
	5/80	7/80	9/80	3/81	3/82	3/83	
0	1820						
25	1750	1800	1820	1750	1820	-	1800
50	1780	1830	1800	1840	1890	1770	1790
100	1920	1740	1760	1840	1750	1800	1790
200	1780	1850	-	1840	1820	1870	1950

3. DM yield (kg/ha) 13/10/1983. Means of 3 reps. 90% clover.

K rate (kg/ha)	KCL applied						SCK 5/80
	5/80	7/80	9/80	3/81	3/82	3/83	
0	3650						
25	3420	3570	3140	3520	3620	-	3450
50	3610	3430	3970	3700	4000	3600	3750
100	3640	3460	3630	4180	3670	3660	3430
200	3820	3640	-	3640	3910	3780	3790

Summary:

1. No response to K, despite no K until 1979 on nil plots, and marginal soil levels.
2. Residual value of K calculated from K uptake data (appears higher than expected).

1984

Trial to be terminated.

80AL6

Results:

1. DM₂ yield (kg/ha) 15/6/1983. Means of 3 reps. 80% clover.

K rate (kg/ha)	KCL applied						SCK* 5/80
	5/80	7/80	9/80	3/81	3/82	3/83	
0	1520						
25	1490	1680	1560	1570	1700	-	1520
50	1650	1670	1610	1540	1690	1420	1460
100	1590	1630	1610	1620	1570	1410	1600
200	1730	1750	-	1580	1660	1550	1600

* Sulphur coated KCL (31.5)

2. DM yield (kg/ha) 10/8/1983. Means of 3 reps. 70% clover.

K rate (kg/ha)	KCL applied						SCK 5/80
	5/80	7/80	9/80	3/81	3/82	3/83	
0	1930						
25	2180	2170	1980	2150	2015	-	1850
50	1910	1980	2040	1960	1990	1890	1940
100	1900	1790	1870	2020	1980	2210	2180
200	1880	2160		1980	2110	2250	2160

Summary: 1. Small response to K, though variable. No K since 1979 on nil plots. Low soil test levels.

1984 Trial to be continued for one more year.