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1975 - SUMMARY OF RESULTS OF FIELD EXPERIMENTS
ON LEGUME SEED INOCULATION

(January 1976)

D.L. CHATEL - RESEARCH OFFICER
PLANT RESEARCH DIVISION

DEPARTMENT OF AGRICULTURE
WESTERN AUSTRALIA

LIST OF EXPERIMENTS

1. The effect of cobalt and seed inoculation on Unicrop lupins. GREEN RANGE
2. The effect of cobalt and seed inoculation on Unicrop lupins. BRAMLEY RESEARCH STATION
3. The effect of cobalt and seed inoculation on Unicrop lupins. McALINDEN
4. The effect of cobalt and seed inoculation on Unicrop lupins. CHOWERUP
5. The effect of cobalt and seed inoculation on Unicrop lupins. ALANOOKA
6. The effect of cobalt and seed inoculation on Unicrop lupins. LANCELIN
7. The effect of inoculation on Unicrop lupins. KATANNING
8. The effect of inoculation on Unicrop lupins. BORDEN
9. The effect of inoculation on Unicrop lupins. WOODANILLING
10. The effect of superphosphate drilled with the seed on the nodulation of lupins. LANCELIN
11. The effect of manganese sulphate drilled with the seed on the nodulation of lupins. LANCELIN
12. The effect of superphosphate drilled with the seed on the nodulation of lupins. WANDERING
13. The effect of manganese sulphate drilled with the seed on the nodulation of lupins. WANDERING
14. The effect of method of inoculation and fungicides on the nodulation and growth of field peas. BREMER BAY ROAD
15. The response of some new early subterranean clovers to inoculation. MERREDIN

INTRODUCTION

Most of the field work was aimed at extending our knowledge of where responses to seed inoculation might be obtained in Western Australia.

In some experiments this aim was combined with that of ascertaining the extent of the soils on which lupins responded to soil applications of cobalt (jointly with Mr J.W. Gartrell).

Unfortunately, many trials were compromised by inadequate nodulation of the plants by the inoculant rhizobia. This was why the two trials examining the effect of drilled fertilizer on nodulation (75MO28, 29) were repeated with late sowings at Wandering (75NA32,33).

Only one of the six cobalt experiments (the one at Lancelin) showed a response to cobalt. This may mean that Lancelin is indeed the only area low enough in cobalt to give a response. Also, there may have been differences in seed quality (cobalt content of seed). Note that the seed used in the very responsive 1973 and 1974 trials came from the West Midlands and had very low cobalt levels (in the order of <0.005 ppm to 20 ppm Co), whereas the seed in the 1975 trials came from Avondale and had a cobalt level of 0.095 ppm.

The reasons for the apparent inoculation failure on trials (75GE32, A123, B2, MO28, 29, 30) are not known. It is tempting to say that faulty peats were the main cause of the problem because the brand used had lower counts than usual. However, all but one of the peats sampled in the country survey passed the routine tests. This may mean that our standards need review. We do have laboratory evidence that wetting and drying cycles may lower the viability of rhizobia on seed. Perhaps this and an overall drop in the viability of the peats may have combined to cause the problem. This is the first time we have encountered this problem since we commenced trials in 1969.

The pea inoculation trial was conducted by the Albany Regional Office and was sampled by us at the invitation of Mr Najman. The response to inoculation was quite dramatic, despite the fact that the trial was sown as a first crop on old clover land. Hopefully similar trials can be done in 1976 with an appropriate variety of freezer peas.

Trial 175AL23/2993EXThe effect of cobalt and seed inoculation on
Unicrop lupins - Old land

(With J. Gartrell and S. Trevenen)

- Locality : Green Range (D. Burrell - Bundaleer).
- Soil type : Grey sand over clay, Tarnup soil type. Mallee and Chittick.
- History : Cleaned 66-67: 1967 one bag super and one bag Cu, Zn super, sown to Woogenellup clover: 1968-69 2 bags super/year, clover harvested 1969: 1970 1¼ bags super and clover harvested (600 kg/ha seed for the 2 years): 1971 one bag super and rape, 27 bu/ac: 1972-73 1¼ bags super/year: 1974 1¼ bags super and rape sown with 30-40 lb super.
- Fertilizer : Superphosphate at 307 kg/ha, CuSO₄ at 9.6 kg/ha and ZnO at 2.4 kg/ha topdressed across plots prior to seeding. Seed drilled with 195 kg/ha super and 15 kg/ha MnSO₄ and 0.42 kg/ha CoSO₄ where indicated.
- Sowing : Sown at 96 kg/ha on May 15, 1975 with seed inoculated previous day.

Treatment	Plant density ,000's/ha	Plant wt.		Tap Root N'dn %		Plant wt kg/ha	Seed yield kg/ha
		g/plant July 15	g/plant Sept 4	July 15	Sept 4		
+Co +Inoc	403	1.09	6.75	36	39	3524	870
-Co +Inoc	425	1.05	6.84	39	44	3085	1200
+Co -Inoc	394	1.07	7.72	28	43	3324	806
-Co -Inoc	484	1.08	6.22	27	34	3428	1090
LSD's 5%	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	*

N.S. = not significant, * P < 0.005, LSD 257 kg/ha

- Comments
1. Slight response to inoculation based on nodulation. However 20% of plants were very poorly nodulated irrespective of inoculation. Eighty per cent nodulation without inoculation is indicative of a quite high soil population of rhizobia.
 2. There was no measurable response to cobalt.
 3. The only significant difference was in seed yield where inoculated lupins, without cobalt, outyielded non-inoculated lupins with cobalt. I cannot explain this result.

Trial 275B2/2993EXThe effect of cobalt and seed inoculation on
Unicrop lupins - Old land

(With J. Gartrell and S. Dilkes)

- Locality : Bramley Research Station,
- Soil type : Brown gravelly loam, Jarrah.
- History : Pasture only for many years. No cobalt history. Silage cut 1974. In 1975 disc cultivated twice, harrowed twice. Rolled-harrowed.
- Fertilizer : Super : Potash 3 : 2 topdressed March. Plain super 165 kg/ha or cobalt super (0.42 kg/ha) drilled with seed.
- Sowing : Sown at 93 kg/ha May 16. Germination apparent May 19. Seed inoculated May 16. Simazine applied after sowing.

Treatment	Plant density ,000's/ha	Plant wt. (O.D)			Tap root nodulation %	Seed yield kg/ha
		g/plant		kg/ha		
		June 25	Sept 23			
+Co +Inoc	262	0.13	11.43	1781	95	2153
-Co +Inoc	265	0.13	10.79	1833	93	2236
+Co -Inoc	314	0.13	10.44	2284	92	2294
-Co -Inoc	293	0.13	10.71	1994	97	2224
Sign.	N.S	N.S		N.S	N.S	N.S

- Comments
1. No response to inoculation or cobalt.
 2. The nodulation of the non-inoculated plants was as good as any I have seen.
 3. We were unable to identify inoculant rhizobia with serological testing. This indicates inoculation failure. We don't know what effect the simazine had on the inoculant. Another possibility is that the inoculant rhizobia were unable to compete with the already established population of Rhizobium lupini.

Trial 375BR14/2993EXThe effect of cobalt and seed inoculation on
Unicrop lupins - New land

(With J. Gartrell and D. Rees)

Location : McAlinden (E.C. Harley).Soil type : Grey sandy loam, gravel variable depth. Jarrah.History : New land.Fertilizer : Superphosphate, 310 kg/ha, CuSO₄ 9.6 kg/ha, ZnO 2.4 kg/ha topdressed across plots before sowing. Either Cobalt sulphate (4.2 kg/ha) super at 200 kg/ha or plain super at 190 kg/ha drilled with seed.Sowing : Seed sown at 94 kg/ha May 13 moist seed bed with dusty surface. Seed inoculated May 13.

Treatment	Plant Density ,000's/ha	Plant wt. (O.D.)			Nodulation %		Seed yield kg/ha
		/plant July 8	/plant Sep 23	kg/ha	July 8	Sept 23	
+Co +Inoc	249	.307	8.14	1818	94	93	2060
-Co +Inoc	225	.270	9.64	1414	91	97	2364
+Co -Inoc	290	.230	4.14	1083	16	11	1826
-Co -Inoc	213	.270	5.28	1123	8	12	1896
Sign.	N.S	-	**	N.S	***	***	N.S
LSD's 5%			1.48				
1%			2.72				

- Comments
1. Only 2 reps sown.
 2. Colour differences between + - inoculation very obvious in September.
 3. No response to cobalt.
 4. Very significant response to inoculation, based on nodulation. No detectable response in seed yield, however the difference was nearly significant.

Trial 475BR15/2994EXThe effect of cobalt and seed inoculation on
Unicrop lupins - New land

(With J. Gartrell and D. Rees)

Location : Chowerup (C.L. Evans, "Mooringa").Soil type : Yellow sandy loam. Jarrah.History : New land.Fertilizer : Superphosphate 310 kg/ha, CuSO₄ 9.6 kg/ha, ZnO 2.4 kg/ha topdressed across plots before sowing. Either CoSO₄ (.42 kg/ha) super at 200 kg/ha or plain super at 190 kg/ha drilled with the seed.Sowing : Seed sown at 94 kg/ha on May 28 into moist soil. Inoculated May 28.

Treatment	Plant density ,000's/ha	Plant wt. (O.D.)			Nodulation %		Seed yield kg/ha
		per plant Jly 8	per plant Sep 29	kg/ha Sep 29	Jly 8	Sep 29	
+Co +Inoc	290	0.23	3.82	917	92	98	718
-Co +Inoc	286	0.23	3.72	1025	96	97	702
+Co -Inoc	373	0.23	2.15	725	0	4	624
-Co -Inoc	391	0.23	2.26	577	0	8	687
Sign.	N.S			***		***	N.S
LSD (0.1%)			1.23	305			

- Comments
1. Very large nodulation response to inoculation.
 2. On the first nodulation assessment 85 per cent of the non-inoculated plants were not nodulated. By the second sampling this was less than 10 per cent.
 3. There was no response to cobalt.
 4. There was a highly significant response to inoculation based on plant growth in Spring (Sept.). This was not continued through to seed yield.

Trial 575GE32/2993EXThe effect of cobalt and seed inoculation on
Unicrop lupins - Old land

(With J. Gartrell, D. Highman & M. Ewing)

- Locality : Alanooka (I.R. & R.H. Harrison, "Bolgaweena").
- Soil Type : Grey sand over yellow sand to depth. Sandplain.
- History : Cleared 1968. First crop 1969. Super history 720 kg/ha, 1974 pasture topdressed at 160 kg/ha.
- Fertilizer : Superphosphate 295 kg/ha, CuSO₄ 5.5 kg/ha and ZnO 1.65 kg/ha topdressed across plots before seeding. Super 200 kg/ha and MnSO₄ 30 kg/ha drilled with the seed - with and without CoSO₄ (0.42 kg/ha).
- Sowing : Sown June 9 at 100 kg/ha, non-inoculated and 103 kg/ha, inoculated. Inoculated June 9.

Treatment	Plant Wt. July 24	Nodulation %	Seed yield kg/ha
+Co +Inoc	0.17	60	700
-Co +Inoc	0.18	61	781
+Co -Inoc	0.17	63	714
-Co -Inoc	0.18	57	814
Sign.	N.S	N.S	N.S

- Comments
1. This trial was part of a larger nutrition trial (also 75GE32) which will be reported by Mr Gartrell.
 2. There was no response to cobalt. In fact there was an indication of a slight yield depression with the addition of cobalt.
 3. There was no response to inoculation. In fact serological testing failed to show any inoculant rhizobia. (See comments for Trial 2 - 75B2).
 4. This site was extremely deficient in potash - which may account for the low yields.

Trial 675M030/2993EXThe effect of cobalt and seed inoculation on
Unicrop lupins - New land

(With J. Gartrell)

- Locality : Lancelin (K. Williams).
- Soil type : Yellow sand. Banksia, Christmas tree, blackboy scrub.
- History : Rolled, burnt and fallowed 1972, ploughed 1973, ploughed and raked 1974, ploughed 1975.
- Fertilizer : Super 300 kg/ha, CuSO₄ 9.6 kg/ha, ZnO 2.4 kg/ha topdressed across plots before seeding. Super 200 kg/ha and MnSO₄, 35 kg/ha drilled with the seed, with and without CoSO₄ (0.60 kg/ha).
- Sowing : Sown April 29 at 87 kg/ha not inoculated and gum slurry inoculated and 97 kg/ha lime pellet. Seed inoculated April 28.

Treatment	Density 1000's/ha	Colour Ranking		Plant wt. O.D.			Nodulation%		Seed Wt. kg/ha
		June 18	Aug 13	g/plant		kg/ha Sep 19	May 28	Aug 22	
				May 28	Aug 22				
+Co +Inoc	225	3	5	.195	14.91	4373	23	23	1084
+Co -Inoc	234	4	5	.196	11.82	4380	30	28	1126
Co +Inoc	188	2	4	.205	12.32	3228	24	28	1249
-Co -Inoc	234	1	4	.185	11.26	3481	20	29	1076
LSD 5%	N.S	-	-	N.S	*	*			N.S
					2.34	775			

- Comments
1. There was no effect of inoculation on nodulation. Either inoculation failed because of the low count peats or the inoculant did not survive the period between sowing and germination. Serological typing failed to show the presence of inoculant rhizobia.
 2. There was a response to cobalt based on top growth in August and September. This did not continue through to seed yield.

Trial 775KA21aThe effect of inoculation of Unicrop lupins -
Old land

(with J. Wise)

Locality : Katanning (A. Ladyman)Soil type : 0-10 cm grey gritty sand, 10 cm + yellow mottled sandy clay. White gum, Jam.History : Old land cleared 60 years. Total super over 3 500 kg/ha. Last crop rape in 1972.Fertilizer: Plain super drilled with seed, 190 kg/ha.Sowing : Seed gum slurry inoculated May 22, sown May 23 at 98 kg/ha. Non inoculated seed sown at 100 kg/ha.

Treatment	Density 1000's/ha	Plant wt. O.D.			Nodulation %		Seed yield kg/ha
		g/plant		kg/ha	July 17	Sept 11	
		Jly 17	Sep 11	Sep 11	Nil Tap	Nil Tap	
Inoculated	357	0.52	4.29	1201	78 7	31 15	780
Not inoculated	385	0.50	3.04	938	99 0	62 3	249
Sign.	N.S	N.S		N.S			*

Comments

1. Response to inoculation, based on nodulation. Most nodulated plants were nodulated on lateral roots. It is not known if high soil nitrogen levels affected early tap root nodulation. The plants were rather deeply sown and the soil was also very waterlogged.
2. Very obvious colour differences in September. Inoculated green, non-inoculated very yellow.
3. There was a significant seed yield response to inoculation.

Trial 875KA21b/2993EXThe effect of inoculation on Unicrop
lupins - Old land

(with J. Wise)

- Locality : Borden (T. & J. O'Meehan)
- Soil Type : 0-30/40 cm grey brown gritty sandy loam, 30 + red brown gritty sandy clay. Yate and york gum.
- History : Old land cleared 60+ years. Total super over 2,250 kg/ha. Last cropped 1964.
- Fertilizer: Plain super drilled with seed at 190 kg/ha.
- Sowing : Sown May 26. Gum slurry inoculated seed sown at 98 kg/ha and non-inoculated at 100 kg/ha. Seed inoculated May 26.

Treatment	Density 1000's/ha	Plant wt. O.D.			Nodulation %	
		g/plant		kg/ha	July 17	Sept 4
		July 17	Sept 4	Sept 4	Nil Tap	Nil Tap
Inoculated	253	0.33	4.61	1386	44 21	4 36
Not inoculated	265	0.34	3.27	1046	99 0	97 0
Sign.	N.S	N.S	***	**	***	***

Comments

1. Response to inoculation based on nodulation and spring growth.
2. The plots were extremely weedy and the grass was much taller than the lupins in spring.
3. Very obvious colour differences in September.
4. Seed not harvested because plots were over-run by ryegrass.

Trial 975KA21c/2993EXThe effect of inoculation on Unicrop
lupins - Old land

(with J. Wise)

Locality : Woodanilling (G. Horne)Soil type : 0-20 cm grey sand, 20-40 cm yellow sand, 40-50 cm yellow clay/sand. Jam, Sheoak, Christmas tree.History : Old land last cropped in 1965.Fertilizer: Plain super drilled with the seed at 190 kg/ha.Sowing : Sown June 3. Gum slurry inoculated seed sown at 98 kg/ha and non-inoculated seed sown at 100 kg/ha.

Treatment	Density 1000's/ha	Plant wt. O.D.			Nodulation %		Seed yield kg/ha
		g/plant Jly 17	kg/ha Sep 11	kg/ha Sep 11	July 17 Nil Tap	Sept 11 Nil Tap	
Inoculated	234	0.17	4.75	969	81 11	5 9	1810
Not Inoculated	228	0.17	4.81	824	99 0	33 0	1467
Sign.	N.S	N.S	N.S	N.S	*		N.S

Comments

1. Nodulation response to inoculation.
2. These plots were very deeply sown.
3. Very obvious colour differences in September.
4. No difference between inoculated and non-inoculated lupins in seed yield.

Trial 1075M028The effect of superphosphate on the nodulation of Unicrop
lupins drilled with the fertilizerLocality : Lancelin (K. Williams)Soil type : Yellow sand, banksia, Christmas tree, blackboy scrub.History : Rolled, burnt and fallowed 1972, ploughed 1973, ploughed and raked autumn 1974, ploughed 1975.Fertilizer: Superphosphate, 300 kg/ha, CuSO₄, 9.6 kg/ha, ZnO 2.4 kg/ha and CoSO₄ 0.60 kg/ha top dressed across plots before sowing. Plain superphosphate at rates of 0, 100, 200 or 300 kg/ha drilled with the seed.Sowing : Sown April 30 with seed, either gum slurry or lime pellet inoculated April 28. Gum slurry and nil inoculated seed sown at 97 kg/ha and lime pelleted seed sown at 100 kg/ha.

TREATMENT Super Rate kg/ha	Inoc	May 28			July 3		
		Nodulation%		wt/plant	Nodulation%		wt/plant
		Poor	Good	(g)	Poor	Good	(g)
0	Lime P	46	10	0.17	22	14	1.07
	Gum S	46	2	0.17	38	8	1.35
	Nil	50	2	0.16	42	8	1.30
Means							
100	Lime P	56	0	0.18	36	8	1.65
	Gum S	52	2	0.20	38	6	1.93
	Nil	44	2	0.18	40	14	1.61
Means							
200	Lime P	58	4	0.19	32	12	1.80
	Gum S	52	2	0.18	40	8	1.91
	Nil	58	4	0.18	48	6	1.59
Means							
300	Lime P	60	6	0.18	30	12	1.77
	Gum S	50	6	0.19	40	10	1.87
	Nil	58	0	0.17	50	6	1.50
Means							

Comments

1. A very disappointing experiment. Only occasional inoculant rhizobia were found in the nodules. It is not known what this was due to. Possibilities include low count plots and soil physical conditions not conducive to proper survival and nodulation.
2. At the second sampling there were less plants in the poor nodulation category (no nodules or occasional lateral root nodules) with lime pelleting than with either gum slurry or non-inoculated seed. This was independent of super rate.

Trial 1175M029/2993EX

The effect of manganese superphosphate on the nodulation
of Unicrop lupins drilled with the fertilizer

- Locality : Lancelin (K. Williams).
- Soil type : Yellow sand, Banksia, Christmas tree, blackboy scrub.
- History : Rolled, burnt and fallowed 1972, ploughed 1973, ploughed and raked autumn 1974, ploughed 1975.
- Fertilizer : Superphosphate 300 kg/ha, CuSO₄ 9.6 kg/ha, ZnO 2.4 kg/ha and CoSO₄ 0.60 kg/ha topdressed across plots before sowing. Plain superphosphate at 200 kg/ha and MnSO₄ at either 0, 14, 28 or 42 kg/ha drilled with the seed.
- Sowing : Sown April 30 with seed either gum slurry or lime pellet inoculated April 28. Gum slurry and nil inoculated seed sown at 87 kg/ha and lime pellet seed sown at 97 kg/ha.

Treatment MnSO ₄ kg/ha	Inoc	May 28			July 3		
		Nodulation%		Wt/plant	Nodulation%		Wt/plant
		Poor	Good	(g)	Poor	Good	(g)
0	Lime P	52	8	.181	30	8	1.62
	Gum S	50	6	.193	54	8	1.86
	Nil	58	6	.180	44	12	1.64
Mean							
14	Lime P	44	8	.207	38	8	2.19
	Gum S	50	8	.212	40	10	2.23
	Nil	44	6	.199	40	12	2.15
Mean							
28	Lime P	52	8	.199	36	8	2.26
	Gum S	52	6	.205	48	10	1.61
	Nil	60	4	.202	50	6	1.82
Mean							
42	Lime P	48	10	.211	38	10	2.25
	Gum S	62	6	.216	58	4	2.17
	Nil	50	4	.203	46	4	2.06
Mean							

Comments

1. Similar to previous experiment.
2. This experiment failed to show any effect of manganese on nodulation and must be repeated.

Trial 1275NA32/2993EXThe effect of superphosphate on the nodulation of Unicrop
lupins drilled with the fertilizerLocality : Wandering (O'Leary).Soil type : Yellow loamy gravel 0-30 cm (shot gun). White gum , grevillea.History : New land. Disc harrowed.Fertilizer : 200 kg/ha plain super topdressed autumn 1975 and an additional 305 kg/ha immediately prior to seeding. Plain super at rates of 0, 100, 200 and 300 kg/ha drilled with the seed.Sowing : Sown June 13 with seed either gum slurry or lime pellet inoculated June 11. Gum slurry and non-inoculated seed sown at 100 kg/ha and lime pellet at 110 kg/ha.Nodulation : Fifty plants from each plot were examined for nodulation. There were triplicate plots of each treatment. Each plant was ranked for nodulation according to the following system.

0 = No nodules

1 = Few lateral nodules (10 or less)

1.5 = Many lateral nodules

2 = Few tap root nodules (5 or less). Few lateral nodules

2.5 = Few tap, many lateral (more than 5)

3 = Many tap root nodules

4 = Collar nodules (small)

5 = Collar nodules (large)

Treatment		Nodulation Category (%)							
Inoc.	Super kg/ha	0	1	1.5	2	2.5	3	4	5
Lime Pellet	0	1	1.3	5.3	6.0	8.0	30.7	27.3	20.7
	100	0	2.7	13.3	3.3	8.7	15.3	26.0	30.7
	200	0	0	3.3	2.7	9.3	16.7	27.3	34.0
	300	1	1	1.3	2.0	4.7	33.3	44.0	13.3
Gum Slurry	0	0	2.7	10.0	4.0	8.7	33.3	30.0	11.3
	100	1	1	4.7	1.3	9.3	38.0	27.3	18.0
	200	1	1.3	8.7	1.3	14.7	17.3	26.0	30.0
	300	0	1.3	8.7	2.0	10.0	30.7	27.3	20.0
Nil	0	72.0	10.0	0	16.7	1	0	1	0
	100	82.0	6.0	0	11.3	0	0	1	0
	200	66.0	12.0	0	21.3	0	1	0	0
	300	68.7	16.7	0	14.7	0	0	0	0

Treatment		Nodulation (Summary) %			
Inoc.	Super kg/ha	0 Nil	1 + 1,5 Lateral	2 + 2.5 Few tap	3+4+5 Many tap
Lime Pellet	0	1	7	14	79
	100	0	16	12	72
	200	0	3	12	85
	300	1	2	7	87
Gum Slurry	0	0	13	13	74
	100	1	5	11	83
	200	1	10	16	83
	300	0	10	12	78
Nil	0	72	10	18	1
	100	82	6	11	1
	200	66	12	21	1
	300	69	17	15	0

- Comments
1. There was a very good response to inoculation.
 2. None of the superphosphate rates reduced the nodulation to that of the nil nodulation, i.e. none of the fertilizer treatments completely killed the rhizobia.
 3. There was no real difference between lime pellet and gum slurry. Therefore it is impossible to talk about lime pelleting protecting the inoculant rhizobia from plain superphosphate. There were slightly more large collar nodules on the lime pellet than the gum slurry.
 4. This trial was sown late into moist soil. And although inoculated at the recommended rate it is highly likely that a higher count peat was used in this trial than in the same trial done at Lancelin (Trial 10, 75M028). Also the Lancelin trial was sown early into drying soil, i.e. harsher physical conditions.
 5. This Wandering site would be a very high phosphate fixing and buffering capacity soil relative to the sandy Lancelin site.
 6. Before the problem of survival of rhizobia in contact with super can be resolved it will be necessary to examine the effects of:
 - a) soil type differences (particularly differing in buffering capacity) and
 - b) rates of inoculation.

The latter to cover the complete range of seed populations of rhizobia achieved in practice. It is possible for high inoculation rates to mask any deleterious factors.

Trial 1375NA33/2994EXThe effect of manganese superphosphate on the nodulation
of Unicrop lupins drilled with the fertilizerLocality : Wandering (O'Leary)Soil type : Yellow loamy gravel 10-30 cm (shot gun). White gum, gravilla.History : New land. Disc harrowed.Fertilizer : 200 kg/ha plain super topdressed autumn 1975 and an additional 305 kg/ha immediately prior to seeding. Plain superphosphate at 200 kg/ha and $MnSO_4$ at either 0, 14, 28 or 42 kg/ha drilled with the seed.Sowing : Sown June 13 with seed either gum slurry or lime pellet inoculated June 11. Gum slurry and non-inoculated seed sown at 100 kg/ha and lime pellet at 110 kg/ha.Nodulation : See Trial 12 (75NA32).

Treatment		Nodulation (%)							
Inoc.	$MnSO_4$ kg/ha	0 1	1 2	1.5 3	2 4	2.5 5	3 6	4 7	5 8
Lime Pellet	0	0	0	1.3	1.3	8.0	22.7	38.0	26.7
	14	0	0	6.0	0	6.7	23.3	36.7	27.3
	28	1.3	0.7	4.0	1.3	3.3	32.0	36.0	21.3
	42	0.7	2.0	6.0	0.7	10.0	36.7	26.7	17.3
Gum Slurry	0	0.7	1.3	1.3	2.0	6.0	32.0	34.0	22.7
	14	0	0	5.3	2.7	7.3	34.0	33.3	17.3
	28	1.3	1.3	5.3	1.3	7.3	30.0	35.3	18.0
	42	0.7	0	6.0	2.7	6.0	32.0	29.3	23.3
No Inoc ⁿ	0	69.3	14.7	0	16.0	0	0	0	0
	14	74.7	8.0	0	17.3	0	0	0	0
	28	76.0	11.3	0	12.7	0	0	0	0
	42	76.0	10.0	0	14.0	0	0	0	0

Treatment		Nodulation (Summary) %			
Inoc.	MnSO ₄ kg/ha	0 Nil	1 + 1.5 Lateral	2 + 2.5 Few Tap	3+4+5 Many Tap
Lime Pellet	0	0	1	9	90
	14	0	6	7	87
	28	1	5	4	90
	42	1	8	11	80
Gum Slurry	0	1	2	8	89
	14	0	5	10	85
	28	1	6	9	84
	42	1	6	9	84
No Inoc ⁿ	0	69	15	16	0
	14	75	8	17	0
	28	76	11	13	0
	42	76	10	14	0

- Comments
1. There was a very good response to inoculation.
 2. Manganese sulphate drilled with the seed did not deleteriously affect nodulation - under the conditions of this experiment.
 3. This experiment, like the previous one (75NA32), should be repeated under harsher conditions (moisture stress, sandier soils).

Trial 1475JE30/2613EXThe effect of inoculation and fungicide treatment
of seed on Dunn's field peas

(This trial was established by J. Najman and
D. Nicholas of the Albany District Office
- it was sampled by the Plant Research Division)

- Locality : Boxwood Hills, Bremer Bay Road (R. Stoney).
Soil type : Gravel sand/sand over gravelly clay.
History : Clover paddock.
Fertilizer : 215 kg/ha Mix A copper zinc superphosphate drilled with the seed.
Inoculation: Seed inoculated July 21. Soil inoculation at time of sowing (water suspension of peat inoculum through 1.83 m boom - 20 psi, 20 l/ha, 18 seconds/plot). There were many blockages for Blocks C and D. Blocks A and B, 5 psi nozzles removed and dribbled onto plots. All plots probably received 2-3 times intended rate.
Fungicide : Fungicides dusted onto outside of inoculated seed morning July 22.
Sowing : July 22.
Nodulation : Sampled September 11, 1975.

50 plants per plot Blocks 3 and 4; 30 per plot for Blocks 1 and 2. Nodulation was categorised for each plant as follows:

- 0 = no nodules
1 = no nodules upper root*, <10 lower root
2 = <10 " " " , 0 " "
2.5 = <10 " " " , <10 " "
3 = >10 " " " , 0 " "
4 = >10 " " " , <10 " "
5 = >10 " " " , >10 " "

* Upper root within 2 inches of seed placement

Small = <2mm, Medium = >2- <4mm, Large = >4mm

Treatment	Plant Density 1000's per ha	Nodulation							O.D wt per plant (mg)	Top Dry Matter kg/ha
		Rating	Total %	Tap root %	Nodule number per plant					
					Total	Small	Medium	Large		
Not inoculated	500	0.37	18 (25)	1 (4)	0.6	0.4	0.2	0.1	577	299
Lime Pellet	505	2.73	97 (79)	39 (38)	21.0	16.9	3.4	0.5	640	291
Lime Pellet & Captan	451	1.50	68 (55)	7 (15)	5.0	2.8	1.8	0.3	502	314
Lime Pellet & Thiram	418	2.62	93 (74)	28 (32)	17.8	10.5	6.7	0.6	524	230
Lime Pellet & Benlate	440	2.68	95 (78)	43 (41)	23.1	15.0	4.7	0.9	555	293
Gum Slurry	412	1.65	72 (58)	15 (23)	6.4	4.4	1.7	0.3	558	233
Gum Slurry & Thiram	471	1.18	55 (48)	19 (25)	2.4	1.4	0.8	0.3	550	173
Soil Inoculation	485	2.20	82 (65)	15 (22)	12.7	5.0	3.3	0.5	577	282
LSD 5%	N.S	0.43	10	12	6.9	-	-	-	N.S	N.S
1%		0.58	14	16	9.4					
0.1%		0.79	19	22	12.6					

() = Arc sin transformed percentages.

- = Not done.

Results : Nodulation

1. Very good response to inoculation (as measured by nodulation).
2. Lime pellet superior to gum slurry.
3. Soil inoculation intermediate. There were complications with this treatment (nozzles blocked).
4. Captan treatment gave reduced nodulation.
5. Neither thiram nor benlate were harmful on lime pelleted seed (I am not able to comment on the effect of lime on the efficacy of the fungicides - as fungicides).
6. Thiram gave reduced nodulation on gum slurry treated seed.

- Comments :
1. Too early at first sampling to say anything about yield of tops. There were no visible differences in top growth or yield. This was almost certainly due to relatively high soil nitrogen at early stages (because of clover history of paddock). By early October the non-inoculated plots were very yellow and nitrogen deficient - in contrast to the green inoculated plots.
 2. The addition of fungicides subsequent to inoculation was contrary to normal practice. The Captan treated seed usually has to be inoculated.
 3. It remains to be seen if fungicides are necessary in the "new" areas.
 4. This type of trial should be done with the larger seeded 'freezer' peas.

Trial 1575M42/2994EXThe response of early flowering subterranean clover to inoculation

- Locality : Merredin Research Station
- Soil type : Norpa sand, pH 4.5 (CaCl₂). Acacia, Casuarina.
- History : Cleared 1965. Fallow since 1968. Clover sown 1966 with 200 kg/ha Cu, Zn, Mo super - failed.
- Fertilizer : 200 kg/ha plain super hand broadcast and raked in prior to sowing.
- Sowing : Sown May 21 with seed, lime pellet inoculated May 19. Commercial inoculant used; Group BC, WU95 + CC2480a and White clover group TA1.
- Treatments : Promising crossbred clovers (Nos. 584, 239 and 175) from Dr Francis' programme compared with Northam A, Geraldton and Dwalganup.

Treatment		Nodulation		Plant wt (gm)		Aug 7 Growth Rating*	
Host	Inoculum	Aug 28	Oct 1	Aug 28	Oct 1	Col. Growth	
584	TA1	3.3	3.6	.207	1.40	1.5	2.8
	WU95 + CC2480a	3.1	3.6	.226	1.73	1	2.3
	Nil	1.3	1.5	.176	1.39	1	2.3
239	TA1	3.3	3.3	.232	1.90	3	3
	WU95 + CC2480a	3.1	3.5	.311	2.50	3	3.8
	Nil	1.0	1.2	.298	2.06	3	3
Northam A	TA1	3.0	2.4	.161	0.90	2.8	2.5
	WU95 + CC2480a	3.0	2.8	.141	1.02	3	3
	Nil	0.7	0.8	.107	0.63	3	2.8
Geraldton	TA1	3.3	3.5	.166	1.80	2	2
	WU95 + CC2480a	3.6	3.8	.202	1.57	2.3	2.8
	Nil	0.5	0.3	.169	1.26	1.8	2
Dwalganup	TA1	3.4	3.1	.245	1.19	2	3
	WU95 + CC2480a	3.2	3.2	.158	1.00	2	3
	Nil	1.0	1.6	.170	1.02	2.5	2.5
175	TA1	3.1	2.6	.159	0.95	2.8	2.3
	WU95 + CC2480a	2.9	3.3	.112	1.18	2.8	2.3
	Nil	1.7	0.9	.143	1.10	3	2

- Colour : 1 = red, 2 = red-green, 3 = green. These plants seemed very deficient in phosphate.
- Growth : 1 = v. small, 2 = small, 3 = medium, 4 = large plants.
- Comments : 1. All hosts responded to inoculation based on nodulation.
2. There was no effect of inoculation treatment on yield of clover on either sampling occasion. However there was a consistent tendency for CC2480ato be superior to TA1.