1985

Effect of soil type on relative crop yields, effect of seeding time on pea and lupin yields, effect of seeding rate on field pea yields, studies in legume nodulation and response of cereals in the year following legumes.

R. French

DEPARTMENT OF AGRICULTURE

WESTERN AUSTRALIA

SUMMARY OF 1985 EXPERIMENTAL RESULTS

R.FRENCH
PLANT RESEARCH DIVISION
DRYLAND RESEARCH INSTITUTE
MERREDIN

CONTENTS

INTRODUCTION

The 1985 field pea agronomy programme at Merredin fell broadly into five categories. These were
1) Effect of soil type on relative crop yields
2) Effect of time of seeding on pea and lupin yields
3) Effect of seeding rate on field pea yields
4) Studies in legume nodulation
5) Response of cereals in the year following various legume crops

In addition to simply measuring the end result of the treatments imposed, some attempt has been made to understand why these treatments act as they do. While all of the data has yet to be analysed, what is presented here should give a general indication of the years results.

1) Effect of Soil Type on Relative Crop Yields.

Results of previous trials have shown that peas perform well on heavy soils where lupins grow poorly. In fact in 1984 peas outyielded wheat on a Salmon gum soil at Merredin (84M53) which was surprising since eastern states experience suggests that peas rarely, if ever, equal cereal yields. In 1985 four trials were conducted comparing the yields of seven crops. Included were two lupin lines from Dr.Gladstones (75A-258 and 75A-259) descended from a Moroccan parent collected on a heavy alkaline soil, to test whether they are better suited to heavier soils than current commercial varieties.

RESULTS

Trial 85M36 Relative crop yields - Heavy land

Soil type Salmon gum/red-brown sandy clay loam

Sowing date 14/6/1985 (dry)

Herbicide 14/6/1985 1.5 L/ha diuron + 1.5 L/ha trifluralin on legume plots

Fertilizer 14/6/1985 100 kg/ha plain super drilled with seed

Yields

Treatment	D.matter (t/ha) 25/9/85	D.matter (t/ha) 4/11/85	grain (t/ha) 13/11/85	HI(%)
Wheat (Bodallin)	1.91	2.12	0.57	27.3
Barley (O'Connor)	1.48	1.86	0.55	30.1
Peas (Derrimut)	1.51	1.47	0.65	44.4
Lupins(Yandee)	1.33	0.86	0.17	19.5
Lupins (Chittick)	1.33	0.80	0.13	16.8
Lupins (75A-258)	1.41	0.85	0.15	18.5
Lupins (75A-259)	1.18	0.92	0.19	21.4
LSD (P=0.05)	n.s	0.25	0.12	9.7

Notes

The trial was seeded into dry soil and only light falls of rain followed for some time. As a result germination was uneven. Patches of the trial were established three weeks after seeding, whereas plants were still emerging a month after seeding. Nevertheless reasonable densities of all crops were eventually established.

Trial 85M37 Relative Crop Yields - Medium land

Soil Type Salmon gum/mallee - red-brown sandy loam

Sowing date 8/6/1985 (moist)

Herbicide	8/6/1985	1.5 L/ha diuron + 1.5 L/ha trifluralin on legume plots
	23/7/1985	1 L/ha brominil M on cereal plots
Insecticide	4/7/1985	70 ml/ha Rogor across whole trial for red-legged earth mite
Fertilizer	8/6/1985	80 kg/ha agran top dressed onto cereal plots before seeding. 100 kg/ha plain super drilled with seed.

Yields

Treatment	D.matter (t/ha) 4/11/85	Grain yield (t/ha) 13/11/85	HI(%)
Wheat (Bodallin)	-	1.44	-
Barley (O'Connor	-	1.54	-
Peas (Derrimut)	3.07	1.22	40
Lupins (Yandee)	1.53	0.44	28
Lupins (75A-258)	2.04	0.61	31
Lupins (75A-259)	2.06	0.92	44
LSD (P=0.05)	0.91	0.22	7.3

Notes

The light falls of rain not sufficient to germinate the seed on 85M36 were enough to establish the crops on this site. There was some confusion with the packets of 75A-258 and 75A-259 for the cone seeder which resulted in half plots being sown of each line which meant that these lines had to be quadrat harvested. However quadrat harvesting of the peas gave similar results to machine harvesting.

Trial 85M38 Relative Crop Yields - Good Light land

Soil Type Mallee/Sand over clay

Sowing Date 6/6/1985 (dry)

Herbicide 6/6/1985 1.5 L/ha diuron + 1.5 L/ha trifluralin on legume plots.
8/7/1985 1 kg/ha SSH on cereals
1 L/ha fusilade on legumes

Insecticide 4/7/1985 70 ml/ha Rogor for red-legged earth mites

Fertilizer 6/6/1985 80 kg/ha Agran top-dressed on cereal before seeding.
100 kg/ha plain super drilled with seed.

Yields

Treatment	Machine harvest yield (t/ha) 13/11/85	Quadrat grain yield (t/ha) 4/11/85	D.matter (t/ha) 4/11/85	HI(%)
Wheat (Bodallin)	1.06	-	-	-
Barley (O'Connor)	0.89	-	-	-
Peas (Derrimut)	1.19	1.06	2.42	44.2
Lupins (Yandee)	0.19	-	-	-
Lupins (Chittick)	0.27	0.36	1.07	33.9
Lupins (75A-258)	0.26	0.34	1.06	30.4
Lupins (75A-259)	0.32	0.41	0.97	40.6
LSD (P=0.05)	0.20			

Notes

This trial was seeded dry,with consequent poor weed control. In particular, barley grass came up very thickly in some plots. While we were able to control this in the legumes with fusilade we couldn't kill it in the cereals, hence the relatively poor yields for wheat and barley. There was also a considerable amount of capeweed present which couldn't be controlled in the legumes. The peas, with their early canopy development, seemed better able to compete with this than the lupins.

Trial 85M39 Relative Crop Yields - Poor Light Land

Soil Type Wodgil/acid loamy sand

Date Sown 7/6/1985 (moist)

Herbicide 7/6/1985 1.5 L/ha diuron + 1.5 L/ha trifluralin on legume plots
23/7/1985 1 L/ha brominil M +1 L/ha hoegrass on cereal plots
1 L/ha hoegrass on legume plots

Fertilizer 7/6/1985 120 kg/ha agran top-dressed on cereal plots before seeding.
150 kg/ha plain super drilled with seed.

Yields

Treatment	D.matter (t/ha) 25/9/85	D.matter (t/ha) 4/11/85	Grain Yield (t/ha) 27/11/85	HI(%)
Wheat (Bodallin)	0.98	1.63	0.67	41
Barley (O'Connor)	1.19	1.46	0.50	34
Peas (Derrimut)	0.94	1.13	0.40	35
Lupins (Yandee)	0.69	0.94	0.33	34
LSD (P=0.05)	n.s	0.45	0.16	n.s

Notes

This site had a very weedy wheat crop on it in 1984, so although there was a massive capeweed kill by cultivation before seeding there was still a large population of capeweed and ryegrass to contend with. The peas on this site did not nodulate and so grew poorly, and although the lupins originally established well (46 plants/m2 on 25/7/85) they thinned out as the season progressed until they were very thin at the end of the season.

Discussion

In 1985 peas yielded very well in comparision to lupins and reasonably in comparison to cereals, consistent with results in 1984. Their improved performance relative to lupins was due both to increased dry matter production and to a better harvest index. The yields of lupins were disappointing, but 1985 was a dry season and there is evidence that lupins are less drought tolerant than peas (see discussion in time of seeding section). It is becoming apparent that even on some soils that are usually called light peas may be a better grain legume than lupins. This may be because of heavy subsoils restricting lupin root growth, hence further work on defining soil characteristics in relation to pea and lupin growth is necessary. It is of interest that on these duplex soils the lupin line 75A/259 did better than Yandee, although it showed very little advantage on the really heavy site. Lines such as this deserve further attention.

2) Effect of Time of Seeding on Peas and Lupin Yields

To design a total crop package incorporating field peas it is necessary to know the effects of time of seeding on yield and, if the package is also to incorporate lupins, it will also be necessary to know the effect on lupin yield relative to that of peas.

In order to cover the range of environments in which peas are likely to be grown in the W.A. wheatbelt time of seeding trials were done at seven locations throughout the wheatbelt. Each trial consisted of two field pea varieties, Dun and Derrimut, and two lupin varieties, Yandee and 119-6-1, sown at three times. 119-6-1 is particularly interesting because it incorporates the reduced branching character which has been an advantage in the northern wheatbelt.

Trial 85JE17 - Pea and Lupin time of sowing - Jerramungup

Soil Type - Grey sand over clay at 30 cm

Sowing Date - Early - 15/5/85 (dry)
Mid - 27/5/85
Late - 4/7/85

Herbicide 15/5/85 1.5 L/ha Yield + 1.5 L/ha Diuron
20/6/85 1.5 L/ha Hoegrass
4/7/85 Late TOS plots sprayseeded
10/7/85 1.0 L/ha Hoegrass

Fertilizer 120 kg/ha plain superphosphate drilled with seed

Results
Grain Yields (t/ha)

	Derrimut	Dun	Yandee	119-6-1
Early	2.21	1.94	2.54	2.96
Mid	1.11	1.02	1.34	1.92
Late	1.95	0.83	1.20	1.23

LSD (P=0.05) = 0.32

Trial 85KA62 Pea and Lupin Time of Sowing - Katanning

Soil Type - Loamy sand over clay at 50 cm

Sowing Date - Early - 4/6/85
Mid - 17/6/85
Late - 27/6/85

Herbicide 30/5/85 1.5 L/ha Roundup

At seeding 1.5 L/ha trifluralin IBS and 1.5 L/ha diuron IAS.

Fertilizer 150 kg/ha plain superphosphate drilled with seed

Results

Grain Yields (t/ha)

	Derrimut	Dun	Yandee	119-6-1
Early	1.95	2.01	1.37	1.82
Mid	2.52	2.51	0.93	1.28
Late	2.55	2.38	0.71	1.01

LSD (P=0.05) =0.63

Trial 85N20 Pea and Lupin Time of Sowing - Newdegate

Soil Type - Sand over clay at 40 cm

Sowing Date - Early 24/5/85 (dry)
Mid 24/6/85 (dry)
Late 18/7/85

Herbicide - 1.5 L/ha diuron + 1.5 L/ha trifluralin applied immediately prior to seeding.

Fertilizer - 117 kg/ha superphosphate + Mn drilled with seed.

Results

Grain Yields (t/ha)

	Derrimut	Dun	Yandee	119-6-1
Early	1.07	1.03	0.60	0.58
Mid	1.11	1.12	0.59	0.67
Late	0.59	0.53	o.42	0.40

LSD (P=0.05) = 0.164

Trial 85ME42 Pea and Lupin Time of Sowing - Westonia

Soil Type - Sandy loam over clay at 30 cm

Sowing Date - Early 23/5/85 (dry)
Mid 14/6/85
Late 15/7/85

Herbicide - 1.5 L/ha diuron + 1.5 L/ha trifluralin applied immediately prior to seeding.
22/7/85 1.0 L/ha fusilade

Fertilizer - 100 kg/ha plain superphosphate drilled with seed.

Results

	Grain Yields (t/ha)			
	Derrimut	Dun	Yandee	119-6-1
Early	1.34	1.14	0.75	1.19
Mid	1.23	1.39	0.40	0.57
Late	0.72	0.50	0.25	0.28

LSD (P=0.05) = 0.34

Trial 85ME43 Pea and Lupin Time of Sowing - Kwolyin

Soil Type - Sand over clay at 50 cm

Sowing Date - Early 24/5/85 (dry)
Mid 20/6/85 (dry)
Late 17/7/85

Herbicide - 1.5 L/ha diuron + 1.5 L/ha trifluralin applied immediately prior to seeding.

Fertilizer - 126 kg/ha superphosphate + Mn drilled with seed.

Results

	Grain Yields (t/ha)			
	Derrimut	Dun	Yandee	119-6-1
Early	0.88	0.58	0.27	0.35
Mid	-	0.51	0.29	0.40
Late	0.33	0.29	0.24	0.27

LSD (P=0.05) = 0.123

Note: There is no figure available for mid-sown Derrimut because Dun was sown in its place by accident.

Trial 85ME44 Pea and Lupin Time of Sowing - Bencubbin

Soil Type - Sandy loam over clay at 40 cm

Sowing Dates - Early 23/5/85 (dry)
Mid 14/6/85
Late 15/7/85

Herbicide - 1.5 L/ha diuron + 1.5 L/ha trifluralin applie immediately prior to seeding.
22/7/85 1.0 L/ha fusilade.

Fertilizer - 100 kg/ha plain superphosphate.

Results

Grain Yields (t/ha)

	Derrimut	Dun	Yandee	119-6-1
Early	0.94	0.88	0.28	0.35
Mid	0.85	0.77	0.35	0.39
Late	0.37	0.25	0.12	0.17

LSD (P=0.05) = 0.171

Trial 85WH48 Pea and Lupin Time of Sowing - Wongan Hills

Soil Type - Deep loamy sand.

Sowing Dates - Early 29/5/85
Mid 10/6/85
Late 28/6/85

Herbicide - 29/5/85 2 L/ha sprayseed + 1.5 L/ha diuron across whole site.
7/6/85 1.5 L/ha sprayseed on mid and late treatments.

Fertilizer - none

Results

Grain Yields (t/ha)

	Derrimut	Dun	Yandee	119-6-1
Early	1.22	1.41	2.08	2.63
Mid	1.25	0.87	2.05	2.16
Late	0.72	0.71	1.47	1.65

LSD (P=0.05) = 0.476

Discussion

Taken together these trials indicate two types of response to seeding time. The first, observed in peas in 85JE17 (if we regard the mid time of seeding as anomalous), and 85KA63 and in lupins in 85N20, 85ME43 and 85ME44, showed very little change with delayed seeding. This response appeared to be associated with high yields in peas, i.e. in areas with longer growing seasons, but with low yield in lupins. The second response showed a progressive decline in yield as seeding was delayed. However the decline was greater for lupins than for peas. Averaged over the trials where declines did occur, Derrimut peas lost 11.5 kg/ha yield for each day's delay in seeding, Dun peas 12.2, Yandee lupins 22.0 and 119-6-1 lupins 30.8 kg/ha. Thus on farms where both peas and lupins are grown lupins should be seeded first.

The very poor lupin yields on many of the sites in comparison to peas was surprising. It was not due to unfavourable soil type as each site was chosen because it was on a soil suitable for lupins. It would seem that lupins are less well adapted to the adverse growing conditions of the 1985 season than peas. This is illustrated by Finlay-Wilkinson analysis of the data from the seven trials (log transformation). In the table a represents the intercepts of the regressions and b the slopes.

Time of seeding	Derrimut a	Derrimut b(±se)	Dun a	Dun b(±se)	Yandee a	Yandee b(± se)	119-6-1 a	119-6-1 b(±se)
Early	0.180	0.552 ±0.078	0.078	0.696 ±0.075	-0.379	1.458 ±0.089	-0.097	1.455 ±0.074
Mid	0.132	0.790 ±0.092	0.035	0.732 ±0.141	-0.375	1.221 ±0.159	-0.132	1.228 ±0.137
Late	0.192	0.902 ±0.087	-0.094	0.876 ±0.077	-0.290	1.055 ±0.104	-0.171	1.089 ±0.095
All*	0.140	0.783 ±0.047	-0.004	0.850 ±0.052	-0.320	1.168 ±0.063	-0.097	1.221 ±0.055

* Data from three times of seeding pooled, each time of seeding at each site regarded as a separate environment.

Yield component data from these trials was also collected.

3) Effect of Seeding Rate on Field Pea Yields.

Results of seeding rate trials on peas to date have been confusing. For example, in 83N4 (see G.Walton, Experimental summary 1983) the yield of Derrimut peas responded to increasing plant densities up to 120 plants/m2. In 1984, however, six trials showed no response above 40 plants/m2. In 1985 two trials were conducted comparing the reponse to seeding rate of three pea varieties, Derrimut, Dun, and P-SL-9 (a semi-leafless pea).

Trial 85KA63 Seeding Rates x Pea phenotypes - Katanning

Soil Type Loamy sand over clay at 50 cm

Sowing Date 17/6/85

Herbicide 30/5/85 1.5 L/ha Roundup
17/6/85 1.5 L/ha trifluralin IBS + 1.5 L/ha diuron IAS.

Fertilizer 150 kg/ha plain superphosphate drilled with seed.

Results

Seed rate (kg/ha)	Derrimut		Dun		P-SL-9	
	Plant density*	Yield+	Plant density*	Yield+	Plant density*	Yield+
80	37.1	1.86	39.9	1.47	27.0	1.36
120	48.5	2.17	53.3	1.74	31.1	1.49
160	67.5	1.93	69.9	1.91	38.0	1.73
200	82.0	2.23	71.6	2.10	42.2	1.62

LSD (P=0.05) = 0.327 (grain yield) 9.52 (plant density)

* Plant density in plants/m2 measured 8/7/85
+ Grain yield in t/ha.

Trial 85M33 Seeding Rates x Pea phenotypes - Merredin

Soil Type Salmon gum red sandy clay loam

Sowing Date 20/6/85 (dry)

Herbicide 1.5 L/ha trifluralin + 1.5 L/ha diuron applied immediately prior to seeding.

Fertilizer 126 kg/ha superphosphate + Mn drilled with seed.

Results

Seed Rate (kg/ha)	Derrimut		Dun		P-SL-9	
	Plant density*	Yield+	Plant density*	Yield+	Plant density*	Yield+
80	43.9	0.71	41.9	0.63	19.0	0.48
120	58.8	0.78	62.4	0.60	34.1	0.61
160	64.1	0.72	0.77	0.53	39.8	0.64
200	102.2	0.61	103.6	0.47	44.6	0.66

LSD (P=0.05) = 0.139 (grain yield) 15.9 (plant density)

* Plant density in plants/m2. Measured 16/8/85
+ Yield in t/ha

Discussion

The response of grain yield to plant density for Derrimut was saturated at 50 plants/m2 on both sites, however at Katanning Dun pea yields continued to respond to increasing plant density until 70 plants/m2. At Merredin Dun yields declined with increasing density, presumably due to the dry season coupled with the lateness of Dun. It was not possible to compare the response of P-SL-9 to seeding rate with the other two varieties because the seed quality of this variety meant that very poor stands were established.

These trials are consistent with the currently recommended seeding rate of 120 kg/ha, which results in the establishment of 50-60 plants/m2. However, the increased yield achieved in raising the seeding rate from 80 to 120 kg/ha is often not statistically significant, so more work is necessary to confirm whether it is real.

4) Studies in Legume Nodulation.

In 1984 dressing pea seed with a fungicide aimed at the control of the Ascochyta group of fungi caused a severe loss of nodulation. Since this observation was not reproduced by farmers who used P-Pickel(R) it was thought that this may have been due to the acidity of the site used (84M64), since peas are generally grown on neutral to alkaline soils. To test the hypothesis that P-Pickel(R) would more severely retard nodulation on acid soils, two sites were chosen in 1985. In addition the new product P-Pickel T(R) was included in the trial.

Another trial was done to investigate the effects of gypsum on nodulation since nodulation failure in lupins growing on gypsum treated soil has been observed several times.

Trial 85M32 Effects of Gypsum on Legume Nodulation

Location Glasshouse at DRI, Merredin

Culture Soil collected from a farmer's paddock at Bencubbin at the end of a gypsum trial (85ME63W) in which lupins failed to nodulate in 1983. 3 kg of dried and sieved soil was mixed with 1.4 g superphosphate and the appropiate amount of gypsum and placed in pots. After sowing 10 seeds per pot on 30th May and inoculating, the pots were watered to field capacity. After germination the pots were thinned to five plants per pot.

Treatments

The experiment was a factorial with two species (Derrimut peas and Yandee lupins) X four gypsum rates (nil, low, medium and high) X three inoculum levels (nil, low, high). The gypsum rates were chosen to be roughly equivalent to 2.5, 5.0 and 10.0 t/ha and were achieved by mixing 11.6, 23.1 and 46.2 g gypsum per pot.

Inoculation

A 1% (w/v) suspension of peat inoculum in water was made and 1.0 ml of this pipetted onto each seed for the high inoculum level. For the low level a 1:100 dilution of the suspension was made and 1.0 ml of this pipetted onto each seed.

Measurements

Plants were harvested on 10/7/85. Nodule fresh weight and top dry weight were recorded.

Results

Nodule fresh wt (g/pot)

Inoculum Level	Nil		Low		High		Mean
Species	Pea	Lupin	Pea	Lupin	Pea	Lupin	
Gypsum level							
Nil	0.012	0.91	0.98	1.50	0.56	1.64	0.936
Low	0.061	0.87	0.84	1.36	1.09	1.59	0.970
Medium	0.00	1.24	1.20	1.60	1.30	1.56	1.151
High	0.00	1.21	0.94	1.49	1.28	1.14	1.011
LSD (P=0.05)				0.59			n.s.

No gypsum interactions were significant

Top dry weight (g/pot)

Inoculum level	Nil		Low		High		Mean
Species	Pea	Lupin	Pea	Lupin	Pea	Lupin	
Gypsum level							
Nil	4.41	2.84	4.55	2.94	3.43	3.01	3.53
Low	4.07	2.30	4.26	2.68	3.82	2.51	3.27
Medium	4.14	2.40	4.22	2.80	4.08	2.70	3.39
High	3.90	2.54	3.96	2.62	4.22	2.37	3.27
LSD (P=0.05)				0.49			0.20

No second order gypsum interactions were significant

Notes

Several of the high inoculum peas were slow to emerge and never caught up from the initial setback. Therefore the apparent yield depressing effect of high inoculum on peas in the absence of gypsum is dubious. In any case it is due to differences in germination and emergence, not to effects exerted during growth. The paddock from which the soil was taken had grown lupins, although not on the patch the soil was taken from. This explains the nodulation in uninoculated lupins.

Trial 85M34 Fungicide Effects on Pea Nodulation - Neutral Soil

Soil Type Salmon gum/red brown sandy clay loam.

Surface pH - 6.21

Sowing Date 17/6/85

Herbicide 17/6/85 1 L/ha sprayseed + 1.5 L/ha diuron + 1.5 L/ha trifluralin before seeding

Fertilizer 100 kg/ha plain superphosphate drilled with seed

Results

Treatment	Grain Yield (t/ha)
Uninoculated	0.90
Lime pellet (uninoculated)	0.75
Gum slurry inoculated	0.80
Lime pellet inoculated	0.82
um slurry + P-Pickel	0.73
Gum slurry + P-Pickel T	0.80
Gum slurry + P-Pickel (dry dust)	0.80
Gum slurry + P-Pickel T (dry dust)	0.75
Lime pellet + P-Pickel	0.81
Lime pellet + P-Pickel T	0.80
Gum slurry + P-Pickel/lime mix	0.80
Gum slurry + P-Pickel T/lime mix	0.74
LSD (P=0.05)	n.s

Notes

It was planned to dig up plants for nodulation scoring but when this was attempted in early September the ground was found to be too hard to be able to dig up plants without damaging the root systems. Therefore only an extremely rough assessment of nodulation was possible. All treatments were nodulated, but the uninoculated treatments were probably less well nodulated than the others. No other differences were discernible.

Trial 85M35 Fungicide Effects on Pea Nodulation - Acid soil

Soil Type Mallee/sand over clay

Surface pH - 5.66

Sowing Date 17/6/85

Herbicide 17/6/85 1 L/ha Sprayseed +1.5 L/ha diuron + 1.5 L/ha trifluralin before seeding

Fertilizer 100 kg/ha plain superphosphate drilled with seed.

Results

Treatment	Nodulation Score 3/9/85	% N in Tops 3/9/85	Grain Yield (t/ha)
Uninoculated	1.26	3.44	1.40
Lime pellet (uninoculated)	1.89	3.53	1.20
Gum slurry inoculated	1.65	3.91	1.15
Lime pellet inoculated	1.98	3.76	1.51
Gum slurry + P-Pickel	1.73	3.50	1.29
Gum slurry + P-Pickel T	1.36	3.64	1.29
Gum slurry + P-Pickel (dry dust)	1.66	4.10	1.12
Gum slurry + P-Pickel T (dry dust)	1.66	3.67	1.38
Lime pellet + P-Pickel	1.81	3.76	1.36
Lime pellet + P-Pickel T	1.62	3.73	1.31
Gum slurry + P-Pickel /lime mix	1.46	3.77	1.18
Gum slurry + P-Pickel T/lime mix	1.84	3.66	1.39
LSD (P=0.05)	0.30	n.s.	n.s.

Notes

The arbitrary scoring system used here is not the same as that used in 84M64. The system used here gave 0 to plants with no nodules, 1 to plants with up to ten small nodules (< 2mm diameter), 2 to plants with more than ten small nodules, 3 to plants with up to five large nodules and 4 to plants with more than five large nodules. Each plot was given the average score of thirty plants.

Discussion

Under glasshouse conditions gypsum had no effect on the nodulation of lupins or field peas. However it did have a slight (but significant) depressing effect on top growth, indicating that the glasshouse did not truly represent field conditions. As glasshouse conditions were ideal for nodulation with warm temperatures and non-limiting moisture any stress imposed by the gypsum may have been overcome. Therefore it seems necessary to further test the effects of gypsum on pea nodulation in the field. Nodulation responded to inoculum level, even where there were already bacteria present in the soil, however the N status of the soil seemed high enough for top growth to be independant of nodulation, except for the probably artifactual depression of top growth in peas at high inoculum and low gypsum.

We were not able to repeat 1984's dramatic effects of P-Pickel on pea nodulation even on a moderately acid soil. This may have been due to the presence of R.leguminosarum already on the sites chosen, indicated by the nodulation of uninoculated peas. This could also have been due to these sites having previously grown sub clover, as some strains of R.trifolii have been observed to infect pea roots (A.Robson, pers. comm.). However the effectiveness of such associations is not known. The ability of lime to enhance nodulation again showed up but this time none of the treatments had any significant effect on yield. There was, however, a significant positive correlation between nodulation score and final grain yield (r2 = 26.5%), but it was poorer than the correlation observed in 1984. However in 84M64 most of the variation in nodulation score was due to variation in the number of unnodulated plants, but in the 1985 trials very few plants were unnodulated. Thus, in 1984 many individual plants would have had poor nodulation as their major limitation to productivity, but in 1985 this would have been less limiting so other factors would have had more effect in determining variability in yield.

5) Response of Cereals in the Year following Legumes.

One of the main selling points for lupins as a grain legume in W.A. crop rotations has been the often large responses of following cereal crops. Although the value of peas in this respect has been shown in other states we still don't know what effects to expect here, particularly since the heavy and medium soils to which peas are best suited are less nitrogen responsive than most lupin soils. Three crop comparision trials from 1984 on different soil types were cropped to wheat in 1985 to gauge this response.

Trial 84M50 Relative Crop Yields - Poor Light Land

Soil Type Wodgil/yellow loamy sand with acid subsoil

Sowing Date 15/6/85

Herbicide 29/7/85 1.25 L/ha Hoegrass
1.5 L/ha Brominil M

Fertilizer 120 Kg/ha plain superphosphate

Results

Yields of Wheat in 1985 (t/ha)

1984 Crop	Dry Weight 19/9/85	Grain Yield 25/11/85	Grain N (kg/ha)
Wheat (Bodallin)	1.00	0.65	13.9
Oats (West)	1.01	0.67	12.8
Barley (Clipper)	1.21	0.72	15.7
Triticale (Tyalla)	0.86	0.58	11.1
Cereal Rye (S.A.Commercial)	0.99	0.62	12.7
Lupin (Yandee)	0.90	0.79	18.5
Pea (Derrimut)	1.33	0.86	20.7
Chickpea (Tyson)	1.37	0.86	19.4
LSD (P=0.05)	n.s	0.20	4.0

Trial 85M51 Relative Crop Yields - Good Light Land

Soil Type Mallee/sand over clay

Sowing Date 15/6/85

Herbicide 29/7/85 1.25 L/ha Hoegrass
1.5 L/ha Brominil M

Fertilizer 120 kg/ha plain superphosphate

Results

Yields of Wheat in 1985 (t/ha)

1984 Crop	Dry Weight 19/9/85	Grain Yield 25/11/85	Grain N (kg/ha)
Wheat (Bodallin)	1.92	0.75	12.5
Oats (West)	1.62	0.58	9.0
Barley (Clipper)	1.98	0.70	11.8
Triticale (Tyalla)	1.87	0.74	12.0
Cereal Rye (s.A.Commercial)	1.97	0.78	12.8
Lupin (Yandee)	2.93	0.85	19.6
Pea (Derrimut)	3.26	0.75	18.0
Chickpea (Tyson)	2.38	0.68	13.6
LSD (P=0.05)	0.98	0.14	3.36

Notes

The poor yield after oats was due to the inability to control a wild oat infestation in this crop in 1984 resulting in heavy seed set and subsequent infestation in 1985.

Trial 84M52 Relative Crop Yields - Medium land

Soil Type Salmon gum/Mallee, red-brown sandy loam

Sowing Date 15/6/85

Herbicide 29/7/85 1.25 L/ha Hoegrass
1.5 L/ha Brominil M

Fertilizer 100 kg/ha plain superphosphate

Results

Yields of Wheat in 1985 (t/ha)

1984 Crop	Dry Weight 16/9/85	Grain Yield 26/11/85	Grain N (kg/ha)
Wheat (Bodallin)	1.33	0.48	9.3
Oats (West)	0.82	0.36	7.0
Barley (Clipper)	1.27	0.47	9.1
Triticale (Tyalla)	1.42	0.47	9.1
Cereal Rye (S.A.Commercial)	1.63	0.49	10.2
Lupin (Yandee)	1.78	0.49	11.9
Pea (Derrimut)	1.80	0.61	14.0
Chickpea (Tyson)	1.80	0.63	14.5
LSD (P=0.05)	0.45	0.13	2.93

Notes

See comment for trial 84M51

Discussion

Responses after grain legumes were observed in each trial, although these were not always signifcant. In 84M51 and 84M52 the responses in dry matter production up to mid-September were greater than the response in grain yield. This is probably because their was insufficient water available in late September and during October to allow conversion of this matter into grain yield. In fact leaf firing was observed in the grain legume plots at the time of the September harvest, and water balance measurements on a nearby CSIRO site indicated that soil moisture reserves were almost exhausted in September. The significant responses in grain N even where there was no response in grain yield also suggest that yield was limited by water availability. In 84M50 the responses in dry matter production and grain yield were about the same, suggesting that the growth suppression by the acid subsoil may have benefitted the crop by deferring water use until later in the season.

Generally all grain legumes gave similar responses, except chickpea in 84M51. However, the peas on these sites in 1984 nodulated poorly and it was necessary to top dress them with Agran, so there is some doubt about what the responses would have been under normal circumstances.

On trials 84M51 and 84M52 soon after emergence damage due to the persistence of the diuron applied to the pea and chickpea plots (1.5 L/ha) became apparent. After a few weeks the crops had recovered and the damage had no effect on final yield, but this observation shows that current weed control measures for peas are far from satisfactory. These trials also show some of the effects crop rotation can have on weed control.