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Assessment of 2nd generation acid tolerant strains of R. Meliloti

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Trial: 86M58

Personnel: Howieson
Ewing
Revel

Title: Assessment of 2nd generation acid tolerant strains of R. meliloti

Aim: To assess the acid tolerance of possible replacement strains for WSM419.

Background: Trial sown in June 1986 in paddock 9A(II) on M.R.S., pH 4.9, to 4.5 at 5-10 cm. Cross rows sown May 1987, but failed due to drought. Resown August 1987, and harvested 6 weeks later.

Treatment: 27 strains of R. meliloti x 8 replicates with host Serena

Results: Nodulation (0-10 cm)

Strain	Score	% nodulation	Strain	Score	% nodulation
WSM 379	5.7	42			
WSM 387	3.6	36	WSM 576	2.0	21
WSM 395	4.3	50	WSM 645	4.3	43
WSM 407	3.3	37	WSM 677	2.2	24
WSM 411	4.6	47	WSM 681	5.3	48
WSM 535	6.8	65	WSM 687	4.7	47
WSM 537	4.6	39	WSM 688	5.7	41
WSM 539	2.2	27	WSM 419	2.2	25
WSM 540	6.9	56	WSM 413	2.6	27
WSM 541D	3.8	42	CC 169	2.1	29
WSM 547	3.2	35	WSM 244A	3.6	41
WSM 549	5.0	51	WSM 541L	3.5	33
WSM 550	3.0	39	WSM 396.1	5.2	53
WSM 555	7.1	61	WSM Nil	0.3	6
			LSD (5%)	2.2	16.9

Best strains: From 86M58

	Score	% nodulation
WSM 379	5.7	42
WSM 688	5.7	41
WSM 535	6.8	65
WSM 540	6.9	56
WSM 555	7.1	61
WSM 419	2.2	25
CC 169	2.1	29
LSD 5%	2.2	16.9

Conclusions: Lateral spread was more restricted than usual in the cross row trials probably because the year was so dry, and plants were sown late. Plants grew poorly and were generally unable to pick up nodules in the 11-20 cm region. Hence only data from the 0-10 cm region was analysed. This shows that several strains significantly outperformed WSM419 at this site, which is somewhat more acid than previous sites for the cross row experiments. Two of the best strains, WSM 535 and WSM 540 were collected at the same site in Sardinia. The improved performance of WSM 244A was puzzling.

A summary of the nodulation achieved by selected strains in cross row trials since 1982/83 is appended. All the WSM strains except WSM244 originate from Sardinia. Those strains included in the 1987 trial are indicated ✓

Selected strains	Site of trial							
	82ME22 pH 5.0 lease block	82ME23 pH 5.3 MRS P6	84ME33 pH 4.8 MRS P6	84ME34 pH 4.9 MRS P6	84ME35 pH 4.9 MRS P6	85M28 pH 5.0 MRS P6	86M58 pH 4.9-4.5 MRS P9A(II)	87M12 pH 4.9-5.4 MRS (P9A(II)
U 45	16	7	-	-	-	11	-	-
CC 169	12	3.5	-	14	21	22	29	✓
WSM 419	36	40	21	16	38	26	25	✓
WSM 413	30	33	-	17	38	17	27	-
WSM 244	9	17	-	-	16	-	41	✓
WSM 379			-	33		-	42	-
WSM 387			-	30		-	36	-
WSM 395			-	26		-	50	-
WSM 407			-	31		-	37	-
WSM 411			-	25		-	47	-
WSM 530			14			-	-	-
WSM 532			20			35	-	✓
WSM 534			15			26	-	-
WSM 535X			30			-	65	✓
WSM 537			35			-	39	✓
WSM 539			15			27	27	-
WSM 540X			39			-	56	✓
WSM 541			50			-	53	✓
WSM 547			31			-	35	-
WSM 549			30			-	51	✓
WSM 550						19	39	-
WSM 555			36			-	61	-
WSM 576						24	21	-
WSM 642X						39	-	✓
WSM 643						39	-	✓
WSM 645						30	43	-
WSM 673						44	-	✓
WSM 677						30	24	✓
WSM 681						12	48	✓
WSM 687						29	47	-
WSM 688						35	41	✓

X Strains from the same collection site (44)

WSM 540 will replace WSM 419 in the commercial inoculum in 1988.

Trial: 86GE29

Personnel: Howieson
Hamblin
Nutt

Title: Nodulation and yields of medics on Eradu sand

Aim: 1. To assess the yield and persistence relative to Harbinger of some new medic/*R. meliloti* associations.

2. To assess the effect of deep ripping on pasture yields and persistence.

Background: Harbinger has been identified as possessing poor symbiotic competence on acid soils. This trial explored the possibility of finding a more symbiotically competent host with adaptation to deep sand.

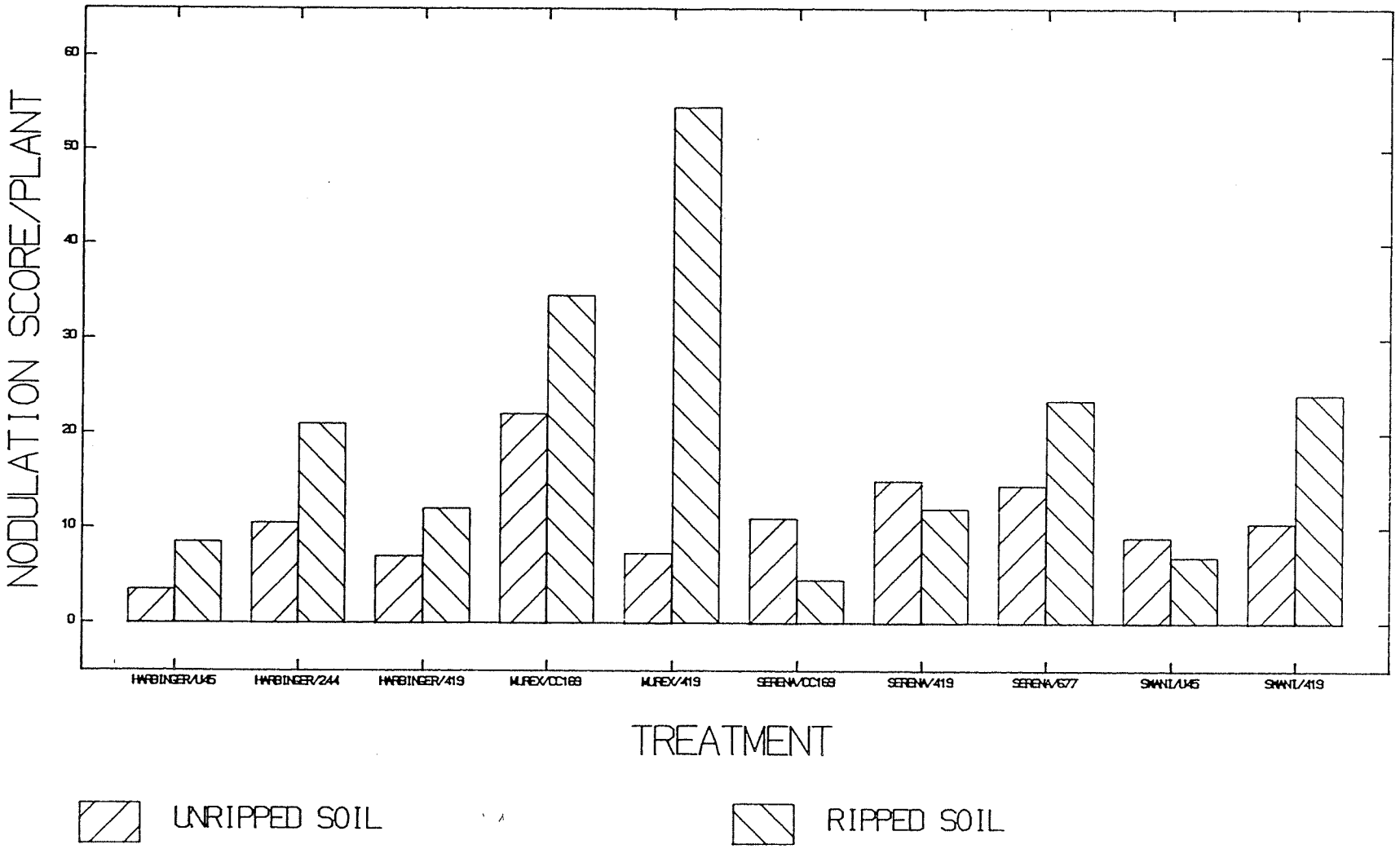
Treatments:

Host		Strains		
Serena	x	WSM419	CC169	WSM677
Harbinger	x	WSM419	U45	244
Swani	x	WSM419	U45	
M. murex	x	WSM419	CC169	

Results: Second year nodulation of host/strain combinations are shown in Figure 1.

Conclusions: On the Eradu sand, *M. murex* displayed greater symbiotic competence than all other species tested. This has been described before on loamy sands (see summaries 82/3 -> 86/7). The trial design did not allow a full analysis of strain effects, however on Serena, Zodiac and Swani, WSM419 produced greater nodulation than CC169. The high compatibility of WSM244A with Harbinger was again evident; indicating that the Harbinger/*R. meliloti* symbiosis can be improved on this soil type without the micro-symbiont necessarily possessing acid tolerance.

NODULATION OF MEDICAGO SPP.



None of the hosts tested appeared to outyield Harbinger, which suggests that the M. littoralis types will be hard to displace from the Eradu sand plain on the basis of plant adaptation.

Trial: 87M83 Personnel: Howieson
Meldrum

Title: Effect of Rovral on nodulation of lupins

Aim: To assess firstly whether Rovral reduces nodulation of lupins, and secondly, whether Rovral resistance in WU425 can overcome this problem.

Background: Sown on MRS, at Carrabin, on paddock new to lupins.
Rovral applied to seed after inoculation in normal manner. Rate 250 mL/100 kg seed.

Treatments:
1. Nil inoculation, Nil Rovral
2. WU425 gum slurry
3. WU425 gum slurry + Rovral
4. Mutant 1 (white pkt) + Rovral
5. Mutant 2 (clear pkt) + Rovral

Results: a) nodulation at anthesis

Reps (60 plants/rep)

		A	B	C	D	$\bar{x}$
Treatments	1	0.58	0.93	0.60	1.15	0.82
	2	3.05	2.54	2.91	3.27	2.94
	3	1.31	1.63	1.93	2.33	1.79
	4	1.88	2.00	2.10	1.91	1.97
	5	2.15	1.27	1.80	1.96	1.79
				LSD ($P < 0.05$)		.07

b) dryweights (g, 5 quadrats/rep at anthesis)

Reps (60 plants/rep)

		A	B	C	D	$\bar{x}$
Treatments	1	356.6	276.3	150.2	107.2	222.6
	2	267.7	266.4	230.1	144.9	227.3
	3	220.9	226.8	175.2	204.6	206.8
	4	340.1	250.5	231.9	223.1	261.4
	5	136.8	287.3	243.7	206.8	218.6
					LSD (5%)	NS

c) seed yield (kg/ha)

Reps (60 plants/rep)

		A	B	C	D	$\bar{x}$
Treatments	1	398.2	444.5	546.3	453.7	460.2
	2	361.1	398.2	463.0	463.0	421.3
	3	361.1	435.2	379.7	444.5	404.7
	4	398.2	342.6	490.8	472.3	425.9
	5	416.7	398.2	518.6	425.9	439.8
					LSD (5%)	NS

Conclusions: The nodulation scores showed a significant response to inoculation. Rovral decreased nodulation, and the presence of Rovral resistance in WU425 mutants was not reflected in the field nodulation which they produced.

The increase in nodulation due to inoculation, and the decrease due to Rovral were not reflected in biological or seed yields. There was no disease pressure at this site, hence yields were not influenced by suppression or otherwise of soil pathogens.

Trial: Soybeans

Personnel: Howieson
Ewing

Title: Supernodulating soybeans

Aim: To assess the nodulation and yield potential of supernodulating soybeans on acid soils.

Background: Sown on MRS, December 1986, reticulated off mains. Acid site, wodjil soil pH 4.3.

Treatment: Factorial combination of:

5 cultivars		and 4 levels of inoculation	
1	Bragg (normal)		
2	nod 49 (non nodulating)	1	nil
3	nts 1116 (++ nodulating)	2	normal
4	nts 1007 (++++ nodulating)	3	10 x normal
5	nts 392 (++++ nodulating)	4	10 x normal + nitrogen

Results: Nodule rating

Cultivar		Level of inoculation			
		Nil	Normal	10x	10x + N
Bragg	rep 1	0	2.5	1.9	0.35
	rep 2	0	1.6	2.2	1.9
	$\bar{x}$	0	2.05	2.05	1.12
Nod 49	rep 1	0.04	0	0.08	0
	rep 2	0.16	0.05	0.13	0
	$\bar{x}$	0.1	0.02	0.15	0
nts 1116++	rep 1	0.58	2.1	2	1.47
	rep 2	0	2.6	1.8	1.5
	$\bar{x}$	0.29	2.35	1.9	1.5
nts 1007++++	rep 1	0.65	3.1	2.97	1.7
	rep 2	1.7	3.2	2.4	1.7
	$\bar{x}$	1.2	3.1	2.7	1.7
nts 392++++	rep 1	2.6	2.5	2.8	2.7
	rep 2	1.6	3.3	2.2	1.5
	$\bar{x}$	2.1	2.9	2.5	2.1

Discussion: Although only 2 reps remained viable through the summer the enhanced nodulation capability of the supernodulating types was evident. This was expressed in the uninoculated plots and also where inorganic nitrogen was applied. Applied N reduced nodulation of Bragg (commercial variety) compared to the supernodulating mutants. Bragg was also unable to nodulate in the absense of inoculation whereas nts 1007 and nts 392 could. The high level of acidity did not appear to affect nodulation, and heavy inoculation did not enhance nodulation of any cultivars. The non-nodulating mutant failed to achieve nodulation with any inoculation treatment.

Growth of all plants was poor, and did not reflect nodulation status. Perhaps aluminium toxicity was operative.

Trial: 87M13 Personnel: Howieson
Embry

Title: Inoculation of lupins on new land

Aim: To establish whether an increased rate of inoculation, or prior inoculation of soil in the wheat phase, will avoid delayed nodulation of first year lupins.

Background: Experiment sown at Smallcombe's property, Carrabin, on land new to lupins on 12/5/87. Host plants were sown in blocks for ease of weed control in double rows of a 12 run drill. The host cultivar was Danja.

Treatment:	Year 1 (1987)	Year 2	Key
1	WO		
2	WI	all plants	W = wheat
3	W.10I	split into	L = lupins
4	LO	LO + LI	O = nil inoculation
5	LI		I = normal "
6	L10I		10I = 10x normal "
7	L PVPI		PVPI = use of PVP

Results: Nodulation of lupins and plant yields (lupins) were assessed in Year 1.

i) nodulation scores

	Replicates				
	1	2	3	4	$\bar{x}$
LO	2	2.1	2.2	2.2	2.12
LI	2.6	2.3	2.4	2.6	2.47
L10I	2.5	2.7	2.6	2.6	2.60
L PVPI	2.25	-	-	2.40	2.30
LSD ($P < 0.05$)					0.39

Seed yields: (kg/ha)

	Replicates				
	1	2	3	4	$\bar{x}$
LO	1.4	1.6	1.6	1.5	1.5
LI	1.4	1.6	1.6	1.4	1.5
L1OI	1.6	1.6	1.8	1.3	1.6
L PVPI	1.4	-	-	1.7	1.55
LSD ($P < 0.05$)					NS

Conclusions: Despite this land being new to lupins, the uninoculated control plots nodulated well, and yielded reasonably well. A ten-fold increase in the normal inoulation rate was required to achieve a significant nodulation response over the uninoculated control. This was not transformed into a yield response, however. The PVP had no effect on nodulation or yield. At anthesis a colour difference was observed between the uninoculated and inoculated plots.

Trial: 87H12 Personnel: Howieson
Shea

Title: Inoculation of lupins on new land

Aim: as for 87M13

Background: Trial sown at Mawson (Hastings property) on sandy loam (sheoak sand), 26/5/87.

Treatments: as for 87M13

Results:

i) nodulation scores - (4/8/87)

	Replicates				
	1	2	3	4	$\bar{x}$
LO	2.0	2.9	2.6	1.8	2.4
LI	2.7	3.5	2.5	2.5	2.8
L10I	3.1	3.75	3.3	2.8	3.3
LSD ($P < 0.05$)					0.63

ii) biological yields (anthesis)

	Replicates				
	1	2	3	4	$\bar{x}$
LO	671	896	935	844	836
LI	707	939	934	874	863
L10I	561	1071	992	942	891
LSD ($P < 0.05$)					NS

iii) Seed yield (kg/ha)

	Replicates				
	A	B	C	D	X
LO	345.5	1020.4	948.1	883.8	787.4
LI	305.3	1012.4	899.9	924.0	787.4
L10I	524.8	956.2	964.2	1044.5	851.7
LSD ($P < 0.05$)					NS

Conclusions: As with the previous experiment, the uninoculated control plots achieved a level of nodulation similar to the inoculated plots.

In both trials, a ten-fold increase in the level of inoculation resulted in a significant increase in nodulation over the control plots. This was not reflected in seed or biological yield. It would be useful to determine whether net nitrogen accretion differs for the varying treatments in future experiments.

Trial: 87M15 Personnel: Howieson
French

Title: Saprophytic competence of R. leguminosarum

Aim: To assess the saprophytic competence of pea rhizobia as demonstrated by nodulation of peas and faba beans on acid land with a previous pea history.

Background: Sown at Kondinin on gravelly sand of pH 4.75 ($CaCl_2$) which had peas 3 or 4 years previously.

Treatment:
1 Pea (derrimut)
2 Pea (P.SL-27) ± inoculation
3 Bean (383A)
4 Bean (100134)
5 Vetch (lanquedoc)

Results:

i) Nodulation score (8/87)

Treatments		Replicates A	B	$\bar{x}$
1	- inoc	3.5	4.0	3.75
	+ inoc	5.3	4.3	4.8
2	- inoc	4.4	4.2	4.3
	+ inoc	4.9	5.3	5.1
3	- inoc	1.4	3.4	2.4
	+ inoc	4.4	4.1	4.25
4	- inoc	3.4	5.4	4.4
	+ inoc	3.6	3.5	3.5
5	- inoc	5.3	4.2	4.25
	+ inoc	6.1	4.9	5.5

ii) Seed yields (kg/ha)

	Replicates				
	A	B	C	D	$\bar{x}$
1	1155	1340	739	785	1004.7
	924	1062	878	924	947
2	370	277	139	92	219.5
	370	277	185	46	219.5
3	NO YIELD				
4	NO YIELD				
5	370	323	462	323	369.5
	739	693	231	554	554.3

Conclusions: Nodulation achieved by all hosts, except perhaps Faba Bean line 383A, was adequate in the absence of inoculation. This is somewhat surprising considering the acidity of the soil, and the length of time since an inoculated pea crop was sown. Only the vetch should a yield response to inoculation. Growth of the bean lines was poor; as was the performance of the semi-leafless pea type. Future trials may explore soils of greater acidity in higher rainfall regions. Nitrogen applications will be included to allow assessment of whether the nodulation achieved is sufficient for maximum yield.

Trial: 86N32 Personnel: Howieson
Jellicoe

Title: 2nd Generation acid tolerant strains of R. meliloti

Aim: To identify strains of R. meliloti suitable for soils of pH less than 6.

Background: The strains selected represent a group showing superior acid tolerance to WSM419 and from which it is likely an improved acid tolerant strain will be selected. The soil was a sand over clay of pH 6.2 (water) on Newdegate Research Station.

Treatment:
1 WSM419
2 CC169
3 WSM537 x host Serena
4 WSM540
5 WSM541D
6 WSM541L
7 WSM547
8 WSM555
9 WSM677
10 WSM687

Results:

Treatment	Score	% Plants nodulated (2nd Year)
419	17	87
CC169	18	78
537	25	93
540	29	95
541D	18	85
541L	21	64
547	25	93
555	23	99
677	35	99
687	26	96
LSD ($P < 0.05$)	NS	NS

Conclusions: The site was not acid enough to provide a test of acid tolerance.