Groundnut Physiology
Microbiology
Technical Report - 3.

RESPONSE OF GROUNDNUT TO RHIZOBIUM (NC 92) INOCULATION.

Progress report 1 of Project No. G-107(85)

A Report on trials conducted in six Countries.

Co-ordinated by

GROUNDNUT IMPROVEMENT PROGRAMME
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International Rhizobium Inoculation trial (IRIT)

The following Scientists Participated in this Experiment.

Scientist/s	Research Center	Country
1. Alain Mayeux	Sebele National Research Station	Botswana
2. S. Asimi	Institut de Recherhes pour les Huiles et Oléagineux	Burkina Faso
3. Djuber Pasaribu and Sri Hujami	Bogor Research Institute for Food Crops	Indonesia
4. S.N. Nigam	Chitedze Research Station	Malawi
5. N.O. Mukhtar	Gezira Research Station	Sudan
6. Antonio Gomes De Aravio	Wepae De Teresina/ EMBRAPA	Brazil
7. Zhang-Xue Jiang Wu-Sheng tang and Jiang Rong Wen	Oil Crops Research Institute of Chinese Academy of Agricultural Sciences	Peoples Republic of China
8. L.T. Chen	Guang Dong Academy of Agricultural Sciences	Peoples Republic of China

Summary

Based on our earlier observations that some groundnut cultivars in India produced higher yields when inoculated with a Rhizobium strain NC 92 (For details see Nambiar, 1985) a trial to be conducted in few other countries was proposed. Scientists from 18 countries responded to our invitation and we have despatched peat inoculant and seeds (Cv Robut 33-1) to those centers along with details of the observations to be recorded. Apart from cv Robut 33-1, two local cultivars were proposed to be included in this experiment. We received data from 10 locations in eight countries which is presented in this report.

Inoculation with strain NC 92 significantly increased yield of three cvs (Hong-Hua, E-Hua, and Robut 33-1), a 10 % increased yields over the uninoculated control was obtained at Hubei Province in China. But in other countries there were no significant effects of Rhizobium inoculation on pod yield. However, a pooled analysis showed a significant ($p < 0.05$) yield advantage on cv Robut 33-1 (6% over the uninoculated control) across the locations tested (Table 16) .

In an independent experiment conducted by scientists at Institute of Agronomic Research, Centre of Maroua, in North Cameroon, it was observed that inoculation with strain NC 92 increased the yields of cv 28-206 by 26 %. In North Cameroon cv 28-206 covers 80% of the current acreage cultivated in groundnut (Institute of Agronomic Research, 1983).

It is suggested that inoculation trials need to be conducted in these centers, if possible using several Rhizobium strains. One major problem that we face in carrying out these trials is the loss of viability of Rhizobium in the carrier based inoculum during transport. Alternatively inoculants need to be produced on a zonal basis for a better delivery rather than inoculum being produced at ICRISAT Center and despatched to various centres.

References:

1. Institute of Agronomic Research, Centre of Maroua, (1983). United Republic of Cameroon. Annual Report 1983. pp. 51-52.

2. Nambiar, P.T.C. (1985). Response of groundnut (Arachis hypogaea L) to Rhizobium inoculation in the field. Problems and porspects. MIRCEN Journal of Applied Microbiology and Biotechnology 1:293-309.

INTERNATIONAL RHIZOBIUM INOCULATION TRIAL

Experiment	: Response of Rhizobium strain NC 92
Country	: Botswana
Research station	: Sebele National Research Station
Scientist-in-charge	: Mr. Alain Mayeux
Year/season	: 1984
Total Rainfall	: 409.8 mm
Experiment Design	: Randomized Block Design
Date of Sowing	: 9-01-1984
Date of Harvesting	: 24-05-1984 and 8-6-1984
Fertilization	:
Plant protection	: Permethrine (Ambush) (at 34 days after sowing)
Soil Type	:
Plot Size	:
Harvest Area	: 7.5 m²
Result	:

Table 1. Yield data

Treatment	Pod yield (kg ha^{-1})				
	Robut 33-1	Sellie	Natal Common	Mean	SE
Rhizobium NC 92	1670	1396	1242	1436	
Uninoculated	1477	1308	1446	1410	±73.1
SE		±126.6			
Mean	1573	1352	1344		
SE		±89.5			

ANOVA

	DF	MS	VR
Rep	5	572279	-
Cvr	2	203198	2.113
Treatment	1	6084	0.063
Cv*Treatment	2	126852	1.319
Residual	25	96154	-
Total	30	102334	-

Table 2. Plant stand per plot

Treatment	Plant stand per plot				
	Robut 33-1	Sellie	Nat.l Common	Mean	SE
Rhizobium NC 92	86.2	79.2	73.8	79.7	
Uninoculated	61.5	49.2	47.3	52.7	±2.39
SE		±4.14			
Mean	73.8	64.2	60.6		
SE		±2.93			

ANOVA

	DF	MS	VR
Rep	5	1470.2	-
Cvr	2	563.7	5.485
Treatment	1	6588.0	64.102
Cv*Treatment	2	22.0	0.214
Residual	25	102.8	-
Total	30	344.3	-

Experiment	: Response of *Rhizobium* strain NC 92
Country	: Burkina Faso
Research station	: Institut de Recherhes pour les Huiles et Oléagineux
Province/District	:
Scientist-in-charge	: Dr. S. Asimi
Year/season	: 1983
Total Rainfall	: 800 mm
Experiment Design	: Randomized Block Design
Date of Sowing	: 21-06-1983
Date of Harvesting	: 20 and 22-09-1983
Fertilization	:
Plant protection	: Benomyl (at 40 days after sowing, 300 gms/ha)
Soil Type	:
Plot Size	:
Harvested Area	: 19.2 m^2
Results	: Table 3 and 4

Table 3. Yield data

Treatment	Pod yield (kg ha^{-1})					
	Robut 33-1	TS 32-1	KH 149	CN 94	Mean	SE
Rhizobium NC 92	1015	1204	860	1139	1055	
Inoc+N	1013	1207	891	1140	1063	
Uninoculated	1065	1251	998	1330	1116	±30..
SE		±61				
Mean	1031	1221	916	1203		
SE		±35.2				

ANOVA

	DF	MS	VR
Rep	2	5634	-
Cvr	3	190492	17.072
Treatment	2	42259	3.787
Cv*Treatment	6	4870	0.436
Residual	22	11158	-
Total	33	28203	-

Table 4. Plant stand per plot

Treatment	plant stand per plot					
	Robut 33-1	TS 32-1	KH 149	CN 94	Mean	SE
Rhizobium NC 92	231.0	301.3	280.3	291.7	276.1	
Inoc+N	230.7	301.3	280.3	301.7	278.5	
Uninoculated	217.3	301.3	280.0	302.0	275.2	±2.98
SE		±5.96				
Mean	226.3	301.3	280.2	298.4		
SE		±3.44				

ANOVA

	DF	MS	VR
Rep	2	295.8	-
Cvr	3	10886.3	102.067
Treatment	2	35.6	0.334
Cv*Treatment	6	83.4	0.782
Residual	22	106.7	-
Total	33	1078.1	-

Experiment	: Response of Rhizobium strain NC 92
Country	: Indonesia
Research station	: Bogor Research Institute for Food Crops
Province/District	: West Java
Scientist-in-charge	: Dr. Djuber Pasaribu and Sri Hujami
Year/season	: 1983/84
Total Rainfall	: 641 mm
Experiment Design	: Randomized Block Design
Date of Sowing	: 07-11-1983
Date of Harvesting	: 02-02-1984
Fertilization	:
Plant protection	: Diazinon/Sevin (at every 8 days) 2 cc/litre of water
Soil Type	:
Plot Size	:
Harvested Area	: 10.08 m^2
Results	: Table 5 and 6

Table 5. Yield data

Treatment	Pod yield (kg ha^{-1})				
	Robut 33-1	Banteng	Hamping	Mean	SE
Rhizobium NC 92	1253	1698	1336	1429	
Uninoculated	1229	1447	1488	1388	±64.
SE		±111.0			
Mean	1241	1572	1412		
SE		±78.5			

ANOVA

	DF	MS	VR
Rep	5	150144	-
Cvr	2	329821	4.465
Treatment	1	15378	0.208
Cv*Treatment	2	122687	1.661
Residual	25	73867	-
Total	30	92236	-

Table 6. Plant stand per plot

Treatment	Plant stand per plot				
	Robut 33-1	Banteng	Hamping	Mean	SE
Rhizobium MC 92	112.7	256.0	250.2	206.3	
Uninoculated	134.0	266.8	242.3	214.4	±8.56
SE		±14.82			
Mean	123.3	261.4	246.3		
SE		±10.48			

ANOVA

	DF	MS	VR
Rep	5	513	-
Cvr	2	68811	52.199
Treatment	1	592	0.449
Cv*Treatment	2	655	0.497
Residual	25	1318	-
Total	30	5749	-

Experiment	: Response of Rhizobium strain NC 92
Country	: Malawi
Research station	: Chitedze Research Station
Province/District	: Lilongwe Central province
Scientist-in-charge	: Dr. S.N. Nigam
Year/season	: 1983-84
Total Rainfall	: 875 mm
Experiment Design	: Randomized Block Design
Date of Sowing	: 20-12-1983
Date of Harvesting	: 18-05-1984,30-5-84,6-6-84
Fertilization	:
Plant protection	: Rogor EC (at 43 days after sowing) 8 ml diluted in 10 ltrs of water.
Soil Type	:
Plot Size	: 21.6 m^2
Harvested Area	: 9.0 m^2
Results	: Table 7

Table 7. Yield data

Treatment	Pod yield (kg ha^{-1})				
	Robut 33-1	Chalimbana	Manipinter	Mean	SE
Rhizobium NC 92	2076	2141	3139	2452	
Uninoculated	2006	2080	3200	2428	±68.6
SE		±118.8			
Mean	2041	2110	3170		
SE		±84.0			

ANOVA

	DF	MS	VR
Rep	5	39165	-
Cvr	2	4802298	56.713
Treatment	1	4931	0.05
Cv*Treatment	2	16193	0.191
Residual	24(1)	84676	-
Total	29	402557	-

Experiment	: Response of Rhizobium strain NC 92
Country	: Sudan
Research station	: Gezira Research Station
Province/District	: Wad Medani
Scientist-in-charge	: Dr. M.O. Mukhtar
Year/season	: 1982/83
Total Rainfall	: 292.5 mm
Experiment Design	: Randomized Block Design
Date of Sowing	: 07-07-1983
Date of Harvesting	:
Fertilization	:
Plant protection	:
Soil Type	: Vertisol
Plot Size	: 25.2 m^2
Harvested Area	: 16.8 m^2
Results	: Table 8

Table 8. Yield data

Treatment	Pod yield (kg ha^{-1})				
	Robut 33-1	Ashford	Barbeton	Mean	SE
Rhizobium NC 92	1753	1768	879	1467	
Uninoculated	1807	1841	637	1428	±121..
SE		±210.5			
Mean	1780	1804	758		
SE		±148.8			

ANOVA

	DF	MS	VR
Rep	3	916057	-
Cvr	2	2851485	16.095
Treatment	1	8982	0.051
Cv*Treatment	2	62531	0.353
Residual	15	177166	-
Total	20	424725	-

Experiment	: Response of Rhizobium strain NC 92
Country	: Brazil
Research station	: UePae De Teresina/ EMBRAPA
Province/District	: Teresina-Piawi
Scientist-in-charge	: Dr. Antonio Gomes De Aravio
Year/season	: 1984
Rainfall	: 1375.8 mm
Design	: Randomized Block Design
Date of Sowing	: 19-03-1984
Date of Harvesting	: 09-07-1984
Fertilization	:
Plant protection	:
Soil Type	: Red Yellow Latosol
Plot Size	: 10.0 m^2
Harvested Area	: 5.0 m^2
Results	: Table 9 and 10

Table 9. Yield data

Treatment	Pod yield (kg ha^{-1})				
	Robut 33-1	Tatu	V-108	Mean	SE
Rhizobium NC 92	1563	933	883	1127	
Uninoculated	1347	927	1127	1133	±58.7
SE		±101.6			
Mean	1455	930	1005		
SE		±71.9			

ANOVA

	DF	MS	VR
Rep	5	49387	-
Cvr	2	967500	15.610
Treatment	1	400	0.006
Cv*Treatment	2	159100	2.567
Residual	25	61979	-
Total	30	126769	-

Table 10. Plant stand per plot

Treatment	Plant stand per plot				
	Robut 33-1	Tatu	V-108	Mean	SE
Rhizobium NC 92	62.8	51.8	36.7	50.4	
Uninoculated	60.5	56.2	46.3	54.3	±2.95
SE		±5.11			
Mean	61.7	54.0	41.5		
SE		±3.61			

ANOVA

	DF	MS	VR
Rep	5	163.8	-
Cvr	2	1243.4	7.93
Treatment	1	136.1	0.86
Cv*Treatment	2	108.4	0.69
Residual	25	156.7	-
Total	30	225.2	-

Experiment	: Response of Rhizobium strain NC 92
Country	: Peoples Republic of China
Research station	: Oil Crops Research Institute of Chinese Academy of Agricultural Sciences.
Province/District	: Hubei
Scientist-in-charge	: Dr. Zhang-Xue Jiang, WuSheng tang and Jiang Rong wen
Year/season	: 1984
Total Rainfall	: 1093.3 mm
Experiment Design	: Randomized Block Design
Date of Sowing	: 24-04-1984
Date of Harvesting	: 14-09-1984
Fertilization	:
Plant protection	:
Soil Type	: Alluvial Soil of Yangtze Valley
Plot Size	: 14.4 m^2
Harvested Area	: 9.6 m^2
Results	: Table 11

Table 11. Yield data

Treatment	Pod yield (kg ha^{-1})				
	Robut 33-1	Hong-Hua	E-Hua	Mean	SE
Rhizobium NC 92	2648	3316	3941	3302	
Uninoculated	2352	3030	3516	2966	±36.4
SE		±87.8			
Mean	2500	3173	3728		
SE		±69.2			

ANOVA

	DF	MS	VR
Rep	5	190249	-
Treatment	1	1013937	42.58
Residual	5	23811	-
Total	6	188832	-
Cvr	2	4539885	78.922
Cv*Treatment	2	18160	0.316
Residual	20	57524	-
Total	24	427774	-

Experiment	: Response of Rhizobium strain NC 92
Country	: Peoples Republic of China
Research station	: Guang Dong Academy of Agricultural Sciences
Province/District	: Guang Dong Province
Scientist-in-charge	: Dr. L.T. Chen
Year/season	: 1983
Total Rainfall	: 1600 mm
Experiment Design	: Randomized Block Design
Date of Sowing	: 08-08-1983
Date of Harvesting	: 01-12-1983
Fertilization	:
Plant protection	: Daconil (at 27 days after sowing)
Soil Type	: Red Loam (Paddy Soil)
Plot Size	: 13.33 m^2
Harvested Area	: 13.33 m^2
Results	: Table 12 and 13

Table 12. Yield data

Treatment	Pod yield (kg ha^{-1})			
	Robut 33-1	Yue-You	Mean	SE
Rhizobium NC 92	3848	4222	4035	
GD-C1	3781	4389	4085	±72.9
Uninoculated	3627	4222	3924	
SE		±103.1		
Mean	3752	4277		
SE		±59.5		

ANOVA

	DF	MS	VR
Rep	3	41052	-
Cvr	1	1654578	38.895
Treatment	2	53903	1.267
Cv*Treatment	2	34703	0.816
Residual	15	42539	-
Total	20	123494	-

Table 13. Plant stand per plot

Treatment	Plant stand per plot			
	Rebut 33-1	Yue-You	Mean	SE
Rhizobium MC 92	206.8	161.5	184.1	
GD-C1	210.0	163.3	186.6	±4.58
Uninoculated	212.3	161.5	186.9	
SE		±6.48		
Mean	209.7	162.1		
SE		±3.74		

ANOVA

	DF	MS	VR
Rep	3	187.0	-
Cvr	1	13585.0	80.827
Treatment	2	18.5	0.11
Cv*Treatment	2	16.2	0.09
Residual	15	168.1	-
Total	20	808.8	-

Experiment	: Response of Rhizobium strain NC 92
Country	: Peoples Republic of China
Research station	: Guang Dong Academy of Agricultural Sciences
Province/District	: Guang Dong Province
Scientist-in-charge	: Dr. L.T. Chen
Year/season	: 1984
Rainfall	:
Design	: Randomized Block Design
Date of Sowing	:
Date of Harvesting	:
Fertilization	:
Plant protection	:
Soil Type	:
Plot Size	:
Harvested Area	:
Results	: Table 14

Table 14. Yield data

Treatment	Pod yield (kg ha^{-1})			
	Robut 33-1	Yue-You	Mean	SE
Rhizobium NC 92	1775	2206	1991	
Uninoculated	1719	2126	1941	±23.4
SE		±33.4		
Mean	1747	2184		
SE		±23.4		

ANOVA

	DF	MS	VR
Rep	3	2344	-
Cvr	1	765734	174.301
Treatment	1	10003	2.277
Cv*Treatment	1	156	0.035
Residual	9	4393	-
Total	12	67953	-

Experiment	: Response of Rhizobium strain MC 92
Country	: Peoples Republic of China
Research station	: Guang Dong Academy of Agricultural Sciences
Province/District	: Guang Dong Province
Scientist-in-charge	: Dr. L.T. Chen
Year/season	: 1983
Rainfall	:
Design	: Randomized Block Design
Date of Sowing	:
Date of Harvesting	:
Fertilization	:
Plant protection	:
Soil Type	:
Plot Size	:
Harvested Area	:
Results	: Table 15

Table 15. Yield data

Treatment	Pod yield (kg ha^{-1})			
	Robut 33-1	Yue-You	Mean	SE
Rhizobium NC 92	2005	3034	2520	
Uninoculated	1902	2925	2438	±79.1
SE		±111.8		
Mean	1958	3005		
SE		±79.1		

ANOVA

	DF	MS	VR
Rep	3	23407	-
Cvr	1	4420485	88.353
Treatment	1	26615	0.532
Cv*Treatment	1	1976	0.039
Residual	9	50032	-
Total	12	408280	-

Table: 16. Summary of response of cv Robut 33-1 Inoculated with *Rhizobium* Strain NC 92

Locations	Pod Yield (kg ha^{-1})		
	Uninoculated	Inoculated	SE
Botswana	1477	1670	±126.6
Burkino Faso	1065	1015	±61.0
Indonesia	1229	1253	±111.0
Malawi	2006	2076	±118.8
Sudan	1807	1753	±210.5
Brazil	1347	1563	±101.6
Peoples Republic of China	3627	3848	±103.1
Peoples Republic of China	2352	2648	±87.8
Peoples Republic of China	1719	1775	±33.1
Peoples Republic of China	1902	2005	±111.8
Mean	1853	1960	±35.9