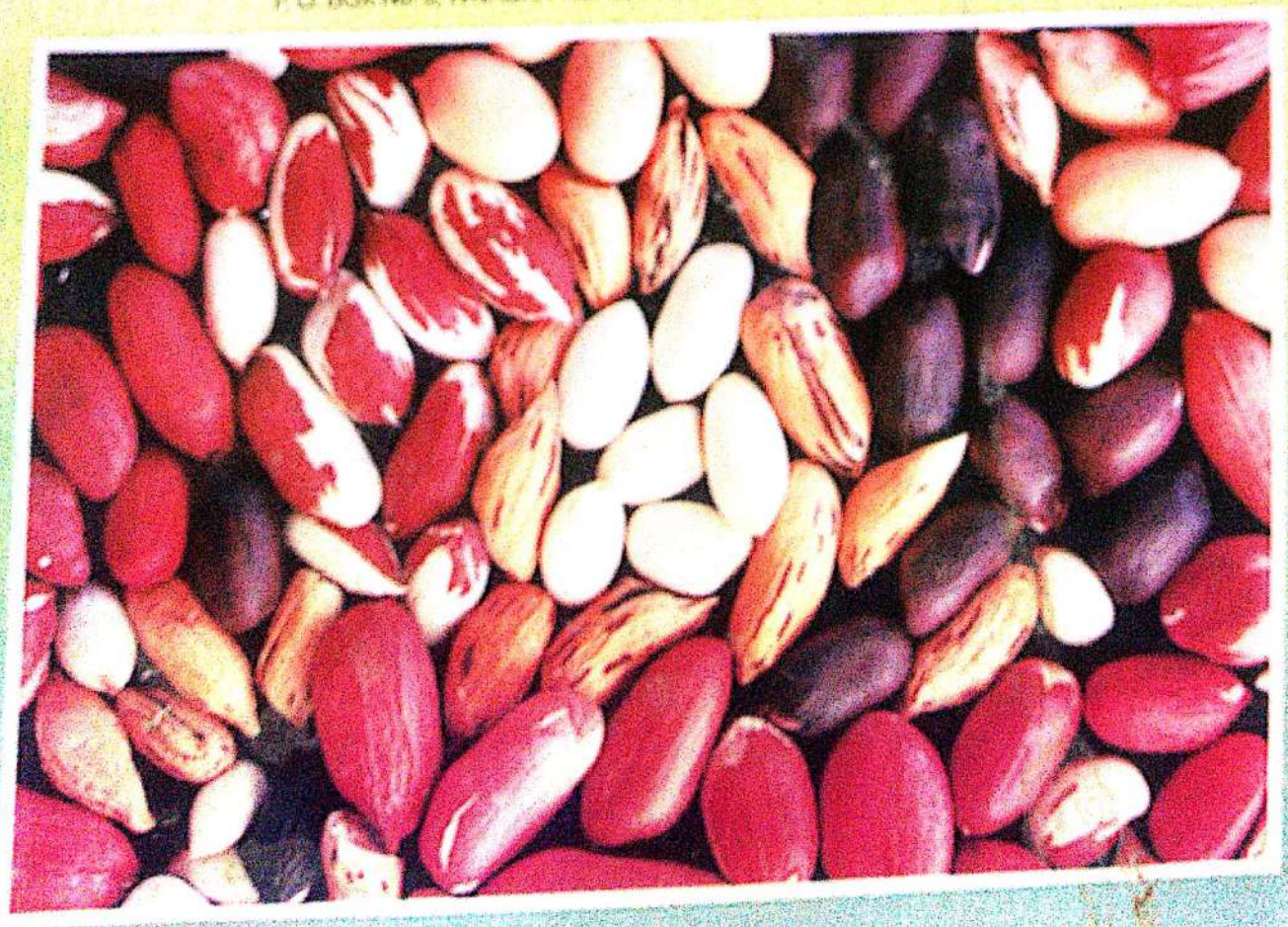
ANNUAL REPORT
1994-1995

NRCG

ICAR

NATIONAL RESEARCH CENTRE FOR GROUNDNUT

P.O. BOX No. 5, IVNAGAR ROAD, JUNAGADH-362 001 GUJARAT (INDIA)



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PREAMBLE

The National Research Centre for Groundnut was established in the year1979 by the Indian Council of Agricultural Research (ICAR) with the following objectives.

1. Collection, maintenance, evalua tion, documentation and utilization of genetic resources of groundnut.
2. Breeding varieties for high yield, quality, earliness, fresh seed dormancy, peg strength, tolerance to drought and cold, and resistance to major insect pests and diseases.
3. Supply of early generation segregating material for breeding varieties suitable for different agroecological situations.
4. Gene transfer from wild to cultivated species and rapid multiplication of hybrid material.
5. Studies on farming systems.
6. Studies on economically important diseases and insect pests and identification of stable sources of resistance among germplasm for further use in breeding programmes and development of crop protection technologies with an emphasis on integrated control of diseases and pest complex.
7. Studies on groundnut composition and quality in relation to oil and protein.
8. Physiological studies on fundamental and applied aspects on productivity, energy harvest, mineral nutrition; abiotic stresses including moisture, temperature and salt stresses; seed dormancy and viability, pod development and post harvest problems.
9. Studies on nitrogen fixation in relation to ***Rhizobium***, host and environment.
10. Monitoring the programmes of multi-locational coordinated trials under All India Co-ordinated Research Project on Groundnut (AICRPG) through project coordinating unit.

The research activities of the Centre are carried out by nine scientific sections- Genetics Resources, Plant Breeding, Genetics and Cytogenetics, Agronomy, Biochemistry, Plant Pathology, Entomology, Plant Physiology and Microbiology. Eigteen research projects have been formulated to suit the Centre's mandate and appropriate strategies are followed for the successful implementation of these projects. In addition, three externally funded projects are also implemented at the NRCG. The supporting sections of the Centre are: Library, Farm, Establishment and, Audit and Account.

A brief account on the most significant achievements of the Centre during the year 1994-95 is presented below :

RESEARCH ACCOMPLISHMENTS

1. Germplasm resources :

The national collection of germplasm comprising 4627 accessions belonging to the four habit forms were rejuvenated and characterized. Twenty-seven released groundnut varieties were assembled. Five bold seeded accessions were identified as promising for confectionery purposes.

2. Multiple resistant genotypes :

Three genotypes, ICGV 86606, CYTO 134 (N) and 27(7) were found to possess multiple disease resistance. Interspecific cross

derivatives, Tx-4-3 (cv. GG 2x *Arachis duranensis*) and Sel. 29 were found to be resistant to early leaf spot (ELS), late leaf spot (LLS) and rust.

3. Disease resistant cultures :

The following advanced breeding lines which are resistant to major foliar diseases were identified at the **NRCG.**

Early Leaf Spot (ELS) : PBDR 32-1, PBDR 18, DRV 19 A

***Alternaria* blight:** ICGVs 86707, 86594, NCAc 343, PBS 20, PBDR 34-2, PBDR 49, Code No 8,

***Alternaria leaf spot*:** DRV 9, DRV 49 A, PBDR 32-6.

4. Insect pest resistant cultures:

Five advanced breeding lines, IR 1, IR 29, IR 14, and PBS 118 were found to possess resistance to thrips while two cultures PBS 118 and PBS 48 were resistant to leaf miner.

5. Promising bold-seeded accessions:

Out of the 39 bold-seeded and high yielding advanced breeding lines, NRCG's 5505, 7276, 8939 (Virginia Bunch), 750, 2746 and 5850 (Virginia Runner) were found to be suitable for confectionery purposes and were also tolerant to seed colonization by *Aspergillus flavus*.

6. Utilization of wild *Arachis* species:

Twelve new interspecific hybrids involving *Arachis hypogaea*, *Arachis* species, *Arachis duranensis* and *Arachis paraguariensis* were produced.

Eight promising advanced interspecific derivatives from crosses involving *Arachis hypogaea* as female parent and the wild species, *Arachis chacoense*, *Arachis cardenasii*, *Arachis duranensis* and *Arachis villosa*, as male donors were found to possess agronomically desirable traits.

Four interspecific derivatives with stable high oil-content (53 to 55.5%) were developed.

7. *In vitro* studies :

A reproducible protocol was standardized for micro-propagation of groundnut through multiple shoot formation. Immature de-embryonated cotyledons were cultured on Murashige and Skoog's (MS) medium supplemented with 15 ppm Benzyladenine (BA). Protocols were also standardized for *in vitro* somatic embryogenesis by culturing the explants on MS medium containing 2, 4-Dichlorophenoxyaecetic acid (2,4-D) and Naphthalene Acetic acid (NAA).

8. A new growing season for groundnut:

Planting of groundnut during September-October, which is not a usual practice in Saurashtra region, appears to be feasible especially where irrigation is not a constraint. Produce of this season generally contained low oil-content. This season can be useful to grow HPS varieties where low oil-content is desired.

9. Studies on mulching :

A combination of wheat-straw and black polythene mulch encouraged seed germination and retention of this polythene until pod development stage increased pod yield.

Under wheat-straw, application of 25 kg N/ha as basal dose maintained higher N content during the early stages of crop growth.

10. A new drying technique :

A novel technique involving integration of drying and storage of summer groundnut produce for retaining/prolonging its viability till the next summer season was developed.

11. Integrated management of insect pests, diseases and weeds:

An integrated pest management concept involving pheromones, trap crops like bajra and castor and the effective-insecticide-mixtures were most effective in reducing the incidence of insect pests in groundnut.

Seed treatment with carbendazim 50 WP @ 2 g/kg seed and intercropping groundnut with redgram in 3:1 ratio and spraying fungicidal mixture (carbendazim 0.05% + mancozeb 0.2% at 55 days after sowing) and a spray of cell-free culture filtrate of *Penicillium islandicum* at 70 days after sowing (DAS) effectively reduced the intensity of ELS and LLS.

12. Managing diseases through plant products :

Seed treatment with 2% neem seed powder or 2% dried leaf powder of *Eucalyptus* spp. was found to be effective in controlling seed and seedling diseases of groundnut.

13.Studies on Peanut Stripe Virus (PStV)

Germplasm accessions and other breeding materials comprising of a total of 2010 seed samples were analyzed for the detection of PStV through ELISA. Out of these 279 samples were PStV positive.

14. Studies on residual toxicity of pesticides:

The residual toxicity period in an insecticidal mixture (2% crude neem oil + 0.02% phosphomidan + 0.04% endosulfan) was found to be nine days on two mite species on groundnut, as compared to six days in case of Kelthane.

15. New device for oil estimation:

A simple device was developed for rapid determination of oil-content in the groundnut seeds. The device was christened as *Arachilopometer,* which works on the principle of inverse relationship between oil-content and specific gravity of groundnut seeds.

16. Studies on biochemical basis resistance to biotic stresses:

The occurrence of trypsin-inhibitor in the leaves of groundnut genotypes has been demonstrated. The augmentation of such inhibitors in the leaves of groundnut genotypes which interfere with digestive proteases of insects pests through breeding may enhance resistance to such insect pests.

17. Identification of genotypes tolerant to iron chlorosis:

Four genotypes A4, B 19 (Selection of Girnar 1) PBS 70 and PBS 71 were found to be tolerant to iron chlorosis.

18. Studies on seed dormancy:

Testa was found to have a predominant role in seed dormancy. The degree of maturity, position of seed and the storage period have a confounding effect on seed dormancy besides the genotype.

19. Microbiological studies:

Four efficient strains of Phosphorous solubilizing micro organisms (PSM) namely *Psuedomanas striata, Bacillus polymyxa, B.circulans, Aspergillus awamorii* in addition to *Penicillium oxalicum* isolated from native soils of NRCG are being maintained for use and distribution.

Application of *Pseudomonas striata* and *Penicillium oxalicum* in combination with 50 kg P_2O_5 / ha of Single Superphosphate (SSP) at 60 DAS increased nodulation, available soil P and yield.

Planting of groundnut with and without *Bradyrhizobium* inoculation increased nodulation, biomass at 60 DAS and pod yield.

OTHER ACTIVITIES

A canteen for the staff of the NRCG was opened on 30.03.95.

In Addition to the existing facilities, the Centre aquired Laminar airflows, Nikon camera, Water potential system, Inverted microscope, Cryostat circulator, Ultra deep freèz, pH meter, Microfuge, Growth chamber, Shaker, Thermohygrograph, Microwave digestion system, Osmometer, ELISA reader, Microscope etc. for facilitating better research activities.

GENETIC RESOURCES

Project : 1.1 Collection, maintenance, evaluation, documentation and distribution of genetic resources of cultivated groundnuts and related *Arachis species*. (N.R.Bhagat, K.Rajgopal, K.Chandran, P.Paria, M.P.Ghewande, V. Nandagopal, A.L. Singh and S.K. Yadav)

1. Collection of germplasm

Twenty-seven released groundnut varieties (valencia:1, Spanish:15, Virginia Bunch:5 and Virginia Runner:6) were assembled from AICRPG and State Agricultural University (SAU) centres for characterization.

2. Distribution of germplasm

Inter-sectional supply to Plant Physiology (174), Entomology (140) and Plant Pathology (202) was met to support ongoing research programme. About 980 Virginia accessions were supplied to the Plant Quarantine Division, NBPGR, New Delhi for screening against the presence of seed/pod-borne nematodes.

3. Maintenance of Arachis species

Twenty -four *Arachis* species belonging to the sections *Arachis* (19), *Erectoides* (3), *Extranervosae* (1) and *Ambinervosae* (1) which were free from PStV were maintained in the poly-house.

4. Maintenance and multiplication of cultivated germplasm.

The entire working collection belonging to ssp. *fastigiata* (Valencia:702 and Spanish: 1858) and ssp. *hypogaea* (Virginia Bunch: 759 and Virginia Runner: 1308) and special-feature accessions (279) was rejuvenated and multiplied.

Heavy rains in July-August 1994 with about 80-100% soil saturation at peak flowering and peg formation phenophases resulted in poor pod set in 113 Valencia, 382 Spanish, 111 Virginia Bunch and 231 Virginia Runner accessions. The entire collection was free from both primary and secondary foliage symptoms of PStV.

The accessions were harvested between October and December. The produce of each accession is stored in water-proof envelopes under ambient storage conditions.

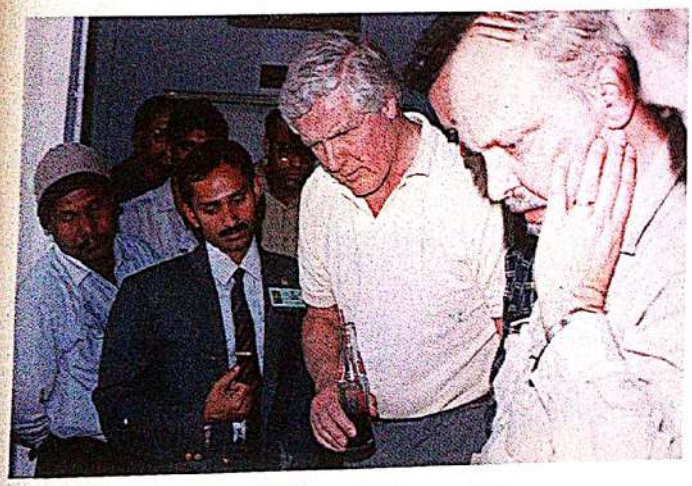
5. Evaluation of cultivated germplasm

The accessions belonging to Valencia (589), Virginia Bunch (648) and Virginia Runner (1077) botanical forms were assessed for pod yield/plant, (PYP) shelling % (SHP), sound mature seed % (SMS) and hundred-seed mass (HSM). The extent of variation within and between these three forms is presented in Table 1.

The yield / plant was poor to moderate in 517 Valencia, 570 Virginia Bunch and 569 Virginia Runner accessions, respectively, representing 87.7, 87.9 and 52.8 % populations. Good pod yield of 12-18 g/plant was recorded in four Virginia Bunch and 68 Virginia Runner accessions. The pod yield in ten Valencia accessions was 9-14 g/plant. Low to moderate SHP (31-60%) was recorded in 187 Valencia, 189 Virginia Bunch and 228 Virginia Runner accessions. Good SHP (70-80%) was recorded in 94 Valencia, 111 Virginia Bunch and 295 Virginia Runner accessions.

The SMS % ranged from 50 to 100 in all the three collections. The recovery of SMS was satisfactory (80-100%) in 517 Valencia, 453 Virginia Bunch and 648 Virginia Runner accessions. The HSM showed wide variation among accessions in all the three collections. In the collection, though, majority of Virginia Bunch (617) and Virginia Runner (1064) accessions exhibited a range of HSM from 20 to 50g, as many as 31 Virginia Bunch and 13 Virginia Runner accessions are available with medium to bold seeds. Accessions transgressing the

Delegates of the First Annual Groundnut Workers' Group meeting.



European delegates at the Centre.

Cultural programme during the *Quami Ekta* Week celebrations.

best local checks of this region are available in the working collection and could be effectively utilized in breeding programmes.

Twenty-two variants of TMV 2 Spanish cultivar collected from Karnataka (12), Andhra Pradesh (6), Tamil Nadu (3) and Kerala (1) were evaluated for eight plant and four pod descriptors. Among these, variation was observed only for stem and leaf hairiness. Profuse stem and leaf hairiness was recorded in eight variants of Andhra Pradesh (4), Karnataka(2) and Tamil Nadu (2). In a preliminary study, the electrophoretic profile of denatured seed proteins of 25 variants, stored for a year at ambient conditions, indicated differences (Plate 1,Top).

6. Variation in late-sown Spanish collection

Delayed sowing of 1476 Spanish accessions, 3-25 days beyond optimum date (June 15) did not show significant differences in mean performance of four sampled traits between four dates of sowing and therefore, the data was pooled for analysis.

As many as 1434 accessions representing 97.1% populations gave poor yield (1 to 7g/ plant), only 42 accessions gave good pod yield of 8-12g/plant. Among these 42, 32 accessions exhibited good SHP (66-77%) and SMS recovery (87-97%). On the other, optimum moisture regime during flowering and pod development phenophases, supported good seed development and maturation, as 1084 and 1056 accessions, representing 73.4% and 71.5% populations, transgressed general means in SHP and SMS, respectively. The HSM of 1476 accessions showed a normal distribution; among these the HSM of 358 accessions were on a par with the general mean (30g), while 707 and 411 accessions, respectively, fell within a range of 20 to 29 and 32 to 46g.

7. Preliminary evaluation of large-seeded Virginia collection

Twenty-nine Virginia Bunch and 66 Virginia Runner accessions sown on August 1, 1994 with M 13 and GG 11 (Virginia Runner) as local controls adopting augmented block design were scored for pod yield/plant , percentage of one-and two-seeded pods, SHP, SMS and HSM (Table 2).

Pod yield/plant and percentage of one-seeded pods showed wide variation in both collections. Though the mean HSM, respectively, was 57.6 and 56.4 g in Virginia Bunch and Virginia Runner collections, both collections exhibited a wide range as delayed sowing (45 days) resulted in poor seed development in certain accessions. Nine accessions with HSM of 57.0 to 72.0g coupled with other desirable characters were identified for further evaluation.

8. Systematic evaluation of large-seeded Virginia accessions

Twelve promising large-seeded accessions (6 Virginia Bunch and 6 Virginia Runner) and two controls (M 13 and GG 11) were field planted in kharif 1994 in an RBD with three replications and evaluated for five agronomic and two quality traits. The accessions of both forms showed significant differences for all the seven traits scored. The pod yield/plant ranged from 4.5 to 8.6 g among accessions as against 4.5 g in controls. However, the oil-content (%) and sugar content (%) did not exhibit much variation among the accessions. Two Virginia Bunch accessions (NRCG's 5505 and 8939) out-yielded controls and other accessions. SMS and HMS were also satisfactory in these two accessions (Table 3).

9. Evaluation of large-seeded Virginia accessions

Seeds of 30 promising large-seeded accessions (13 Virginia Bunch and 17 Virginia

Runner) were analyzed for oil and sugar contents using specific gravity and Anthrone reagent methods, respectively. The oil-content in Virginia Bunch and Virginia Runner accessions, respectively, ranged from 45.9 to 54.8 % and 45.3 to 54.1%, whereas sugar content varied from 4.9 to 12.5 % and 6.7 to 15.6%. The promising accessions exhibiting favourable confectionery traits coupled with high pod yield were NRCG's, 1005, 2863, 5505, 7276 (Virginia Bunch) and 750 (Virginia Runner).

Fifteen large-seeded Virginia accessions, grown in kharif 1994, were tested against seed colonization by *A. flavus* along with susceptible (M13) and resistant (J 11) checks under artificially inoculated conditions. Out of these, NRCG 912 and GG 11 showed moderate resistance to *A. flavus* colonization.

10. Screening of germplasm for Peanut Stripe Virus(PStV) through ELISA

In 14 out of 251 accessions culled out at random from the working collection of kharif 1993 produce PStV was detected by ELISA. These accessions did not express symptoms on crop foliage in the field in kharif 1994. However, leaf samples of 10 accessions gave positive reaction on re-testing.

11. Screening of Virginia Bunch collection for tolerance to iron chlorosis

Seven hundred and fifty nine Virginia Bunch accessions were screened for tolerance to iron chlorosis by taking visual chlorotic rating (VCR) on 1-5 scale, 1 being resistant and 5 being highly susceptible, at pod filling phenophase in August 1994. Only 19 accessions showed low to moderate symptoms (VCR 2) but NRCG's 1707, 1942,2305, 9042 and 9066 were found susceptible (VCR4).

12. Documentation of data on evaluation

Four descriptor states recorded on 589 Valencia, 1476 Spanish, 648 Virginia Bunch and 1077 Virginia Runner accessions, beside passport data, were documented. An inventory of groundnut germplasm held at this Centre was updated with available passport information.

Table 1. Distribution of accessions and range of variation in Valencia (589), Virginia Bunch (648) and Virginia Runner (1077) collections

Trait/range	FST	HYB	HYR
Pod yield/plant (g)			
1.0-3.0	181	294	173
3.1-6.0	336	276	396
6.1-9.0	62	64	308
9.1-12.0	9	10	132
12.1-15.0	1	2	46
15.1-18.0	0	2	22
Mean	4.1	3.7	6.4
Range	1.1-13.6	1.0-17.5	1.1-18.0
CV	54.6	60.9	52.9

Shelling (%)			
30.0-40.0	2	10	7
40.1-50.0	35	45	54
50.1-60.0	150	134	167
60.1-70.0	308	348	554
70.1-80.0	94	111	295
Mean	63.1	63.5	65.3
Range	34.5-76.7	33.1-79.1	30.7-80.0
CV	11.1	12.3	11.2
Sound mature seed (%)			
50.0-60.0	3	27	47
60.1-70.0	13	44	92
70.1-80.0	56	124	290
80.1-90.0	174	240	456
90.1-100.0	343	213	192
Mean	89.7	83.8	81.5
Range	56.7-97.3	50.0-98.0	50.0-100.0
CV	7.9	12.1	12.3
Hundred-seed mass (g)			
20.0-30.0	408	171	222
30.1-40.0	177	250	621
40.1-50.0	4	196	221
50.1-60.0	0	29	12
60.1-70.0	0	2	1
Mean	29.4	37.4	36.5
Range	20.0-50.0	20.0-65.0	20.0-65.0
CV	13.8	23.0	17.8

Table 2 Mean (M), Range (R) and Coefficients of variation (CV) for 6 agronomic traits in large seeded Virginia accessions.

	HYB (29)			HYR (66)		
Trait	**M**	**R**	**CV**	**M**	**R**	**CV**
Pod yield/plant (g)	7.2	0.5-22.0	56.9	6.8	2.2-19.0	51.5
One-seeded pods (%)	33.3	13.0-71.4	37.5	31.3	14.3-57.1	32.3
Two-seeded pods (%)	66.7	28.6-87.0	18.7	68.7	42.9-85.7	14.7
Shelling (%)	60.1	38.7-72.2	12.9	56.8	36.7-73.9	14.3
SMS (%)	74.8	43.5-96.0	14.4	70.9	33.3-91.3	16.6
Hundred-seed mass (g)	57.6	26.7-81.0	21.7	56.4	33.3-81.4	19.8

Table 3. Mean performance of large-seeded Virginia accessions for agronomic and biochemical traits

NRCG NO.	Variety	Pod yield Plant (g)	Pod yield M^2 (g)	SHP (%)	SMS (%)	HSM (g)	OIL (%)	SUG (%)
VIRGINIA BUNCH								
7276	JL 55	5.0	62.7	65.2	76.3	59.8	49.4	10.2
7239	JL 60	5.7	55.0	67.9	79.5	53.6	50.6	12.6
8939	BAU 12	8.6	94.0	67.0	84.3	76.4	50.0	10.9
5505	RS 1	8.4	108.2	68.7	69.2	60.9	50.5	10.9
839	NCAc1865	7.0	64.0	68.0	72.7	60.6	51.4	10.5
2863	UF780-14	5.6	62.6	67.8	68.8	58.1	50.7	10.4
VIRGINIA RUNNER								
5850	Var61-R	6.2	66.0	55.7	68.0	55.4	48.4	11.8
734	NCAc324	6.0	67.2	64.1	64.8	53.8	50.6	12.3
912	NCAc2938	6.8	65.6	62.5	62.5	58.8	49.1	13.7
750	NCAc6755	6.1	65.2	65.4	63.9	60.9	48.6	11.8
2746	Florispan Runner	4.5	49.6	62.8	61.2	60.2	51.2	11.5
698	NCAc2831	6.5	59.3	62.1	68.6	54.7	50.3	11.9
—	M 13 (C)	4.4	47.0	60.4	62.3	53.3	48.1	12.8
—	GG 11 (C)	4.7	51.9	64.0	60.0	48.3	51.0	9.7
Mean		6.1	65.6	64.4	68.7	58.2	50.0	11.7
CD 5 %		1.3	49.1	4.8	11.8	6.1	0.7	0.6

M2 = per square metre : SHP = Shelling percent : SMS = Sound mature seed : HSM Hundred seed mass : OIL = oil-content : SUG = Sugar content

PLANT BREEDING

Project 2.1 : Breeding and genetic studies for improving yield and quality in groundnut (A. Bandyopadhyay, Vijendra Singh and R.K. Mathur).

1. Multiplication , Generation advancement and Selection :

Twenty-five cultures in F_5 generation, 35 in F_6 ,11 in F_7 , 22 in F_9 and 296 advanced breeding lines were sown in summer 1994. One line from F_5 ,six from F_6 ,five from F_7 , one from F_9 and 52 from advanced generations were further selected.

Thirty - seven HPS cultures, 43 ICRISAT lines, five high oil- content lines, 27 SAARC lines, 172 advanced cultures of PBS series, 318 segregating cultures (F_2 to F_6) and 49 F_1 materials were advanced further during kharif 1994.

During summer 1995, 101 advanced cultures of PBS series, 26 of high-oil series, 31 selections, 21 HPS lines and 161 germplasm lines were multiplied for their maintenance. In addition, segregating families at various generations and 684 single-plant- progenies (F_3) of the cross GG 2 X GAUG 1 for dormancy were sown for multiplication and maintenance.

2. Evaluation of advanced cultures:

Two yield trials were conducted during summer 1994. In the first trial consisting of 26 SB/VL cultures along with checks Girnar 1 and JL 24, advanced cultures PBS 64, PBS 66 and PBS 118 had significantly higher HSM than the check JL 24. Fifteen cultures had significantly higher SP than the check variety JL 24 (70%). Advanced cultures PBS 54, PBS 10 and PBS 171 had significantly higher PYP than the check Girnar 1 (19 g). The culture PBS 54 had 72% SHP and 49 g HSM; PBS 10 had 74% SHP and 49 g HSM and PBS 171 had 75% SHP and 45 g HSM. These cultures were found to be promising for summer cultivation.

In the second trial with 20 virginia cultures along with checks Kadiri 3 and ICGS 44, harvesting was done on three days viz., 124, 134 and 144 DAS. Results indicated that highest HSM of advanced cultures PBS 185 (59g), PBS 189 (63g), PBS 157 (52g) and PBS 41 (47g) reached their maximum HSM at 124 DAS. All other cultures except PBS 191 and PBS 162 and check Kadiri 3 and ICGS 44 had their highest HSM at 134 DAS. The range for HSM at 134 DAS was 46 g (PBS) 52 to 65g (PBS 190). The HSM of check Kadiri 3 was 47g and of ICGS 44 was 55g. The advanced cultures PBS 175 and PBS 189 had more than 60g HSM. PBS 190 and PBS 189 were promising for HPS in summer.

Four trials were conducted in kharif 1994 for evaluation of yield and other desirable characters of cultures, the first with 32 SB/ VL, the second with 19 VB/VR, the third with 21 VB/ VR, and the fourth with 26 HPS cultures. Due to certain institutional constraints sowing was delayed and then due to unusual continuous rains, the germination was poor and the plant stands were not proper and hence, results were not fit for proper evaluation.

However, a preliminary observation showed that in the second trial a derivative of M 13 X Robut 33-1 and Ho.24D had

significantly higher pod yield per plant (4.62g and 3.66g, respectively) than the check Kadiri 3 (2.65g). In the third trial, PBS 185, PBS 191, PBS 190, PBS 173 and PBS 187 (3.50g, 3.22g, 3.01g, 2.83g and 2.71g, respectively) were better than checks ICGS 44 (2.32g) and Kadiri 3 (2.58g) for pod yield per plant.

Two yield trials, the first with 16 SB/VL cultures and the second with 18 VB/VR cultures were sown in summer 1995.

3. Mutation experiment:

To improve the SHP of Girnar 1, a mutation been used. The kernels of Girnar 1 were treated with two concentrations of Diethyl sulphonate (DES) (0.01% and 0.02%) and three concentrations of ethylmethane sulphonate (EMS) (0.01%, 0.02% and 0.04%). In addition, treatments were also given in all possible combinations of above mentioned concentrations of DES and EMS.

The M1 generation of all the treatments (11+1) including untreated lot was raised in RBD with four replications. The plot consisted of four rows each of 3m length and were spaced 45cm apart. Observations were recorded on germination (%), plant stands at 15, 30, 45 and 60 DAS and finally at harvest. Post harvest observations on pod and kernel characters were also recorded. Plant stand was reduced to 25-26% in the combined treatments of 0.02% DES + EMS (0.01% or 0.04 %) at 15 DAS. In this study neither LD50 nor LD100 could be scored and hence still more higher dose of DES/ EMS could be applied. Post harvest observation on pod and kernel characters are recorded. For this purpose, data were recorded from 20 randomly selected plants for- no. of pods/ plant, 1-,2-,3- and 4- seeded pods/ plant, pod yield/ plant, HPM, HSM, SHP, number of kernels/ plant and SMK. Further, observations were also recorded on pod length, pod width, pod constriction, reticulation, beak and hump characters, seed length, seed breadth, and testa colour. But no major morphogenetic changes did occur in M1 generations. An experiment based on kharif results were laid out in summer 95 with higher doses of mutagens, namely, DES and EMS.(0.05%, 0.1% and 0.2% and 4 combination treatments including 0.05% and 0.1% doses of DES and EMS. The M1 generation was raised in RBD with 4 replications. The plot size was 3 rows each of 3m length spaced at 45cm apart. Observations were recorded on germination per cent and plant stand. Mortality of plants at germination and 15 DAS in treatment DES 0.2% was 80%. No major morphogenetic changes were visible as in Kharif 1994 on the plants. However, one variegated plant was observed in DES- 0.2% level after 15 days after sowing (Plate 2.2).

4. Hybridization:

The following crosses were made in khari 1994

a) For prolonging viability in Spanish Cultivars

GG 2 X ICG 4724

JL 24 X ICG 4724

GG 2 X ICG 4833

JL 24 X ICG 4833

GG 2 X ICG 4074

b) For resistance to aflatoxigenic fungi

ICGV 89235 X PI 337409

ICGV 88406 X PI 337409

c) Earliness

Somnath X Early Runner

Girnar 1 X Chico

GG 2 X Chico

d) Improving shelling percent

Girnar 1 X GG 2

e) Seed dormancy

Girnar 1 X ICGS 11

Project 2.2: Breeding for resistance to biotic and abiotic stresses in groundnut (Vijendra Singh, A. Bandyopadhyay, M.P. Ghewande, V. Nandagopal and A.L. Singh).

1. Multiplication and selection:

Two hundred sixty seven advanced cultures and selections and 189 segregating genotypes from F_2 to F_6 were grown summer 1994.

Sixty-five genotypes in segregating generations were identified visually to be promising. In Kharif 1994, advanced cultures and segregating genotypes (318 F_2 to F_6) were grown. However, the germination of material was very poor due to heavy rains.

In summer 1995, the advanced cultures of PBS series, 67 of PBDR series, 18 of FDR series, 39 of DRV series and 32 of IR series, 35 Girnar 1 selections and other selections made earlier were multiplied. Segregating materials (152) from F_2 to F_8 generations were sown for multiplication in field. Promising cultures were sown after ELISA test for multiplication in the polyhouse.

2. Screening of advanced cultures for diseases and insect-pests:

Twenty-three advanced cultures, selected earlier for resistance to diseases and insect pests, were further evaluated in summer 1994 for yield and for further confirmation of their resistance. ANOVA revealed significant differences among the genotypes for yield/ plant. Spanish Bunch (SB) advanced cultures IR 1 (derivative of Dh 3-30 X CGS 101), IR 28 (derivative of GAUG 10 X CGC 4007) and IR 34 (derivative of GAUG 10 X CGC 4007B-A) and Girnar 1 were resistant to thrips. The yield per plant of IR 34 (20.9g), IR 1 (17.9g) and IR 28 (17.0g) were on a par with check Girnar 1. The natural population of jassids, leafminer and *Helicoverpa* were not at optimum level to screen the material in the field. Twenty-five Virginia Bunch cultures were sown in field for screening against PStV, bud necrosis and *Alternaria* diseases. In addition seeds of 50 advanced cultures were used for screening against collar rot pathogen (*Aspergillus niger*) under lab conditions. All genotypes but IR 9 (derivative of Latur 33 X CGS 101) were susceptible to collar rot. IR 9 was moderately resistant. It was also resistant to *Alternaria* blight. A VB culture PBS 105, a SB culture PBDR 20 (derivative of CO 1 X NCAc 17133 (RF)) and cultures IR 16B (derivative of BG 2 X CGS 101), PBDR 7 (derivative of JL 24 X PI 259747) and a derivative of a cross Co 1 X EC 76446 were resistant to *Alternaria* blight. In kharif 1994, three trials for screening for disease-pest resistance were conducted. The first trial consisting of 26 Spanish cultures with GG 2, JL 24 and Girnar 1 as checks, the second with 22 advanced cultures including the checks Kadiri 3, M 13, Girnar 1 and ICGS 44; and the third with 15 advanced cultures including Kadiri 3 and Girnar 1 as

checks. GG 2 was sown in alternate plots as a spreader row. To develop sufficient pressure of foliar diseases and insect-pests, cultures of pathogens were sprayed at suitable stages of plant growth and aphids, thrips and jassids population were artificially released on the trials. Congenial conditions for foliar diseases were created by spraying of water on the crop. Some of the cultures were also screened in a 'Uniform Disease Nursery Trial' for foliar diseases like leaf spots, rust and *Alternaria* blight. There was less incidence of Late Leaf Spot (LLS) disease. The screening for jassid could not be done for want of sufficient intensity of its population despite of artificial release. The results are presented below in brief.

A VR culture, DRV 9 (derivative of Latur 33 X PI 275750B), a VB culture DRV 49A (derivative of M 13 X NCAc 2230), a SB culture PBDR 32-6 (derivative of J 11 X NCAc 17090) and Girnar 1 were resistant to *Alternaria* leaf spots. The yield/plant of DRV 49A (6.2g) was on a par with check Kadiri 3(6.2g) and of PBDR 32-6 (2.8g) with the check Girnar 1 (3.9g).

SB cultures, PBDR 32-1 (derivative of J 11 X NCAc 17090), PBDR 18 (NRGS (FDRS) 9-1) and DRV 19A (derivative of M 13 X PI 215696 B) were resistant to Early Leaf Spot (ELS). Among these, cultures PBDR 32-1 (3.4 g) and PBDR 18 (3.3 g) were on a par with the best check Girnar 1 (3.9 g) for yield/ plant. Culture DRV 19A (4.4 g) was on a par with the check ICGS 44 (5.7 g).

SB cultures PBDR 34-2 (derivative of TMV 2 X PI 259747) and PBDR 49 were resistant to *Alternaria* blight. Among these, PBDR 49 (3.8 g) was on a par with the best check Girnar 1 (3.9 g) for yield/ plant. The culture PBDR 34-2 (5.6 g) exceeded the best check Girnar 1.

PBS 105, a multiple disease and insect-pests resistant VB culture identified in previous seasons, was highly resistant to oviposition to thrips with 4.7 eggs/ leaf. The second VB culture, IR 14, was also highly resistant to oviposition by thrips with 3.1 eggs/ leaf. Both the cultures (PBS 105, 4.1g & IR 14, 3.9g) were on a par with the check variety Kadiri 3 (5.1g) for yield/ plant in kharif 1994. However, PBS 105 is generally a poor yielder.

A SB culture, PBS 118 (derivative of Dh 3-30 X NCAc 2230) showed resistance to leaf miner (*Aproaerema modicella* Deventer) with 20.8% foliage damage and to thrips with 5.4 eggs/ leaf, but its per plant yield was lower than check Girnar 1.

A VB culture, PBS 48, though resistant to leaf miner, had lower yield than the check Kadiri 3. It was susceptible to LLS and ELS.

A trial with 15 advanced cultures was sown in summer 1995 for screening against insect-pests and to confirm the results obtained in previous seasons. Further, the advanced cultures were also sown in Uniform Disease Nursery Trial.

3. Identification of iron-efficient lines:

Nineteen genotypes including advanced cultures, Girnar 1 selections and two check lines were evaluated in a RBD trial with 3

replications for yield and tolerance to iron - chlorosis in the field. Visual chlorotic ratings (VCR) for iron-chlorosis were recorded four times at 20-day intervals, on a 1 to 3 scale. Data on chlorophyll *a* and chlorophyll *b* of leaves were also recorded twice at an interval of 20 days. Data on yield/ plant were also recorded. Data on chlorophyll content indicated that genotypes differed significantly for chlorophyll *a* and chlorophyll *b*. Correlation coefficient between chlorophyll *a* and chlorophyll *b* was positive and highly significant (r= 0.97) indicating that the genotypes having higher contents of chlorophyll *a* also had higher contents of chlorophyll *b* and vice versa. A list of genotypes having VCR less than grand mean (1.52) are given in table 1. Based on chlorophyll *a* and chlorophyll *b* (mg/ g dry matter of leaves), VCR and yield/ plant, the genotypes which appears to be promising were Girnar 1 selections A4 and B19, PBS 71 and PBS 70.

4. Screening of advanced cultures for iron-chlorosis:

A field experiment conducted in summer 1995 to screen the advanced cultures for tolerance to chlorosis caused by iron deficiency. The material was sown in a RBD with three replications. Data on VCR were recorded.

5. Evaluation of advanced cultures only for yield:

Two trials were sown during kharif 94. The first with 25 SB cultures including advanced lines and checks, and the second with 16 VB/ VR cultures and checks. Due to heavy rains in early stages of crop growth, the trials failed.

6. New Hybridization in kharif 1994:

1. JL 24	X	NCAc 17149
2. ICGS 11	X	PBDR 2
3. GG2	X	NRCG 2746
4. GG2	X	NRCG 7453
5. Kadiri 3	X	NCAc17090
6. Girnar 1	X	BG 2
7. Girnar 1	X	ICGV 86031
8. M 13	X	IR 13A
9. Kadiri 3	X	PBS 105

Table 1. Performance of genotypes tolerant to iron chlorosis.

S.No.	Genotype	VCR	Chl. a (pooled)	Chl. b (pooled)	Yield/ plant (g)
1.	Girnar 1 Sel. A4	1.50	3.56	3.38	15.1
2.	Girnar 1 Sel. B19	1.08	3.47	3.56	11.9
3.	I 1 (check)	1.00	4.36	4.50	5.4
4.	PBS 71	1.42	3.45	3.50	11.2
5.	PBS 153	1.00	3.43	3.20	4.4
6.	PBS 171	1.42	4.13	4.24	5.6
7.	PBS 185	1.00	3.98	3.95	6.2
8.	PBS 190	1.18	3.91	3.66	5.7
9.	PBS 70	1.00	3.47	3.21	11.3
10.	PKVG 8	1.38	3.24	3.03	7.6
	Mean	1.52	3.44	3.35	8.8
	C.D.		0.70	0.72	3.5

Project 2.3. Genetics of and breeding for high peg strength in groundnut. (T. G. K. Murthy and P. Paria)

1. Generation advancement :

Sixteen crosses were advanced to F9 generation in summer 1994. Twenty seven selections with peg-strength (PS) ranging between 15 to 17 Newtons, 26 with 12-14 N and 10 with 18-26 N were identified for further testing. Large scale seed multiplication was not done due to the presence of PStV. All the crosses were further advanced to F_{10} generation in kharif 1994. The pod loss trial could not be conducted due to sudden down pour of rains and extensive damage of the crop by the wild boar. At harvest, a number of further (bulk and single plant) selections were made for high yield (up to 25 g per plant) and high peg strength (between 16 N and 22 N). Half the quantity of seed of all the selections have been sown in summer 1995 for advancement and evaluation.

2. Study of pod losses :

Pod loss at harvest was studied in 3 selections of cross M 13 x PBDR 25 along with the check M 13 in summer 1994. The direct relationship between peg strength and pod losses was clearly evident in this preliminary experiment. The peg strength and pod loss in the cultures were as follows.

1. Sel. 1 PS=14 N; % Pod loss = 4.4

2. Sel. 2 PS=14 N; % Pod loss = 8.6

3. Sel. 3 PS=12 N; % Pod loss = 9.4

M13 PS=5.7N; % Pod loss = 26.0

Project 2.4. Characterization and utilisation of wild *Arachis* species for groundnut improvement. (T. G. K. Murthy, T. Radhakrishnan and P. Paria)

1. Maintenance of *Arachis* species

Maintained 24 species in polyhouses for their utilization in the breeding programme

2. New hybridizations :

a. Attempted the following reciprocal crosses in Kharif 1994, using four tetraploid advanced interspecific derivatives which were highly resistant to rust, ELS and LLS, as one of the parents. The aim was to transfer the resistance in the derivatives to a high yielding background.

1. SB XI x CT 7 - 1 (J 11 x *A.stenosperma*)
2. M 13 x CT 7-1
3. 7-6 (J 11 x *A.chacoense*) x CT 7-1
4. SB XI x 346-1 (J 11 x *A. chacoense*)
5. SB XI x CT7-2 (J 11 x *A.cardenasii*)

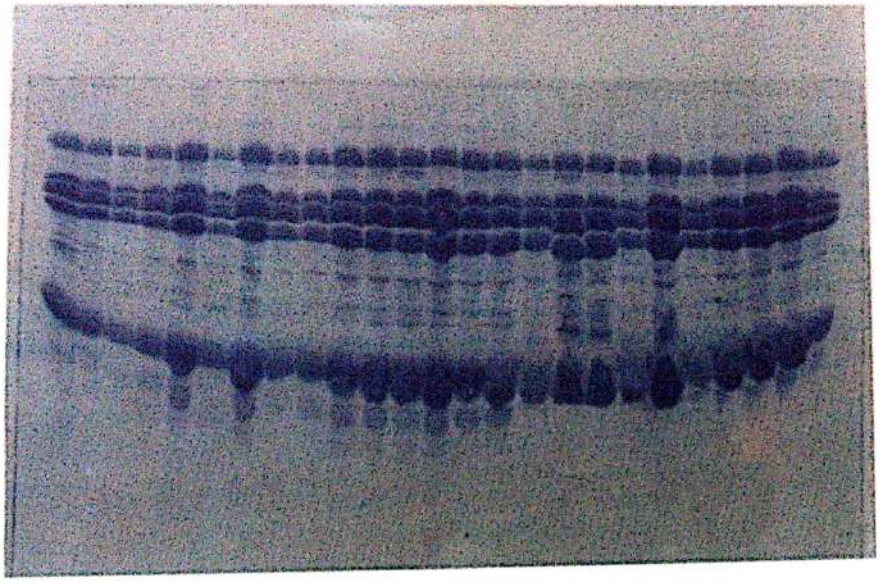
b. One backcross, SB XI x (J 11 x *A. otavioi*-F_1), was effected by using the semi-sterile triploid F_1 hybrid.

c. One (diploid x diploid) species cross, *A. duranensis* (section *Arachis*) x *A. paraguariensis* (*Erectoides*) was done as a bridge cross for facilitating further introgression of genes from *A. paraguariensis* to *A. hypogaea*.

3. Isolation of F_1 hybrids:

a. Interspecific hybrids were isolated from the crosses made in kharif 1993 by using *A. hypogaea* cultivar SB XI as female parent and 12 wild *Arachis* species as male parents. The male parents were :

A. sp. ICG 11558*, *A.* sp. ICG 8132, *A.* sp. ICG 8216, *A.* sp. ICG 8164, *A.* sp. ICG 8954, *A.* sp. ICG 8192, *A.* sp. ICG 8144, *A.* sp. ICG 11561*, *A.* sp. ICG 8906, *A.* sp. ICG



Electrophoregram of seed proteins from TMV 2 variants

A variegated mutant

4983, *A.* sp. ICG 8208*, *A. otavioi* (* obtained for the first time.) plate 3, Top.

b. F_1 hybrids of the following crosses were isolated in summer 1995 from the all the seven crosses made in Kharif 1994. The hybrid (*A. duranensis* x *A. paraguariensis*) was obtained for the first time.

4. Characterization of F_1 hybrids :

The salient features of some of the hybrids were as follows.

a. SB XI x 11558 : Although the species ICG 11558 was reported to be immune to PStV, the F_1 hybrids were susceptible to the virus, indicating the recessive nature of the resistance.

b. SB XI x 4983 : All the 5 hybrids were dwarf bushy type with very narrow leaves. Six of the 21 hybrids did not show PStV infection.

c. SB XI x 8906 : The hybrids were characterized by lemon yellow coloured flowers, a marker transferred from the wild species used as the male parent.

d. SB XI x 8192 : Out of the 19 hybrids, 16 were normal and three extremely dwarf.

5. Cytological studies :

a. Karyotypes of five diploid species were analyzed and the chromosomal complements are as follows.

ICG 8192 : 6 M+ 3 SM + 1 SAT
ICG 8144 : 7 M + 2 SM + 1 SAT
ICG 8130 : 7 M + 3 SM
ICG 8954 : 4 M + 1 SM + 4 AC + 1 SAT
ICG 11561 : 7 M + 2 SM + 1 SAT

M=metacentric;

SM=submetacentric;

AC=acrocentric;

SAT=satellite

b. Over 150 F_3-F_4 single plant derivatives of crosses, J 11 x *A. cardenasii*, J 11 x *A. chacoense* and TMV 2 x *A. chacoense* were analyzed for somatic chromosome number. Most (85%) of them (85%) were hexaploids whereas 3% were tetraploids. A few aneuploids could also be identified. Since parents of these plants were all hexaploids, it is presumed that some kind of chromosome elimination mechanism exists in the hexaploid parents.

6. Generation advancement, evaluation and selection

I. Rabi-summer 1994 :

a. Yield evaluation : Three field trials were conducted. In the first trial, involving derivatives of crosses J 11 x *A.villosa*, GG 2 x *A. chacoense* and M 13 x *A. villosa*, out of the 30 derivatives, seven (5 bunch and 2 ssp.) (codes 28a,9, 7, GBC1, 32, 23 and 13-1) recorded significantly higher (37% to 105%) pod yield than checks SB XI and Kadiri 3. (Range of pod yield in the trial = 9.3 to 24.1 g per plant).

In Trial 2 (comprising derivatives of cross GG 2 x (J 11 x *A. duranensis*), out of 12 cultures, 8 (Codes T4-4-3b,Tx,Tg7-2, T4-4-3a, Tg7-1, T3-3, T5-1, Tg-5) out yielded GG 2 by 37% to 100%. (Range in yield in trial = 10.2 to 20.5 g/plant).

In Trial 3 (comprising cross J 11 x (J 11 x *A. cardenasii)*,only one culture, code J 12, yielded significantly higher than SB XI. (Range of pod yield in trial = 3.3 to 15.3 g/plant).

b. New selections :

Following selections were made on the basis of pod yield and related traits.

1. J 11 x *A. villosa* - 3 sel. in F_5
2. J 11 x *A. stenosperma* - 2 sel. in F_5
3. J 11 x *A. duranensis* - 2 sel. in F_8
4. GG 2 x *A. duranensis* - 8 sel. in F_8
5. J 11 x *A. cardenasii* - 23 sel. in F_5

6. J 11 x *A.sp.*Manfredi5 - 1 sel. in F_4

7. 2-16-1 x JL 24 - 78 sel. in F_4

8. GG 2 x *A. chacoense* - 12 sel. in F_9

c. In addition, 200 F_2-F_3 derivatives of crosses J 11 x *A. cardenasii*, J 11 x *A. villosa*, TMV 2 x *A. chacoense*, M 13 x *A. villosa*, J 11 x *A. correntina*, J 11 x KSSc 36025-1, J 11 x *A.* sp. Manfredi 5, J 11 x *A. stenosperma* and J 11 x *A. helodes* were advanced. Single plant tetraploid selections were made in the crosses J 11 x *A.* sp. Manfredi 5 and J 11 x *A. stenosperma.*

II Kharif 1994 :

a. Yield Trial :

Forty advanced interspecific derivatives of crosses, J 11 x *A. villosa*, GG 2 x *A. chacoense*, M 13 x *A. villosa*, J 11 x *A. chacoense*, J 11 x *A. cardenasii*, Girnar 1 x *A. chacoense* and GG 2 x *A. duranensis* were sown in a RBD with two replications for evaluation of foliar disease resistance, pod yield and related traits kharif 94. More than 80% of the crop was severely damaged by wild boars. Hence, data on disease resistance only could be recorded. Fifteen cultures were promising against ELS, 11 against LLS and 5 against rust. The disease incidence was low in general, although rains were adequate during the season.

b. Oil estimation :

Studies on oil-content in advanced interspecific derivatives were repeated. The high oil-content in four of the derivatives was confirmed. Some of the promising lines are as follows.

Code	Oil Percent	
	1993	1994
28	55.5	54.5
45	54.0	53.0
7	54.0	54.1
11	53.0	54.1
37	52.0	54.4
5	51.4	54.3
62	52.4	55.5
32	Not studied	54.4
JL24	49.0	47.8

c. Multiplication of PStV free seed :

PStV free cut seeds of three promising high yielding and disease resistant interspecific advanced derivatives, namely codes 13, 30 and 28A (first 2 of cross GG 2 x *A. chacoense* and the latter of cross Girnar 1 x (TMV 2 x *A. chacoense)* screened by the Plant Pathologists were multiplied at Bhubaneswar for increasing the quantity of virus-free material.

d. Advancing early selections :

Sixty two F_4 to F_6 selections of seven different interspecific crosses in which the species, *A. chacoense*, *A. villosa*, *A. stenosperma*, *A. cardenasii*, *A. correntina* and *A. sp.* Manfredi 5 constituted one of the parents, were advanced in kharif 94. Of these 17 possessing resistance to all the three foliar diseases, four to ELS and LLS, 5 to ELS and rust, two to LLS and rust and 19 to one of the three diseases, were identified. All the early and advanced interspecific derivatives were again grown in summer'95 for multiplication and effecting further selections for different traits.

Project 2.5 A. Embryo rescue, micro propagation and haploid production in groundnut (T. Radhakrishnan , T. G. K. Murthy and P. Paria)

1. Embryorescue :

Using the embryo rescue method already standardized, immature ovules of crosses SB XI x *A. glabrata*, SB XI x *A. marginata*, SB XI x *A. prostrata*, made in Kharif 1993, were cultured but all the 14 plants thus obtained turned out to be uncrossed plants.

However, one wide hybrid of cross *A. duranensis* x *A. paraguariensis* was obtained.

2. Micropropagation :

1.Through induction of multiple shoots:

By conducting several experiments a reliable method for producing *in vitro* multiple shoots (MSH) was standardized. It involves culturing of mature de embryonated cotyledons in a MS medium containing 15 ppm BA under 16/8 hr. light/dark period.

This method can be applied to most of groundnut genotypes with very high success rate of MSH production.

Also, MSH up to 13.7 per hypocotyl explant of cultivar J 11 could be induced in a preliminary experiment conducted with hypocotyl, epicotyl and and immature leaflets as explants.

2. Through nodal culture :

Nodal culture of the field grown F_3 derivatives of cross J11 x *A. cardenasii* and the laboratory grown cultivar J 11 was attempted on MS medium with 0 to 5 ppm NAA and 0 to 2 ppm BA. Basal medium and that containing 2 ppm NAA only were found to encourage growth of axillary bud and formation of shoot. This will be useful for large scale multiplication of F_1 hybrids and other reproductively blind genetic and cytogenetic material.

Subsequently basal MS medium and MS medium containing 2 ppm NAA were used as growth media for nodal culture of three interspecific hybrids. The basal medium was good for shoot growth whereas MS + 2 ppm NAA was found to encourage root induction also (Table 1).

3. Anther culture studies :

An attempt was made to standardize the physical and physiological parameters for anther culture in *Arachis*. Anthers of diploid species GK 30008 were cultured in MS medium supplemented with 6 combinations of NAA, 2,4-D, kinetin (Kn) and BA. Callusing varied from 8 to 16% in various combinations. Liquid suspension culture was found to support faster and more friable callusing than culture on solid agar or on filter paper wicks. Efforts are on to regenerate the plantlets from the calli.

Table.1 Response of Interspecific hybrids to the nodal culture in 2 different growth regulator combinations

HYBRID	MS + 2 ppm NAA				Basal MS			
	SHOOT ONLY	S+R	ROOT ONLY	TOTAL RESP.	SHOOT ONLY	S+R	ROOT ONLY	TOTAL RESP.
J 11 x ICG 11558	44.1	5.9	2.9	52.9	62.3	-	3.6	67.9
J 11 x A.otavioi	31.0	20.7	10.3	62.0	34.8	-	34.8	69.6
J 11 x ICG 8192	36.7	-	3.3	40.0	60.7	-	-	60.7

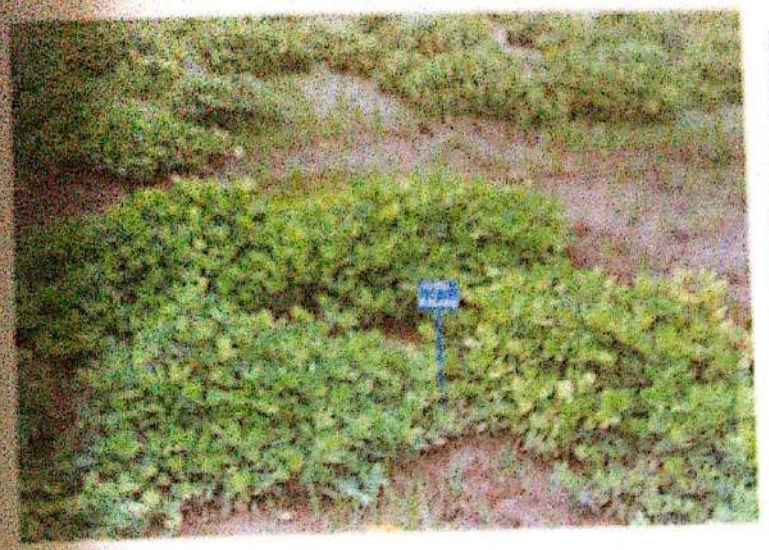
B. NARP project on Bio-technological approaches for increasing and sustaining yield in major field crops Sub project1. Crop improvement Objective 6. Groundnut disease resistance (A.Bandyopadhyay, T. G. K. Murthy and T. Radhakrishnan)

1.Somatic embryogenesis :

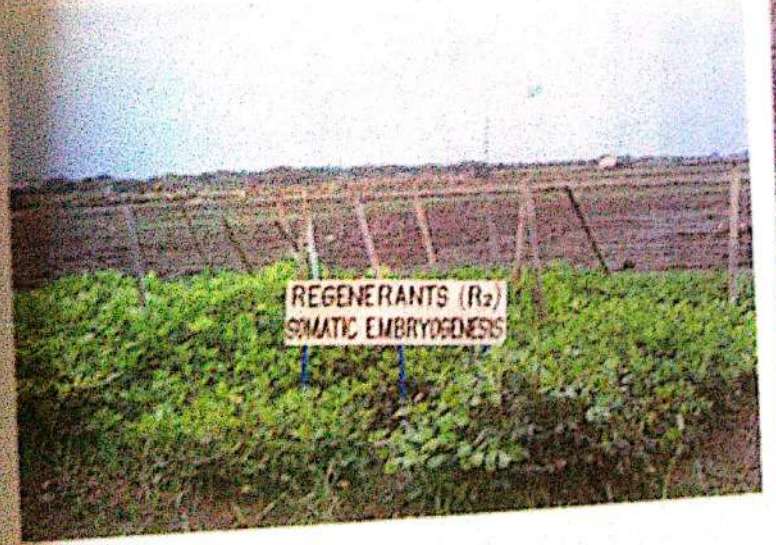
A series of nine experiments were conducted with MS medium containing very low low to high levels (0 to 100 ppm) of 2,4-D and 0 to 5 ppm NAA for standardizing various factors for production of high frequency of somatic embryos. Initially, 30% to 48% somatic embryogenesis (SEG) could be obtained with de - embryonated immature cotyledons (DIC) cultured on the media containing 1-2 ppm NAA in combination with 6 to 8 ppm 2,4-D. Subsequently, immature zygotic embryo-axes (IZE) was found to be better explant than DIC for SEG and 3% sucrose was better than 1.5%. Nearly 100% response was obtained with 2/8 and 1/10 NAA/2,4-D (in ppm) combinations. Mean number of SE per explant 10.3 and 13 respectively in these media combinations. When three genotypes (GG 2, Kadiri 3 and M 13) were tested for their response to SEG in another experiment, 2ppm NAA/14ppm 2,4-D elicited 100% response with 22 and 14 SE/explant in GG 2 and Kadiri 3 respectively, although 1/10 and 2/8 NAA/2,4-D were also good. M 13 showed lower number of SE/explant than the other two genotypes.

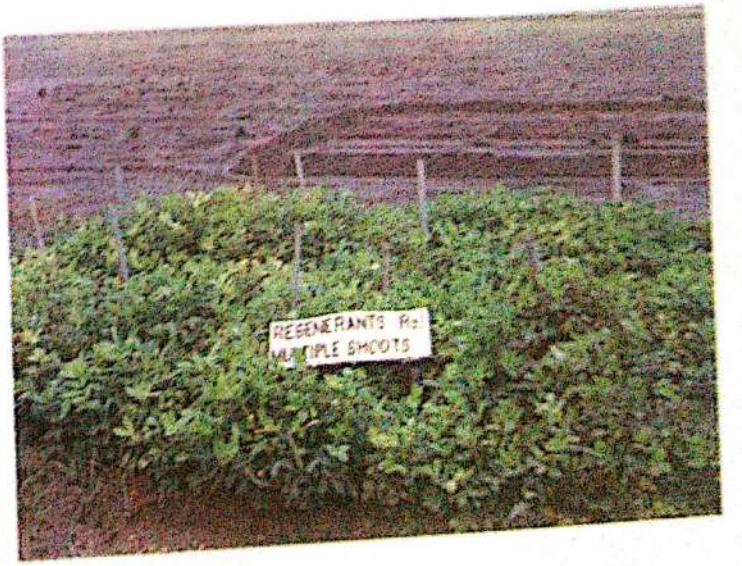
When five higher concentrations of 2,4-D (20,40,60,80 & 100 ppm) were tested for SEG in ZE of genotype 40 ppm elicited best response, after which the response decreased with higher concentrations of 2,4-D. There was no further increase in the SE number per explant in the higher concentrations, as compared to lower concentrations. When 4 levels (25,30,35 & 40 ppm) of 2,4-D in combination with 0,1 and 2 ppm NAA were tried on IZE, 1/30 NAA/ 2,4-D (ppm) gave 100% response with 23 SE/ explant in the cultivar J 11. Over 98% of these embryos were normal. The promoting role of NAA in SEG was brought by this study. In this experiment, mature de - embryonated cotyledon (MEA)also showed 100 response but with lesser number (5.2-6.7/explant) of SE, whereas in all the previous experiments MEA did not respond well. Thus, it has been concluded that MS medium supplemented with 25 to 40 ppm 2,4-D and 1 ppm NAA is the best combination for inducing somatic embryogenesis in a relatively short period (30 days) of culture in groundnut.

MS medium containing 200 ppm casein hydrolysate and 0.2% activated charcoal was found to encourage embryo germination. At present, efforts are on to increase the germination beyond 50% by manipulating concentrations of NAA IBA, and GA3.(Plate 3-bottom)



Interspecific hybrids from crosses J11 x *A* sp. 11558 and J11 x *A. otavio*





Regenerants from somatic embryogenesis and multiple shoots established in field

AGRONOMY

Project 3.1 Development of Suitable Agronomic Practices in Groundnut (Devi Dayal and P.K. Ghosh)

1. Effect of mulching on nutrient availability, growth and yield of groundnut:

A field experiment was conducted in Rabi-summer, 1994 with six mulches, namely (i) wheat straw (WS) @ 5 tons/ha,(ii) white polythene (WP), (iii) black polythene (BP), (iv) WP+WS, (v) BP+WS, and (vi) control (no mulch). Four duration of polythene mulch, *viz.* (i) up to germination, (ii) up to flowering,(iii) up to pod development and (iv) up to maturity were maintained. The significant findings are summarized below.

a. Nutrient availability:

Wheat straw mulch recorded the lowest available N up to 60 DAS. Lower level of NO_3-N was responsible for its less availability of N during early stages of crop growth. However, availability of NO_3- N and total N were more at 90 DAS under wheat straw mulch(43.4 and 62.5 kg/ha, respectively) followed by black polythene. Similarly, higher availability of total N was recorded at pod development stage.

b. Growth and yield :

Early and maximum germination (85%) was recorded in the plot where BP +WS was applied. The flowering began 41, 35 and 42 days after sowing in wheat straw , polythene and control treatment, respectively.

Combination of wheat straw with black polythene recorded maximum pod yield (18.04 q/ha) which was 63% higher than the control. The superiority of treatments with respect to pod yield was in the order of BP+ WS > WP + WS> WS. Duration of polythene mulch also significantly affected pod yield. Maximum yield was recorded when polythene mulch was kept up to pod development stage(15.9 q/ha). Retention of polythene mulch up to maturity of the crop caused reduction in pod yield

2. Effect of Nitrogen(N) application and mulching on nutrient availability and pod yield:

Groundnut plant under wheat straw mulch showed N deficiency in early stage (up to 60 DAS) of growth due to immobilization of N in the soil and N content recorded was even lower than control plot. To over come this, a field experiment was conducted during rabi/ summer 1994 with three mulch treatments namely i) No mulch ii) wheat straw ii) wheat straw + black polythene; two method of N application (basal and top dressing) and two rates of N application (25 and 37.5 kg N / ha).

Soil analyses at 30 and 60 days after sowing revealed that N content in control plot was comparatively higher than wheat straw treatment at 30 DAS. This may be attributed to the utilization of N by microbes in mulch plots. However, cumulative effect of N applied as basal and wheat straw on N content in soil at 60 DAS was higher than no mulch treatment (Table 1). Data also indicated that basal application of 25 kg N /ha under wheat straw mulch maintained higher N content at 60 DAS compared to 37.5 Kg N / ha applied. Low content of N at 60 DAS was recorded in the plots where top dressing was done on wheat straw mulch due to immobilization of N already taken place.

Higher pod yield was recorded in WS+BP (25.8 q/ha) followed by wheat straw (22.47 q/ ha) and no mulch (14.5 q /ha). There was no significant differences in pod yield between basal application and top dressing as well as between lower and higher doses of N applied.

3. Grade characters of groundnut varieties:

Ten spreading and 11 bunch varieties of groundnut were selected to study the different quality aspects for export purpose. Different quality aspect like Hundred Seed Mass (HSM), kernel shape, uniformity of kernel, colour of testa and SMS% were recorded. Among the varieties selected, the varieties like ICGS 76, ICGS 21, TG 19 A, M 335 and Somnath are having mostly bigger size of kernel with HSM and SMS% in the range of 44-66.5 and 88-92%, respectively. Varieties having medium to big size kernel are BG 2 and R 141. Kernels of rest of the varieties were mixture of small, medium and big.

Subsequently, these varieties were sown in field during kharif as well as rabi/ summer 1994 to study the performance/ stability of different quality aspects recorded over the season and the year.

In summer 1994, the varieties, R 141 produced significantly higher pod yield (12.3 q/ha) followed by ICGS 21 (11.3 q/ha), Somnath (10.9 q/ha) , ICGS 11 (10.6 q/ha) and GG 2 (10.1 q /ha). The varieties recorded HSM in the range of 57-66 (bold seeded) with high SMS% (87-92) were TG 19 A, Somnath and M335 (Table 2). Varieties like ICGS 21, ICGS 76 , BG 1, BG 2and BG 3, Tirupathi 2 recorded HSM of 40-50 g (medium to bold seeded).

Because of continuous heavy rain the experiment of kharif 1994 was sown in first week of October 1994. The variety, ICGS 76 recorded maximum pod yield (25.6 q/ha) followed by Co 1, Co 2, Dh 3-30, PG 1 (Table 2). Varieties like TG 19A and M 335 produced HSM more than 50g. However, HSM between 40-50g were recorded in ICGS 76, ICGS 44, ICGS 11, ICGS 21, JL 24, BG 1, BG2, BG 3, ICGS 1 and Somnath.

The varieties (Somnath, R 141, ICGS 21) which performed better in Rabi/Summer 1994 has shown low yield and HSM during Kharif season and the reverse was true in case of ICGS 76, CO 1, CO 2, PG 1, etc. Therefore, variation in performance exists over season.

Samples of both the season's produce have been supplied to plant pathology and biochemistry sections for analysis.

4. Nitrogen Management in Groundnut Intercropping:

A field experiment was conducted in post Kharif season with groundnut, sunflower and sesamum with three levels of nitrogen (0, 50 and 100 % of recommended dose) applied to companion crops. The result indicated that sole groundnut produced higher pod yield (6.85 q / ha) than grown as intercropping (Table 3.). Among the intercropping, highest total yield (12.74 q/ha) and groundnut equivalent yield (11.6 q/ha) were recorded in groundnut intercropped with sunflower when supplemented with half of the recommended dose of nitrogen. This combination also recorded higher L E R value (1.79). Yield of sesame was not obtained due to poor pod filling.

Project 3.2: Factors Affecting Yield in Groundnut Through Variation in Plant Population (Devi Dayal, P.K. Ghosh and V. Ravindra)

1. Effect of seed maturity on germination, growth and yield of groundnut:

Based on the colour of inner surface of pod shell (white to dark brown) seed of bunch cultivar GG-2 were grouped into three categories. These are (i) immature (ii) mature and (iii) overmature. The proportion of these group in a mixed lot of seed were 29.7,50.3 and 20%, respectively.

Subsequently, the germination of the seeds of these groups was tested in field during rabi/ summer 1994. Initial germination recorded at 10 days after sowing was higher in immature group (84%). However, final plant stand recorded at harvest was maximum in mature groups (Table 4). Similarly, dry matter recorded at different stages of growth was higher in mature group followed by over mature group.

There was significant differences in pod yield and number of pods/plant due to seed maturity groups. Higher pod yield was recorded in case of mature seed (13.52q/ha). Number of pods/plant, pod weight/plant and SHP were also higher in mature seed group (Table 4).

Table 1. Effect of N application and mulching on N content in soil.

Mulches	Doses of N (kg/ha)	Nitrogen availability in soil (kg/ha)			
		30 DAS		60 DAS	
		Only Basal	Only Top dressing	Only Basal	Only Top dressing
Wheat straw	25	52.8	73.6	111.6	88.7
	37.5	77.0	74.4	104.6	86.8
WS + BP	25	62.9	69.6	89.3	94.3
	37.5	71.2	63.6	100.2	92.3
No mulch	25	79.3	78.5	105.6	99.2
	37.5	69.5	68.5	102.8	94.5

Table 2. Grade characters of groundnut varieties recorded during kharif and Rabi/summer, 1994.

Varieties	100 Seed Mass (g)		SMS (%)		Pod yield (kg/ha)	
JL 24	38.5	(45.0)	79.5	(87/0)	670	(570)
Dh 3-30	38.5	(38.0)	87.5	(82.6)	641	(1507)
GG 2	36.0	(36.3)	82.1	(85.0)	1011	(1006)
ICGS 21	47.3	(48.0)	86.3	(86.6)	1129	(650)
Co 1	39.7	(40.0)	79.7	(85.3)	713	(1860)
TG 19 A	57.1	(51.2)	87.0	(80.0)	833	(1100)
ICGS 11	37.7	(44.0)	79.3	(77.6)	1063	(1176)
ICGS 44	38.0	(43.5)	78.8	(80.5)	806	(1320)
ICGS 76	47.7	(47.0)	88.2	(79.5)	970	(2560)
Co 2	37.7	(37.5)	82.7	(82.6)	676	(1630)
Tirupathi 2	41.9	(-)	84.3	(-)	658	(-)
BG 2	47.7	(44.0)	83.5	(70.5)	720	(750)
BG 1	45.0	(48.0)	83.3	(82.0)	618	(630)
PG 1	38.6	(38.0)	81.3	(81.3)	866	(1247)
M 37	37.7	(37.3)	81.4	(78.6)	814	(990)
ICGS 1	39.6	(44.0)	82.1	(78.3)	635	(1107)
BG 3	40.9	(48.3)	82.7	(81.3)	647	(790)
K 2	39.9	(37.3)	83.6	(81.6)	769	(940)
Somnath	66.5	(49.3)	92.6	(75.6)	1095	(686)
R 141	36.0	(34.0)	89.5	(87.0)	1230	(420)
M 335	57.6	(52.5)	89.0	(78.6)	810	(1220)
CD (5%)	1.42	(-)	1.85	(-)	749.5	(-)

Data in parenthesis for kharif season.

Table 3. Nitrogen economy in groundnut intercropping.

Intercrops	Pod yield (kg/ha)	Seed yield (kg/ha)	Total yield (kg/ha)	Groundnut equivalent yield (kg/ha)	LER*
Sole Groundnut	685	-	685	-	-
Sole Sunflower	-	731	731	-	-
Groundnut+Sunflower (ON)	607	572	1179	1091	1.66
Groundnut+Sunflower (50% N)	518	756	1274	1157	1.79
Groundnut+Sunflower (100% N)	453	791	1244	1122	1.74

* Land equivalent ratio

Table 4. Effect of seed maturity on germination and some yield trait in groundnut.

Seed Group	No.of pod/plant	Pod yield (q/ha)	Germination (%)	Final Plant stand (lakh/ha)
Immature	4.82	11.14	84	3.83
Mature	5.74	13.52	81	4.16
Over Mature	5.04	11.51	78	3.98
C.D.at 5%	0.62	1.24	-	-

PLANT PATHOLOGY

Project 4.1 Studies on economically important fungal and virus diseases of groundnut (M.P.Ghewande and S.Desai)

1. Identification of sources of resistance to major diseases.

One hundred and forty-four genotypes along with a susceptible check, GG 2, were evaluated against early leaf spot, *Alternaria* leaf spot, peanut bud necrosis disease (PBND) and stem rot diseases in a uniform disease nursery trial during kharif 1994. There was low disease pressure of LLS and PBND. Out of 144 genotypes, 23 for ELS, 12 for *Alternaria* leaf spot and 20 for stem rot appeared to be promising. Three genotypes, ICGV 86606, CYTO 134 (N) and 27 (7) were found to possess multiple disease resistance.

Interspecific cross derivatives, Tx -4-3 (cv. GG 2x *Arachis duranensis*) and Sel. 29 were found to be resistant to early leaf spot (ELS), late leaf spot (LLS) and rust. During summer 1994, out of 134 genotypes, 16 genotypes showed resistance to *Alternaria* blight. During summer 1995, 5 genotypes viz., 86606, ICGV 86707, ICGV 86594, NCAc 343 and code No.8 showed resistance to *Alternaria* blight.

Forty-one genotypes including a susceptible check, GG 2 and a resistant check J 11 were screened for resistance to collar rot pathogen (*Aspergillus niger*) under artificially inoculated conditions. Out of these, only one genotype, IR 9 was found to be moderately resistant to *A.niger.*

2. Management of seed and seedling diseases using seed dressing fungicides and plant products.

Four fungicides (carbendazim 25 SD, Thiram and Mancozeb each @ 3g/kg seed; and carbendazim 50 WP @ 2g/Kg seed) and five plant products (neem leaf powder, neem seed powder; *Eucalyptus* sp.leaf powder; Custard apple leaf powder; *karanj* leaf powder each at 2% level were evaluated along with control (without seed treatment) for their efficacy as seed dressers against collar rot, aflaroot, stem rot and root rot diseases in a replicated field trial in kharif 1994.

Maximum reduction in seedling mortality was recorded in seed treatment with neem seed powder (2%) followed by carbendazim 25 SD (0.3%) and *Eucalyptus* sp. leaf powder (2%).

Dry and wet seed treatment with 1% *Eucalyptus* sp. leaf powder was found to be effective in controlling seed infection and seed colonization by both *A.niger* and *A.flavus* fungi under laboratory conditions. Seed treatment with *Terminalia catapa* dry leaf powder (1%) and 1% karanj both dry and wet leaf powder was also effective against both the species of Aspergillus.

3. Detection of PStV in important groundnut seed material.

In order to clean up the important seed material of groundnut (Germplasm accessions, breeding material), a total of 2010 seed samples were tested for PStV through ELISA. Out of these, 279 samples were PStV +ve.

Project 5.2. Studies on seed pathological aspects with special reference to seed health and aflatoxin contamination of groundnut. (M.P. Ghewande, S.Desai and J.B. Misra)

1. Testing for seed health of released varieties of groundnut.

Testing for seed health of 21 released varieties of groundnut was done by adopting blotter test method. In all, seven fungal species were found to be associated with seeds of these varieties. *Aspergillus flavus, A.niger* and *Rhizopus* sp. were found to be dominant.

Varieties, BG 2, JL 24, TKG 19 A and ICGS 11 were found free from *A.niger* infection. Also, ICGS 21, Co. 1, GG 2 and Co.2 had least (3.3%) infection of *A. niger*. BG 1 was found to be free from *Rhizopus* sp. infection while GG 2 and Dh 3-30 had least infection of *Rhizopus* sp. Out of 21 varieties, GG 2 was found to be least affected by 3 dominating fungi.

A spore feeding mite belonging to *Acaridae* was found to be associated with seeds of BG 1 infected with *A.flavus*.

2. Evaluation of groundnut genotypes for resistance to *Aspergillus flavus* seed colonization.

Sixty-nine genotypes including advanced breeding lines, cross derivatives, germplasm lines and bold-seeded types along with susceptible and resistant checks were screened against *A.flavus* under laboratory conditions. Results indicated that only one genotype, NRCG 912 showed moderate level of resistance to *A.flavus* seed colonization.

ENTOMOLOGY

Project:4.2 Studies on Major insect pests of economic importance in groundnut (V.Nandagopal)

1.Integrated pest management

The experiment on integrated pest management in groundnut was conducted in collaboration with Plant pathology and Agronomy section in kharif 1994. The treatments details were as follows:

T1 - Trap crops (1 middle row of soybean after each 4 rows of groundnut, 3rows of bajra and 1 row of castor in surrounding plot) + Pheromones + spray of Insecticide mixture (Neem oil 2 % + Phosphomidon 0.02 % + Endosulphan 0.04 %) at 40, 55 and 70 DAS.

T2 - Trap crop (1 middle row of pigeon pea after each row of groundnut) +Neem leaf extract 2 % (40 DAS), + Dithane M-45 0.025 % & Bavistin 0.05%(55DAS) +Culture filtrate of *Penicillium* (70 DAS) +Carbendazim 50 WP @ 2g/kg of seed.

T3 - Herbicide (Fluchloralin @ 1.5 kg ai/ha as pre plant incorporation)+ 1 hand weeding(30 DAE) +Interculture (35DAE)

T4 - T1 (Excluding Neem oil 2 %) + T2 +T3

T5 - T1 (Excluding insectide mixture) +T2 (Excluding NLE) + T3

T6 - T1+ T2 (excluding fungicide & NLE) +T3

T7 - T1(excluding insecticide mixture) + T2 (Excluding fungicide) +T3

T8 - T1 + T2 (Excluding NLE) +T3

T9 - T1 + T2 (Excluding NLE) + T3(Two side border crops, bajra & castor)

T10- Only crops(1 middle row of soybean + 2 side rows of pigeon pea +6 rows of groundnut + castor and bajra)

T11- Farmers practices (Application of insecticide + fungicide +1 hand weeding + 1 interculturing)

T12- Control (No hand weeding & No spray)

Each experimental plot consisted of the cultivar Girnar 1 grown in 9 rows of 5 m each with an inter-row spacing of 45 cm.

a. Pest Management (V. Nandagopal)

Significantly lower number of jassids were observed in the plots where trap crops (soybean as the middle row, caster as the border row and bajra surrounding the groundnut crop) were grown and the plots were given with three sprays of insecticides mixture (2% crude neem oil + 0.02% phosphomidon + 0.04% endosulfan). The number of jassids in the postsweep observations at 66 days after germination (DAG) were 10, 16, 13, 14 and 13 per 5 sweeps respectively, wherever pesticides mixtures used, as compared to 28 jassids in control (Table 1 & 2). Similarly the thrips population was 50% less in the pesticides mixture treated plots (Table 1).

Table 1 Jassid and thrips population in the IPM experiment

Treatment	jassid		thrips	
	SPRAY			
	60 DAG pre-	66 DAG post-	60 DAG pre-	66 DAG post-
T1	21.7	10.0	6.0	6.3
T2	10.3	19.3	3.0	10.7
T3	9.1	21.0	5.0	10.3
T4	13.4	16.0	4.3	5.0
T5	25.3	25.7	7.7	10.7
T6	21.3	13.7	7.7	5.0
T7	19.0	24.7	6.3	9.0
T8	24.3	14.3	9.0	3.7
T9	23.0	17.0	7.0	7.0
T10	18.7	6.3	8.0	9.3
T11	13.3	13.0	7.3	5.7
T12	22.7	28.7	9.0	12.7
cd:(5%)	NS	8.21*	5.22**	4.53**

Table 2 Jassid population in the IPM experiment during Rabi 1994.

Treatment	jassid			
	SPRAY		SPRAY	
	45 DAG pre-	60 DAG post-	70 DAG pre-	75 DAG post-
T1	2.0	4.7	8.3	3.3
T2	1.5	7.5	4.2	1.2
T3	1.5	7.2	8.3	5.2
T4	2.7	8.0	3.3	1.2
T5	2.2	9.5	7.5	9.2
T6	2.2	5.8	1.8	0.5
T7	3.7	5.0	5.8	2.8
T8	5.8	6.0	10.8	3.3
T9	3.7	5.8	1.2	0.5
T10	2.8	6.8	1.8	5.8
T11	2.7	9.0	2.7	1.2
T12	3.5	9.7	1.2	6.7
cd:(5%)	NS	NS	5.01**	3.6**

Table 3 Pod Yield in the IPM experiment during Summer 94

Treatment	Kg/ha		
	Groundnut	Soybean	Bajra
T1	2146.03	152.38	24.13
T2	2823.01	169.99	27.41
T3	2695.23	182.38	32.89
T4	4372.22	—	—
T5	2738.09	171.43	28.76
T6	2748.03	139.52	53.48
T7	2390.47	174.76	44.19
T8	1021.42	141.43	40.34
T9	2256.35	158.09	36.37
T10	2329.36	144.29	31.21
T11	2407.94	119.06	20.56
T12	1815.08	—	—

With regard to yields, the main crop yields were not high in kharif 1994, however, in summer experiment the yields were good enough (Table 3).

b. Disease Management (M.P. Ghewande and S. Desai)

The integration of various components to manage insect pests and weed management was attempted in kharif 1994. Results indicated that the treatment T8 reduced ELS and LLS considerably followed by T4 and T9. However, results need further confirmation.

c. Weed Management (Devidayal and P.K. Ghosh)

The result revealed that the plot where only herbicide component (T3) was applied recorded lowest dry matter accumulation at 30 (29.6 kg/ha), 60 (39.3 kg /ha) DAS and at harvest (236 kg/ha) and minimum number of weed at harvest (Table 4). The result also indicated that dry matter of weed was lower where herbicide component was included (T4, T5, T6, T7 and T8) as compared to T1, T2, T9, T10, T11 and T12.

In Rabi/summer also the dry matter accumulation of weed was lower in the treatments where herbicide component was included, and the maximum weed dry matter of 2536.6 kg/ha at 45 DAS was recorded where there was no herbicide component, followed by control plot.

2. Screening of germplasm against major insects

Fifteen stabilized lines from Breeding Section were screened against two sucking pests, thrips and jassids. Girnar 1, IR 18, IR 28, IR 29, IR 34 and PBS 105 have shown high degree of resistance to jassids and thrips.

3. Monitoring of major insect pests

population:

a. Monitoring of flux of aphid population:

To monitor the most common aphid species occurring around Junagadh, *Aphis craccivora* Koch and *Hyalerondera sclariae*, the yellow cylindrical trap (YCT) was put near the cropped and fallow areas. The aphids trapped indicated that the yellow drum trap recorded significantly higher number of the aphids near the cropped area as compared to fallow area (Table 5). During May and June no aphids were recorded. The highest number of aphids 1978 and 1234 were recorded during January and February 1995 respectively.

b. Monitoring of leaf miner moths by pheromone lures :

The square glue trap designed by the NRCG was used to monitor leaf miner in groundnut experimental plots. No moths could be trapped between April 1994 and July 1994. However, the moth population started appearing from August 1994 (Table 6), and January 1995 recorded the maximum population of 18.3.

Table 4. Effect of different treatments on weed number and dry matter accumulation during kharif 1994.

	Weed dry matter (kg/ha) Days After Sowing			No.of weeds/m² at harvest		
Treatments	**30**	**60**	**at harvest**	**Grassy**	**Broad leaves**	**Total**
T1	57.9	77.5	759	18	20	38
T2	62.8	104.6	880	13.6	41.6	55.2
T3	29.6	39.3	236.6	7.3	11.6	18.9
T4	49.1	58.3	456.6	11.3	13.0	24.3
T5	46.5	56.2	581	10.5	17.6	28.1
T6	50.0	62.3	665	15.3	16.0	31.3
T7	46.8	63.1	590	17.0	11.5	28.5
T8	43.1	50.2	286.6	9.0	10.5	19.5
T9	59.0	67.5	713.3	9.6	17.5	27.1
T10	120.8	92.9	1038.3	9.6	23.6	33.2
T11	121.6	107.0	836.6	18	27	45
T12	131.6	710.8	316.6	66	31	97

Table 5 Monitoring of Aphid flux

Month	Yellow drum trap	
	Cropped	Fallow
Jun. '94	—	—
Jul. '94	1.2	0.4
Aug. '94	10.5	8.5
Sep. '94	—	—
Oct. '94	2.0	0.5
Nov. '94	25.0	18.0
Dec. '94	31.6	19.6
Jan. '95	8013.0	4903.0
Feb. '95	5029.0	1594.0
Mar. '95	146.0	79.0

Table 6 Monitoring of leaf miner using pheromone.

Month	No. of moths caught	
	NRCG trap	ICRISAT trap
Jun.-Jul.'94	—	—
Aug. '94	0.75	—
Sept '94	2.9	—
Oct. '94	2.5	—
Nov. '94	1.5	0.75
Dec. '94	4.1	0.75
Jan. '95	18.3	NA
Feb. '95	11.0	NA
Mar. '95	5.0	NA

BIOCHEMISTRY

Project 6.5 Biochemical aspects of groundnut quality and composition (J.B. Misra and S.K. Yadav)

1. Prototype of an *Arachilopometer*:

Based on the principle of an inverse relationship between oil-content and specific gravity of groundnut kernels, prototype of an *Arachilopometer* (densitometer) was developed for determining the oil-content of groundnut kernel samples. The *Arachilopometer* thus developed comprised a sample holder, a buoy, and a stem. It measured 38 cm in length (plate 4) and weighed 56.34 g. The equation of functional relationship [Oil (%) = 239.6 - (176.8 X specific gravity)] was used for calculating the volumes and weights (when fully immersed in kerosene) of 10 g each of the 16 hypothetical groundnut samples, having oil-content from 40.0 to 55.0 % (with an increment of 1.0 %). The under kerosene weights of these 16 hypothetical samples were used for calibrating and graduating the stem of *Arachilopometer*. The length of the stem between the graduations corresponding to 40.0 and 55.0 % oil was 11.4 cm. The oil-content of 23 samples was determined by the standard Soxhlet method- the values ranged from 41.1 to 54.1 %, and also by *Arachilopomet* r- the values ranged from 42.5 to 52.5 %. The values of oil-content predicted by *Arachilopometer* correlated well (r = 0.972) with those determined by Soxhlet method (table 1). The device was so christened to represent both *Arachis*- the generic name of groundnut and lipid - the greasy substances i.e. oil. The *Arachilopometer* can be used as a simple tool for easy and rapid determination of oil-content of groundnut genotypes and samples.

2. Sucrose metabolism of groundnut tissues:

Leaf explants of groundnut were cultured on MS medium containing sucrose (callus-S), fructose (callus-F) or glucose (callus-G) as the sole source of carbon. The tissues in their rapid growth phase were sampled and analyzed for activities (nkat/ fr.wt.) of sucrose phosphate synthase (SPS: the enzyme known to catalyze synthesis of sucrose), sucrose synthase (SS: the enzyme known to catalyze cleavage of sucrose in developing sink) and invertase (the enzyme responsible for hydrolysis of sucrose). The contents (µ mole/g fr.wt.) of sucrose, fructose and glucose were also determined. The SS to SPS ratio was 53.8, 51.5 and 16.6 in callus-F, callus-G and callus-S respectively. The SPS was highest (0.34) in callus-S which was closely followed by callus-F (0.31). The levels of SPS in callus-S and callus-F were about 1.5 times that of callus-G (0.21). The SS was highest in callus-F (16.67) followed by callus-G (10.82) and callus-S (5.64). The activity of acid invertase (pH 5.0) was very low in all the three calli while that of alkaline invertase (pH 7.5) was highest in callus-F (6.62) followed by callus-G (4.25) and callus-S (1.81). Of all the sugars, sucrose was present in the highest quantities (80 to to 125) in all the three calli. The fructose content was 31.4 in callus-F, 0.33 in callus-G and 0.22 in callus-S, while glucose content was 0.15 in callus-F, 12.4 in callus-G and 3.5 in callus-S (table 2).

The sucrose was present in all the three calli irrespective of its availability in the culture medium. Since callus-F and callus-G could not have absorbed ready-made sucrose, the presence of sucrose in these two calli was ascribed entirely to the de novo synthesis. However, the activities of SPS were found to be too low to account for the synthesis of sucrose, whereas the SS in callus-G and callus-F was present in significant quantities in both the tissues and was 2 to 3 times, respectively, that of callus-S. The results confirmed the observations of the previous experiments.

On the basis of data generated, it was concluded that the growing calli of groundnut could use SS for both cleavage and synthesis of sucrose, depending upon the availability of this disaccharide in the culture medium.

Note: The culturing of leaf explants was done by Sh. T. Radhakrishnan , Scientist, Genetics and Cytogenetics Section.

3. Evaluation of HPS genotypes for quality characters:

Kernel samples of 21 HPS genotypes (Rabi-summer 1994 produce supplied by the Agronomy Section) were analyzed for their oil, protein, sucrose, starch, reducing sugars, total sugars, free amino acids and total- and od-phenols contents. The oil-content ranged from 47.9 to 54.9%, the protein from 22.6 to 27.0% and sucrose from 3.43 to 7.92% (table 3). Variety TG 19 A was identified as a low-oil-high-protein-high-sucrose variety. In general, the seeds of the bunch varieties were found to contain lower oil, higher protein and higher sucrose contents compared to that of the spreading varieties.

4. Service to other sections of NRCG and ICAR institutes:

a. A total of 144 samples, received from Genetics and Cytogenetics, Genetic Resources, and Plant Physiology sections and the PC Unit, were analyzed for oil-content.

b. Proximate analysis *Simarouba glauca*- a new oilseed introduced in India from El Salvador:- Both kernels and shell of this new oilseed, received from the NBPGR Research Station at Akola, were analyzed for their quality characters. The kernels were found to contain 62% oil, 20% protein and 9% sucrose.

Project. 6.4 Biochemical basis of resistance to biotic and abiotic stresses in groundnut (J.B. Misra, M.P. Ghewande, A.L. Singh, V. Nandagopal and S.K. Yadav)

1. Chemical composition of leaves of groundnut genotypes *vis-a-vis* their reaction to aphid and jassid.

Leaves of four resistant (Girnar 1, BG 2, PBS 105 and IR 6) and four susceptible genotypes (Kadiri 3, GG 2, PBS 33 and GAUG 10) grown in Rabi-summer 1994 season were sampled at 50, 60 and 75 days after emergence. The leaf samples were analyzed for sugars, amino acids, total- and o-dihyroxy phenols. Activity of polyphenol oxidase was determined only the samples of Girnar 1, BG 2, Kadiri 3 and GG 2. Observation on the population of jassids and thrips supported by these genotypes at 50, 60 and 75 days after emergence were also recorded. The contents of ketose, sucrose, reducing sugars and free amino acids decreased with the increase in the age of crop. However, the contents of total phenols and also the population of both jassid and thrips increased with the increase in the age of crop. None of the chemical constituents showed correlation with the degree of resistance or susceptibility of the genotypes to jassid or thrip.

2. Occurrence protease-inhibitor in groundnut leaves

The leaves of two groundnut genotypes, GG 2 and PBS 105 raised during kharif 1994 were sampled 110 days after sowing. The leaves were homogenised in a buffer system to extract the endogenous proteinase and trypsin inhibitor. The activities of proteinase and trypsin inhibitor were assayed using BAPNA (Na-Benzoyl-DL-Arginine p-Nitroanilide)- a chromogenic trypsin substrate and bovine pancreas trypsin. The leaves of groundnut genotype GG 2 and PBS 105 were, respectively, found to con tain trypsin inhibitor equivalent to 7260 and 5923 units/g fr.wt. The specific inhibitor activity was 1952 and 1431 units/ mg extractable protein in GG 2 and PBS 105, respectively. The levels of endogenous proteinases in the leaves of the genotypes were 600 and 1200 units/g fr.wt. in GG 2 and PBS

Table 1. Oil-content of Groundnut Genotypes as Determined by Soxhlet Extraction Method and Arachilopometer

Genotype	Oil-content (%)		Residual
	Soxhlet	*Arachilopometer*	
Dh 48	44.1	43.5	- 0.6
TG 12	43.8	44.5	0.7
OG 933	47.6	46.5	- 1.1
JL 220	44.7	45.5	0.8
DRG 21	42.1	43.0	0.9
BAU 12	45.1	46.0	0.9
BAU 13	49.1	47.5	- 1.6
TG 22	43.5	44.0	0.5
DRG 9	41.1	42.5	1.4
GG 2	50.5	49.0	- 1.5
Girnar 1	54.1	52.5	- 1.6
	53.9	51.5	- 2.4
JL 24	50.6	49.5	- 1.1
Gangapuri	49.1	48.0	- 1.1
ICGS 11	51.1	50.5	- 0.6
TMV 2	50.9	49.5	- 1.4
ICGS 44	50.2	49.0	- 1.2
	51.8	51.0	- 0.8
S-2-30	49.2	50.0	0.8
SB XI	47.0	46.0	- 1.0
TMV-10	52.1	51.5	- 0.6
M 337	50.5	51.0	0.5
M 13	49.4	48.0	- 1.4
Mean	48.3	47.8	
Minimum	41.1	42.5	
Maximum	54.1	52.5	
CV (%)	7.7	6.3	
r	0.97		

105, respectively. The presence of these inhibitors in the leaves of groundnut plants open up a possibility of enhancing resistance of groundnut genotypes against insects.

3) Effect of moisture-stress on the metabolism of leaves

On the basis of field- and pot- experiments conducted with tolerant and susceptible genotypes, it was inferred that the leaves of both susceptible and resistant genotypes accumulate proline under moisture stress. Also, under stress conditions, the leaves showed a propensity of maintaining the levels of sucrose at the expense of reducing sugars. The differences in the tolerant and susceptible genotypes were, however, not significant.

Table 2. Activities of SS, SPS, and Invertase in Developing Cotyledon and Calli of Groundnut

Tissue	Activity (nkat/g fresh weight)				Sugars (umole/g fresh weight)		
	SS	SPS	Invertase				
			pH 5.0	pH 7.5	Sucrose	Fructose	Glucose
Callus-F	16.7	0.31	0.38	4.53	91.30	31.41	0.15
	(305)	(5.68)	(7.03)	(82)			
Callus-G	10.8	0.21	0.21	2.90	125.25	0.33	12.42
	(197)	(3.83)	(3.90)	(52.8)			
Callus-S	5.6	0.34	0.17	1.24	81.84	0.22	3.47
	(221)	(13.3)	(6.7)	(48.6)			

(Each value represents average of three determinations; values in parenthesis indicate activity nkat/mg protein/min)

Table 3. Composition of some HPS genotypes

Genotype	Constituent (%)								
	Oil	Protein	Starch	Total Sugars	Sucrose	Total Phenol	OD Phenol	Free Amino Acid	Reducing Sugars
Bunch type									
Dh 3-30	48.4	27.0	4.30	5.24	2.79	0.40	0.70	0.14	8.8
GG 2	50.0	24.6	4.11	7.29	2.70	0.63	0.65	0.23	9.9
JL 24	49.1	26.1	3.39	6.42	6.59	0.61	0.65	0.56	10.8
ICGS 21	52.5	22.6	3.57	6.86	3.21	0.63	0.63	0.27	10.9
Co 1	49.7	26.5	4.90	6.30	2.81	0.60	0.60	0.22	8.7
Tirupati 2	54.9	23.5	2.60	4.99	2.85	0.35	0.65	0.18	8.9
Co 2	48.5	28.4	4.87	4.74	2.41	0.42	0.55	0.21	7.5
TG 19A	47.9	26.4	5.34	7.61	3.36	0.59	0.68	0.26	13.2
ICGS 11	50.5	24.3	5.73	7.92	2.31	0.49	0.63	0.25	11.0
ICGS 44	51.0	25.3	6.12	6.61	2.03	0.46	0.56	0.22	9.9
ICGS 76	50.0	23.9	4.58	6.61	2.63	0.47	0.54	0.29	10.3

Spreading type									
BG 2	50.7	23.5	4.09	4.30	2.97	0.52	0.68	0.28	6.2
BG 1	50.5	24.8	3.99	3.43	3.16	0.42	0.80	0.30	6.7
PG 1	50.8	23.8	4.69	5.49	3.26	0.55	0.61	0.24	8.7
M-37	52.6	24.6	5.16	5.74	2.46	0.32	0.57	0.20	8.3
ICGS-1	52.9	24.6	6.20	5.80	2.47	0.38	0.51	0.20	8.9
BG-3	50.6	23.6	6.48	5.80	2.99	0.45	0.63	0.21	10.1
K-2	52.8	23.1	6.22	6.98	2.53	0.47	0.61	0.29	12.4
Somnath	50.6	24.9	4.87	5.99	2.69	0.51	0.67	0.25	10.6
R-141	49.5	23.7	6.67	6.98	2.95	0.69	0.63	0.31	11.3
M-335	52.3	24.4	2.71	6.17	2.65	0.41	0.64	0.27	9.4

Arachilipometer

PLANT PHYSILOGY

Project 6.1 Studies on abiotic stresses in groundnut (Y. C. Joshi , V. Ravindra, P. C. Nautiyal and Ajay)

1. Drought tolerance mechanism in groundnut.

The response of nine Spanish Bunch cultivars to soil moisture stress imposed at three phenophases was studied. Soil moisture stress was imposed by with-holding irrigation for 44 days at vegetative (20 days after sowing), 30 days at flowering (55 DAS) and 25 days at pod filling (80 DAS) phenophases to ensure that gravimetric soil moisture content was 7-8% at 0-15 cm soil depth at peak stress. At peak stress, observations on water relations i.e. leaf relative water content (RWC), water potential (Ψ), osmotic potential, conductance (g), photosynthetic rate (Pn) and growth were taken simultaneously on stressed and unstressed plants of all the varieties. The results are presented in tables 1-4.

It was observed that the reduction in leaf RWC, water potential, osmotic potential, Pn, and g was maximum at flowering affecting growth both in terms of total bio-mass accumulation and leaf area development. Genotypic differences were distinct as seen from ranges given in tables 1-4. The Leaf RWC appeared to regulate Pn, g, growth and leaf area development particularly under stress conditions. The tolerant line (ICGS 11, GG 2) maintained leaf RWC above 80% at all the phenophases under stress, while in the susceptible line (JL 24) fell below 70% at peak stress.

The stress effects in general were severe and quicker at later phases of growth due to the compounding effect of high atmospheric temperatures prevailed.

2. Heat tolerance mechanism:

The cultivars used in the above experiment were also analyzed for their heat tolerance, following leaf-membrane-thermostability method. The protocols of this method are being standardized for large scale screening of the germplasm/advanced breeding material.

3. Screening for cold tolerance:

Since most of the germplasm material was destroyed under PStV eradication program, no further screening could be taken up for cold tolerance. A pooled analysis of the data available on coefficient of velocity of germination and seedling vigor index confirmed the cold tolerance of *Arachis monticola*, 27 germplasm accessions and the cv. Girnar 1 (Table 5).

4. Photosynthesis in relation to leaf position and sink manipulation:

A field experiment was conducted to study photosynthetic rate in relation to leaf position and sink size. Two plots of equal size (4x2 m) were sown with cv. GG 2 at 30x10 cm spacing. In one plot the flowers were retained on the plants while in the other the flowers were removed everyday till 80 days. Observations on Leaf Pn were taken in the order of leaves on the main axis and branches from three plants in each treatment. The results at pod filling phase are presented in Table 6. In general, it was observed that the plants without sink were stunted. The Leaf Pn was found to be maximum in the 2nd and 3rd order leaves from the top and declined gradually in the lower order leaves irrespective of their position on the main axis or branch. The results need further confirmation.

5. Effect of low temperature on seed quality ofcertaingroundnut varieties in rabi (Oct.-Feb.) sown groundnut :

After the rains had receded, 25 cultivars were sown in October 1994 (a non-conventional sowing time in Saurashtra region) for assessing their pod yield and seed quality. The growth and development of the crop was initially better, but it slowed down at the pod filling phase due to low temperatures. The varietal differences for pod yield were distinct. The seeds of all the cultivars were subsequently analyzed for oil-content, protein and total soluble sugars. In general, there was a reduction in oil percent which ranged between 2-6% as compared to the summer or kharif seasons (Table 8). The reduction in oil percent, however, seems to have been compensated by increase in total soluble sugars in majority of the varieties, and proteins in a few varieties. The SHP was in general higher as compared to that of summer season. These preliminary findings suggest a possibility that HPS grade varieties, where low oil and high sugars are preferred, may be grown in this season, provided irrigation facilities are available. Further studies in this aspect are required.

Table 1. Response of Spanish groundnut cultivars to soil moisture stress (Vegetative to flowering)

Variables	Normal	Stress
		(44 days)
RWC (%)	93	82
	(90-97)	(75-88)
Leaf ψ	7.06	14.26
(bar)	(3.79-8.85)	(10.32-18.55)
Leaf π	18.80	23.31
(bar)	(16.05-23.95)	(18.93-28.23)
P_N (Photosynthesis)	28.17	18.76
(mg dm^{-2} h^{-1})	(22.18-37.62)	(15.94-25.64)
g (conductance)	0.576	0.274
(mol m^{-2} s^{-1})	(0.430-0.834)	(0.233-0.373)
TDM (g/plant)	8.53	2.67
	(6.95-10.74)	(2.16-3.07)
Leaf Area	480	133
(cm^2/plant)	(298-609)	(73-273)

Values in the parentheses indicate the range of response

Table 2: Response of spanish groundnut cultivars to soil moisturestress (Flowering - pod formation)

Variables	Normal	Stress (30 days)
RWC	90 (88-95)	69 (62-85)
Leaf ψ	6.49 (3.96-9.58)	29.26 (24.33-34.93)
Leaf π	15.79 (13.98-18.80)	41.55 (30.68-46.55)
P_N (photosynthesis)	24.95 (16.49-33.37)	6.41 (3.37-9.47)
g (conductance)	0.487 (0.322-0.709)	0.055 (0.031-0.100)
TDM	11.90 (8.32-15.40)	6.36 (5.27-8.68)
Leaf area	598 (383-686)	270 (213-380)

Values in the parentheses indicate the range of response

Table 3: Response of spanish groundnut cultivars to soil moisturestress (Pod formation - pod filling)

Variables	Normal	Stress (30 days)
RWC	92 (90-94)	69 (62-84)
Leaf ψ	8.53 (7.44-9.71)	29.00 (20.83-34.19)
Leaf π	23.13 (20.73-27.40)	38.12 (33.65-46.28)
P_N (photosynthesis)	27.64 (20.28-35.34)	4.50 (1.00-7.15)
g (conductance)	0.571 (0.415-0.835)	0.101 (0.041-0.132)

Values in the parentheses indicate the range of response

Table 4: Response of ICGS-11 and JL-24 to soil moisture stress

Variables	Normal		Stress (7-8% SMS)	
	ICGS-11	JL-24	ICGS-11	JL-24
	Vegetative -Flowering			
RWC	96	92	88	75
Leaf ψ	8.80	8.85	15.51	13.76
Leaf π	19.13	21.10	22.90	26.10
P_N	37.62	23.53	19.74	18.90
g	0.683	0.521	0.277	0.245
TDM	9.30	10.74	3.01	2.37
LA	362	609	130	85
	Flowering - Podformation			
RWC	92	91	85	69
Leaf ψ	6.02	7.12	30.07	34.04
Leaf π	16.05	14.40	40.80	40.10
P_N	26.73	18.36	8.67	3.37
g	0.633	0.322	0.052	0.037
TDM	10.42	14.43	5.80	5.62
LA	418	672	219	213
	Podformation - Pod filling			
RWC	92	93	84	64
Leaf ψ	7.99	8.39	24.83	28.26
Leaf π	23.00	20.83	35.80	36.23
P_N	35.34	20.28	6.02	1.00
g	0.707	0.415	0.141	0.041

VC - Relative Water Content, LA - Leafarea, Flo - Flowering, PF - Pod Formation, Pfill - Po
ing

Table 5 : Screening for cold tolerant lines

Genotypes/ Accession Nos.	G(%)	SVI	CVG(%)
6738(Ah-812)	84	72	22
2510(x9-2B-25b)	88	101	23
6408 (CBRR-4)	93	105	25
1338 (U2-12-3)	97	174	25
A.monticola	100	113	32
CGC-4018	100	180	27
Girnar-1	84	134	26

G = Germination
SVI = Seedling vigour index
CVG = Coefficient of velocity of germination

Table 6: Effect of Leaf position and sink manipulation on photosynthesis (mg dm^{-2} h^{-1})

Leaf Position	Main axis		Branch	
	Low sink	High sink	Low sink	High sink
1.	9.02	10.12	13.84	10.12
2.	14.45	8.95	18.93	10.38
3.	15.02	15.58	18.73	9.75
4.	12.95	7.19	11.72	13.49
5.	11.04	6.71	9.47	8.10
6.	12.29	7.27	9.49	3.99
7.	10.63	4.51	9.07	7.04
8.	5.71	3.06	-	-
9.	4.08	2.28	-	-

Values at pod filling stages.

Table 7: Genotypic variation for emergence and flower initiation

Varieties	Days to germination	Days to flowering
VRI 1	6	27
ICGS 11	7	28
CO 2	6	27
AK 12-24	6	27
TAG 24	6	24
ICGS 44	7	27
GG 2	6	24
GIRNAR 1	6	24
SG 84	9	32
JL 24	6	28

Table 8: Chemical composition of Kernels and shelling percent of rabi (Oct.-Feb.) sown groundnut

Varieties	Protein %	Total sugars %	Oil %	Shelling %
TMV 2	20.73	9.36	47.7	63
TMV 7	22.62	9.67	47.6	73
CO 2	22.00	6.59	48.1	67
VRI 3	24.66	8.86	47.1	70
Jyoti	21.56	8.92	47.5	68
Kisan	21.84	6.80	49.9	66
KRG 1	19.86	10.47	44.5	70
TG 17	21.67	7.43	47.6	63
TG 22	19.35	13.05	45.5	68
TG 3	21.77	9.78	45.2	67
Jawan	21.11	7.90	44.8	64
MH 1	27.14	12.08	44.9	72
SB XI	20.46	10.00	47.3	73
S 206	21.6	9.34	47.5	69
Dh 8	23.52	6.65	48.1	62
GG 2	18.69	10.36	46.9	71
Girnar 1	20.16	7.57	48.6	60
JL 24	24.72	9.67	44.7	62
ICGV 86590	23.26	6.60	46.3	59
TAG 24	21.38	8.10	48.5	70
TMV 10	24.82	8.16	47.6	60
ICGS 11	15.42	8.33	48.8	62
ICGS 44	26.65	5.69	46.5	67
SG 84	20.10	7.08	46.8	64
Kadiri 3	19.24	9.40	48.6	61
Somnath	21.94	11.30	46.2	65
Kaushal	21.19	10.25	46.9	54

Project 5.1 Physiology and biochemistry of seed viability and dormancy in groundnut

(P.C. Nautiyal, V.Ravindra and J.B.Misra)

1. Studies on seed viability.

a. Effect of drying and storage methods on viability and seed protein pattern.

I Viability and vigour :

Rabi-summer-produced groundnut pods (cv. GG 2) were dried following three methods viz. (i) New method (NRCG) (ii) DOR method and (iii) Wind-row shade method for five days and on the sixth day due to heavy rains, the drying structures were shifted to the sheds. After two days of drying under the sheds the pods were picked-up and dried spreading in a thin layer. Subsequently the pods were exposed to bright sun-shine for 5-6 hours. After thorough drying the pods were stored at a moisture content between 7-8% in polyethylene lined gunny bags (1 kg capacity) with or without CaCl2 or silicagel. Seed viability and seedling vigour was monitored during storage (Table 9). The differences in seed viability and vigour due to drying methods though distinct immediately after drying became more pronounced after four months storage. Viability and vigour was more in the seeds obtained from the pods dried by New (NRCG) and DOR method and stored with desiccant. Since the pods experienced rain at the end of drying cycle, the seeds after six months of storage lost viability and vigour, irrespective of drying and storage method.

II Seed protein pattern :

After post harvest drying, seeds proteins were were separated by PAGE on a 14% gel. The difference in the electrophoretic protein patterns due to the drying treatment were however, not conspicuous.

b. Effect of packaging material on viability

Rabi-summer-produced groundnut pods (cv. GG 2) were picked one day after harvest and dried inside the cotton bags till they attained a moisture content of 6-7%. The pods after drying were stored as follows :

T1= Pods in cotton bag stored inside the galvanized bins.

T2= Pods in polyethylene lined gunny bags.

T3= Pods in polyethylene bags (350 gauge thick).

T4= Pods in earthen pitcher with CaCl2.

T5= Pods in earthen pitcher with sand layer at the top.

T6= Pods in gunny bags.

Viability of the seed was monitored after eight months of storage (Table 11) and the highest germinability was found in T1 (68%) followed by T3 (52%).

2. Studies on seed dormancy.

a. Relationship between dormancy and viability:

Fourteen dormant and non-dormant groundnut genotypes (Table 3) were raised during the rabi-summer 1995 and pods after thorough drying were placed in cotton bags and stored inside the galvanized bins. The viability of the seeds was monitored at different storage periods. Dormant genotypes maintained higher germinability than the non-dormant types. The germinability of the dormant genotypes viz. ICGS 11, ICGS 44, and TG 22 was > 90%, even after eight months storage.

b. Role of externally applied ABA and GA 3 on seed germination:

Pods of cv. ICGS 11 (dormant) and Girnar 1 (non-dormant) were picked-up immediately after harvest. Seeds with coat (S) and without seedcoat (SW) were treated with different concentrations of ABA (in case of non-dormant) and GA 3 (in case of dormant) and incubated at 30C. After six days of incubation, germination percentage was computed (Table 12). ABA 200 ppm induced dormancy

by 100% and GA 3 at 200 ppm was found to break dormancy of the seeds without seed coat. The removal of seed coat enhanced germination in dormant type while reduced in non-dormant type.

Project 6.2 Inorganic nutrient requirements and their disorders in Grodundnut. (A.L.Singh, Y.C.Joshi and Ajay)

1. Effectiveness of iron containing compounds in alleviation of iron chlorosis in groundnut.

Four iron containing compounds namely FeEDTA, FeEDDHA, FeSO4 and iron citrate at different concentrations were tested for alleviating lime induced iron chlorosis in groundnut using both Fe-inefficient and efficient genotypes. Four Fe-efficient, GG 2, CSMG 84-1, TAG-24 and TG-26 and four inefficient PBS-13, PBDR-36, VRI 3 and VRI 2 genotypes were used in this study. Soil application of all the sources of iron reduced the occurrence of iron chlorosis and excessive vegetative growth, increased chlorophyll and F_{e2}+contents of leaves, and pod yield. Though the higher doses (20 kg Fe/ha) of $FeSO_4$ and Fe-citrate did increase the pod yield than at lower doses (5 kg Fe/ha), at constant rate (5 kg Fe/ha) the beneficial effects of iron sources of groundnut were more pronounced with FeEDDHA and Fe-citrate than others. Fe-inefficient genotypes performed better when supplemented with iron sources than the efficient ones.

2. Yield evaluation of Fe - efficient genotypes:

Six high yielding Fe-efficient groundnut genotypes tested during 1992 and 1993, were further tested for their yield and yield attributing characters during Rabi/summer 1994 along with national and zonal checks (JL 24, GG 2, and SB XI). The pod and haulm yields, SHP, oil % and HSM of these genotypes were recorded (Table 1). The Fe-efficient genotypes, NRCGs 7085-1, 7085-3, 6919 and 2588 out yielded GG 2 and NRCG 1308 showed very poor yield due to its thermosensitivity. The SHP of these genotypes ranged between 67 and 73. The genotypes NRC 6919, 7085-1 and 7085-3 were early maturing too.

The oil-content of kharif 1993 produce of these genotypes was also estimated (Table 1). NRCG 7085-1 showed high oil-content (52.9%) where as NRCG 6919 less (44.9%).

The results of the three consecutive years revealed that the genotypes NRCGs 7085-1, 70885-3, 2588 and 6919 of Spanish group and NRCG 7599 of Valencia group have good yield potential and hence can be tested under AICRPG system for their suitability for release for cultivation.

3. Effect of macro and micronutrient on yield and pod filling.

A field experiment was conducted during Rabi/summer 1994 to find out the effect of macro and micronutrients on the growth and yields of groundnut and the yield losses caused by the deficiencies of these micronutrients in calcareous soil. It was observed that the application of N, P, K, Ca, Mg and S increased 47.4% pod yield (Table 14). The yield losses caused by the deficiencies of Fe, Mn, Zn, Cu, B and Mo were 22.2, 16.7, 20, 14.2, 26 and 17.6% respectively. The SHP and the HSM also increased with the application of micro- and macronutrients. But the oil percent decreased with the micronutrient treatments.

A pot experiment was conducted to differentiate the individual effects of macronutrients on four genotypes.

Application of micronutrients alone increased chlorophyll content, but decreased carotene and pod yield over no macro- and micro-nutrients in all the genotypes. However, these micronutrients when accompanied by macronutrients, increased the photosynthetic rate and pod yields (from 16.4-51.9% depending

upon the genotypes) (Table 15). It was observed that non supply of nitrogen caused severe yellowing during the early growth stages upto 50 days, but soon after the nodules were developed, the yellowing was reduced. In general, when individual micronutrient is excluded from combined macro and micronutrient (T3) pod and fodder yields were reduced, but with varying response among the genotypes. The genotype NRCG 6919 showed no yield loss due to exclusion of N and Ca, and NRCG 7085-1 due to exclusion Ca and S and hence, these genotypes may be N and Ca efficient. The treatment without P showed maximum yield reduction whereas non-application of P and S caused maximum reduction in photosynthetic rates.

4. Screening of groundnut varieties, breeding lines and germplasm accessions for their tolerance of iron chlorosis.

Eighty (34 during summer'94 and 46 kharif'94) selected groundnut genotypes comprising of released varieties, advanced breeding lines and germplasm accessions were screened for their tolerance to iron chlorosis by growing them in two replicates of 2 rows of 5 m length each. The visual chlorotic rating scores (VCR) for top 5 leaves of groundnut were given and the genotypes were classified into the different categories based on their level of tolerance. The tolerant, moderately tolerant and highly susceptible genotypes are listed in Table 16.

5. Detailed studies of the iron-efficient groundnut genotypes.

Total and active iron content, chlorophyll, total nutrient uptake and their concentration, and activities of peroxidase and nitrate reductase were estimated in the field grown plants of the Fe-efficient (GG 2, PKVG 5, and TG 17)and inefficient (NRCGs 162, 7472 and NcAc 17090) groundnut genotypes. The Fe-efficient (tolerant) genotypes showed 2-2.5 times more active iron content, and higher uptake of all the minerals than the inefficient ones. The chlorophyll content, and peroxidase and nitrate reductase (NR) activities in leaves and peroxidase activity of root in Fe-efficient plant was also appreciably higher than the inefficient one. However, the respiration rate of root was lower in Fe-efficient genotype than inefficient one.

6. Influence of various levels of micronutrients in nutrient solution on the growth and yield of groundnut.

A series of sand-culture experiments in pots were conducted at various levels of deficiencies and toxicities of Mn, Zn, Cu, B and Mo during kharif 1994 to find out the optimum levels of micronutrients for best growth and yield of groundnut. It was noticed that the toxicity levels of Cu and B caused stunted growth and interveinal to complete chlorosis leading to iron deficiency whereas Mo toxicity caused complete chlorosis. The rate of photosynthesis was maximum at 5, 0.5, 0.25ppm of Mn, Zn, Cu, B and Mo, respectively but the growth and pod yield was best at 5, 1, 0.5, 0.5 and 0.25ppm levels of these micronutrients respectively, and hence, the latter were the best combination of the doses for nutrient culture studies of groundnut. The respiration rate in the roots was more at the toxic levels of these micronutrients.

7. Basic studies on the nutrient efficient groundnut genotypes.

Sand-culture experiments in pots were conducted to study the photosynthesis, respiration and growth rates, and pod yielding ability of Ca, S and Fe-efficient and inefficient groundnut genotypes. Though genotypic differences were noted, Fe-efficient genotypes showed maximum protochlorophyllides, chlorophyll (both Chl a and b), and carotene

contents as compared to that of Fe-inefficient lines. However, the rate of photosynthesis did not increase in proportion to these parameters in Fe-efficient genotypes. Though TG 17, a Fe-efficient genotype showed maximum photosynthesis (18 mmol/s) with an average rate of respiration, the genotype NRCG 1308 which is Fe- and S-efficient but Ca-inefficient, showed fairly high photosynthetic rates (14.1-16.4mmols/s). At the same time, the genotype NRCG 2588 which is Fe, S and Ca efficient and I1 and NRCG 4659 which are Fe and S efficient, respectively, showed comparatively lower rates of photosynthesis. In general, the genotypes with high rate of leaf photosynthesis showed comparatively lower root respiration. Barring a few exceptions, the genotypes having high photosynthesis in leaves and low respiration in roots showed higher pod yields.

Project. Selection for water use efficiency (WUE) and partitioning (P) in groundnut (AICAR funded project) (Y.C.Joshi and P.C.Nautiyal).

The experiment on selection for WUE in groundnut with 50 genotypes was conducted during rabi-summer 1994 with the following treatments :

T1= Adequately irrigated condition. Replenished 100% of cumulative pan evaporation at 4 day interval.

T2= Simulated drought between 40 to 75 days after sowing (DAS). Irrigated with 25% of cumulative pan evaporation at 4 day interval.

Sampling for growth analysis, SLA and carbon isotope discrimination was done at 40, 75 DAS and at maturity. The lines viz. ICGV 86031, ICGV 86644, TMV 2, NLM, ICG 3106, ICG 3309, and ICG 4446 were found with low SLA under soil moisture stress condition (T2). However, the lines viz. ICGV 86707, ICGV 87354, ICGV 86031, ICG 4226 and ICG 3309 showed low SLA under normal condition (T1). Following important inferences were drawn from the experiment.

1. Lower SLA resulted to higher bio-mass productivity.

2. High yielding lines showed higher PGR at 75 DAS.

3. High yielding lines have higher sink size (pod dry mass, PDM) at 75 DAS.

4. Low yielding lines accumulated more vegetative dry mass than PDM under stress at 75 DAS.

Table 9 : Effect of drying and storage method on seed viability and seedling vigour in groundnut.

Treatment	Storage period (months)								
	0			4			6		
	G	SVI	EC	G	SVI	EC	G	SVI	EC
Control									
NM	94	676	0.111	47	241	0.166	17	35	0.220
FM	79	516	0.085	50	184	0.089	15	33	0.261
DOR	89	646	0.105	51	227	0.121	13	20	0.329
CaCl2									
NM	98	678	0.080	66	493	0.072	16	41	0.292
FM	80	526	0.085	44	205	0.107	10	34	0.280
DOR	88	646	0.093	70	487	0.138	22	76	0.205
Silica Gel									
NM	93	666	0.080	73	395	0.080	16	36	0.265
FM	75	513	0.085	55	398	0.119	13	32	0.286
DOR	90	648	0.093	65	400	0.073	16	44	0.248
SEm±	3	20	0.026	8	36	0.025	3	10	0.052
CD(P=0.05)	6	43	0.055	17	78	0.054	7	22	0.052

NM = new method (NRCG), DOR method = directorate of oilseeds research method, FM = farmers method, G = Germination percent, SVI = seedling vigour index, EC= electrical conductivity of seed leachate (umol/g seed)

Table 10. Effect of packaging material on groundnut seed viability.

Treatments	Storage period (months)	
	0	8
	Germination (%)	
T1	94	68
T2	92	08
T3	98	52
T4	92	19
T5	94	14
T6	95	10
SE m±	2.8	5.4
CD (P=0.05)	6.4	12.1

Table 11. Germination percentage of seed dormant and non-dormant groundnut genotypes.

Genotypes	Habit group	Seed type	Storage period (months)			
			0	2	4	8
			Germination (%)			
M 13	VR	D	0.0	47	89	81
Somnath	VR	ND	78	82	78	50
BG 3	VG	D	5	7	86	87
Kadiri 3	VG	D	1	95	94	86
ICGS 11	SB	D	3	91	93	90
ICGS 44	SB	D	1	93	87	92
TG 26	SB	D	40	76	85	85
ICGS 1	SB	D	3	95	96	83
TG 22	SB	D	7	94	92	92
Dh 8	SB	D	1	92	87	71
SG 84	SB	D	3	92	94	85
Girnar 1	SB	ND	95	99	91	65
GG 2	SB	ND	95	98	93	68
Jyoti	SB	ND	93	97	96	73
Sem±	-	-	2.7	3.8	3.0	4.2
CD (P=0.05)	-	-	5.5	7.8	6.4	8.9

D= dormant, ND= non-dormant, VB= Virginia Bunch, VR= Virginia Runner, SB= spanish Bunch.

Table 12. Effect of different concentrations of ABA and GA 3 on seed germination of dormant and non-dormant groundnut.

Girnar 1 (non-dormant)			ICGS 11 (dormant)		
Treatent		Germination (%)	Treatment		Germination (%)
Control S		87	Control S		19
	WS	66		WS	33
ABA (ppm)			GA 3 (ppm)		
50	S	82	100	S	39
	WS	85		WS	44
100	S	81	200	S	37
	WS	80		WS	71
200	S	00			
	WS	00			

S = seed with seed-coat, WS = seed without seed-coat.

Table 13 . Evaluation of yielded and other characters of groundnut genotypes.

Genotypes	NRCG No.	pod yield (kg/ha)	% increased over GG 2	Shelling %	100 kernal wt.(g)	% oil yield
1. GG 2(ZC)	-	983	-	72	35	51.4
2.SB-11 (NC)	-	483	-	68	32	49.8
3.JL-24 (NC)	-	903	-	68	35	-
4.FeESG10-1	7085-1	1158	17.8	67	32	52.9
5.FeESG10-3	7085-3	1323	34.6	72	32	50.0
6.FeESG8	6919	1311	33.4	69	32	44.9
7.FeESG2	2588	1330	35.3	73	34	-
8.FeEVG5	1308	382	-	64	31	45.9
9.FeEVG6	3498	958	-	70	40	47.1
LSD(0.05)	-	146	-	-	-	-

Table 14. Assessment of yield losses due to micro-nutrient deficiencies in groundnut during dry season of 1994.

Treatments	Pod yield	Yield loss over T3(%)	Shelling (%)	100 seed wt. (g)	% Oil (kg/ha)
T1, Control	1292	-	67	32	53.7
T2,N,P,K, Ca,S,Mg	1904	-	71	35	50.9
T3,T2+Fe,Mn, Zn,Cu,B	2131	-	67	36	50.5
T4,T3-Fe	1658	22.2	66	34	50.8
T5,T3-Mn	1775	16.7	66	34	50.5
T6,T3-Zn	1705	20.0	68	36	50.7
T7,T3-Cu	1828	14.2	69	36	52.6
T8,T3-B	1576	26.0	70	34	51.4
T9,T3-Mo	1756	17.6	68	35	51.3

Table 15. Assessment of yield losses due to macro-nutrient deficiencies in groundnut grown in calcareous soil during wet season of 1994.

Treatments	Pod yield (g/pot = * 200 kg/ha)			
	GG 2	6919	JL 24	7085-1
T1, Control	11.5	14.6	14.4	10.8
T2,All micronutrients	8.31	7.96	8.89	7.29
T3,T2+ macronutrients	15.9(38)	17.0(16)	20.2(40)	16.4(52)
T4, T3- N	12.6	17.1	13.4	12.2
T5, T3- P	11.0	12.6	12.7	14.6
T6, T3- K	11.9	13.9	12.6	13.6
T7, T3- Ca	12.1	17.1	15.9	16.1
T8, T3- S	15.6	12.1	14.1	16.0
T9, T3- Mg	14.9	13.6	14.9	15.1
LSD(0.05)				
Varieties means	0.92			
Treatment means	1.00			
Interactions	1.80			

Figures in parentheses show percent increase over control

Table 16. Groundnut genotypes showing tolerance of iron chlorosis.

Tolerant tolerant	Moderately	Susceptible
1. Varieties		
JL 24, TG 26	CSMG 9101	VRI 3
TG 17, CSMG 84-1		
VRI 2, TGA 24, SG 84		
2. Advanced breeding lines		
PKVG 8, Akola Sel.	CGC 3, PBS 13,	AK NRCG 1,12
I1, PBDR 41,	145, 90, PBDR 39,	PBDR 13,36, 2-21
PBS 70, 89, 91, 189,		
3. Germplasm accessions		
NRCGs 5389, 4255,	NRCGs 4015, 7110,	NRCGs 7472, 162
6450, 5513, 7267,	4659	
7027, 7417		

Project 6.3 Studies on biological nitrogen fixation and phosphorus solubilization in groundnut. (P.K.Joshi)

1. Effect of mulching on nitrogen fixation in groundnut :

The observations on nodulation, plant bio-mass and plant nitrogen content were recorded from the mulching experiment plot of Agronomy Section. More nodulation and plant bio-mass were observed in black/white polythene with wheat-straw mulch at flowering stage in comparison to wheat straw mulch and control. There was significant increase in number of nodules on application of white polythene alone and white and black polythene mulch with wheat straw up to pod maturity stage in comparison to control.

2. Evaluation of cultivars for high nitrogen fixation :

Released cultivars were screened for nodulation and growth along with non-nodulating lines both in Rabi/Summer and Kharif 1994 seasons. The Cultivars ICGS 76, BG 2, Somnath and ICGS 1 recorded higher number of nodules, whereas, the cultivars ICGVS 21 and GG2 showed lowest nodulation and nitrogen contents (Table 1).

3. Effect of phosphorus solubilizing microbes (PSM) and phosphorus sources on groundnut :

During summer season two PSMs namely *Pseudomonas striata* (H5) and *Penicillium oxalicum* were tested in combination with 50 kg P2O5/ ha of either as SSP or Rock phosphate (RP) on cultivars ICGS 11. The result revealed that there was an increase in plant phosphorus on application of *P. striata* and *P. oxalicum* in combination with 50 kg P2O5/ha of SSP and RP, but did not show the increase in available soil P (Table 2) probably due to absorption of those P by the plants. *P. striata* inoculation along with SSP could also increase the pod yield over P application.

H5 and PSF are *P. striata* and *Penicillium oxalicum*, respectively.

During Kharif 1994, a field experiment was conducted with five PSMs namely *Pseudomonas striata*, *P. circulans*, *B. polymyxa*, *A. awamori* and *Penicillium oxalicum* in combination with application of 50 kg P2O5/ ha as SSP and Rock phosphate on JL 245. It was observed that there was increase in nodulation, crop growth and plant phosphorus at 60 DAS and at harvest of crop on application of PSMs with and without P fertilization. However, due to heavy rainfall during the later stages of crop growth resulted in crop losses and hence, meaningful conclusions could not be drawn.

4. Growth and nodulation in groundnut grown on flat and raised beds:

A field experiment was conducted on flat bed and Raised broad beds with and without *Bradyrhizobium* inoculation (NC 92) to study their effects on nodulation, nitrogen contents and yield in groundnut. Observations on nodulation at 30 days did not show any significant differences among treatments. However, at later stages (45 DAE) the raised bed planting of groundnut with and without Bradyrhizobium inoculation were significantly superior to flat bed planting in terms of nodulation, plant bio-mass and pod yield (Table 3). There was significant correlation between nodulation and plant biomass, nodulation and pod yield and plant bio-mass with pod yield.

5. Combined effects of inoculation with Bradyrhizobium and Pseudomonas striata :

Inoculation of *Bradyrhizobium* and *P. striata* individually and in combination were studied on cv.GG 2 by using two methods of inoculation (liquid inoculation in furrows and seed coating).

It was observed that these microbes increased the nodulation and growth initially, but due to heavy rain and water logging at later stages of growth no data could be recorded on the differences in further nodulation and pod yield.

6. Collection, isolation and maintenance of PSMs and *Bradyrhizobium*

Four efficient strains of PSMs namely *P. striata*, *B. polymyxa* , *B. circulans* and *A. awamori* were procured from IARI, New Delhi. Another PSM namely *P. oxalicum* was isolated from native soil of NRCG. These cultures are being maintained for their further multiplication and distribution to all India testing centres.

Forty *Bradyrhizobium* strains collected from various sources being maintained both on long and short term storage. The efficient strains are being multiplied and supplied to various agencies and research workers in India.

Table 1. Nodulation and nitrogen fixation in groundnut varieties

Varieties	Nodule number per plant	Plant Dry wt. (g/plant)	% Nitrogen
BG 1	60	20.0	2.57
BG 2	62	16.4	2.54
BG 3	38	15.5	2.82
CO 1	35	13.2	2.46
CO 2	54	9.0	2.43
Dh 3-30	31	10.5	2.34
GG 2	20	16.1	2.21
ICGS 1	55	16.6	2.56
ICGS 11	48	12.8	2.54
ICGS 21	19	21.1	2.35
ICGS 44	36	6.3	2.69
ICGS 76	62	12.0	2.77
JL 24	30	11.8	2.52
K 2	46	11.8	2.68
M 37	28	22.8	2.59
M 335	20	17.3	2.05
PG 1	48	19.1	2.50
R 141	51	16.2	2.55
Somnath	70	14.5	2.61
Tirupati	48	10.5	2.84
TG 19 A	27	7.6	2.62

Table 2. Effect of phosphorus solubilizing microbes on the nodulation and yield of groundnut.

Treatments	Nodule nos/plant plant	Plant dry wt. at 60 DAE	% Nitrogen in leaves	Soil P (ppm)	Pod yield (kg/ha)
Control	15	4.78	2.80	3.72	1386
RP 50	11	3.74	2.86	4.35	2106
SSP 50	16	4.57	2.97	4.55	2117
H5+RP 50	15	3.92	2.64	4.20	2042
H5+SSP 50	17	4.60	2.78	4.27	2402
PSF+RP 50	16	3.84	2.89	4.20	2085
PSF+SSP 50	11	4.36	2.89	4.07	1503

Table 3. Nodulation and yield of groundnut planted on flat and raised beds.

Treatments	Nodule Nos. Per plant at 60 DAE	Plant dry wt. (g/plant) at 60 DAE	% Nitrogen (kg/ha)	Pod yield
Flat bed	17.72	5.08	2.91	1484
Flat bed + Bradyrhizobium	15.72	5.39	2.84	1522
Raised bed	22.60	8.29	2.83	2244
Raised bed + *Bradyrhizobium*	25.92	7.73	2.80	2276

Publications :

(a) Research papers published:

1. Bandyopadhyay, A., Murthy, T.G.K. and Radhakrishnan, T. 1994. High frequency of somatic embryogenesis in groundnut. In: Proc. Fifth All India Conf. on Cytol. Genet., Kurukshetra, p.106.

2. Bandyopadhyay, A., Murthy, T.G.K., Radhakrishnan, T., Dobaria, J.R., Pandit, P.U. and Bhatt, D.R. 1995. High frequency in vitro regeneration through somatic embryogenesis in groundnut. Groundnut News 7(1) : 4-5.

3. Bhagat, N.R., Fondoun, J, and Mengesha, M.H. (1994). Joint Groundnut Germplasm Collection in Cameroon. Genetic Resources Progress Report 80, Genetic Resources Division, ICRISAT, Patancheru, 502 324, Andhra Pradesh, India pp 1-10

4. Bhagat, N.R., Rajgopal, K., Ghetia, N.R. and Bhalodia, P.K.(1995). Occurrence of variability in Virginia Bunch groundnut germplasm by country of origin. Groundnut News 7 (1): 2-3

5. Ghewande, M.P. (1995). Management of major foliar fungal diseases of groundnut (Arachis hypogaea L.) using aqueous leaf extract of neem (Azadiracta indica A.Juss.) In: Neem for the management of crop diseases, 1995 (Ed.V.Mariappan) Associated Publishing Co., New Delhi, India, pp. 37-42.

6. Ghosh, P. K. (1995) Scope of groundnut in North Eastern hill region of India. Groundnut News. 7 (1) : 4.

7. Ghosh, P.K. and Singh N.P. (1994). Soil-nitrogen status under summer legumes - maize (*Zea mays*) Sequence. Indian J. Agric. Sci. 64 (12) : 856 - 857.

8. Ghosh, P.K. and Singh N.P. (1994). Growth and development of maize as affected by preceding summer crops and nitrogen levels applied to maize. Annals of agric. Res. 16 (1) : 82 - 83.

9. Joshi, Y.C., Nautiyal, P.C. and V.Ravindra (1994). Screening for salinity in groundnut (Arachis hypogaea L) pp. 3 Ibid.

10. Joshi, Y.C., Nautiyal, P.C. and V. Ravindra (1994). Screening for cold tolerance and osmoconditionining to enhance germination of groundnut (Arachis hypogaea L) in sub- optimal temperatures. Tropical Science (In press).

11. Misra, J.B., Nautiyal, P.C., Ravindra, V. and Yadav, S.K. 1995. Photosynthesis and sucrose metabolism of groundnut leaves. Plant Physiol. Biochem. (India). In Press.

12. Misra, J.B. and Yadav, S.K. 1995. Bioenergetic considerations in increasing yield of groundnut. International Arachis Newsletter. In Press.

13. Nautiyal, P.C., Joshi, Y.C. and Ravindra, V. (1994). Response of groundnut (Arachis hypogaea L.) genotypes to salinity. Bio-Science Research Bulletin 910: 59-62.

14. Nautiyal, P.C., Joshi, Y.C. and Zala, P.V. (1994). Screening of spanish groundnut cultivars for germination under simulated drought stress. International Arachis News letter, pp. ICRISAT, Hyderabad.

15. Nautiyal , P. C. , Ravindra, V. and Bandyopadhyay, A. 1994. Peanut seed dormancy. Food Legume Newsletter. p2.

16. Nautiyal, P.C., Ravindra, V. and Bandyopadhyay, A. (1994). Peanut seed dormancy. Food Legumes News letter, pp 2, Australia.

17. Nautiyal, P.C., Ravindra, V and Joshi, Y.C. (1994). Gas exchange and leaf water relations in two peanut cultivars of different drought tolerance. Biologia Plantarum (In press).

18. Ravindra, V., Nautiyal, P.C. and Joshi, Y.C. (1994). Ontogenetic changes in growth and net photosynthetic rate of two peanut (Arachis hypogaea L.) cultivars. Biologia Plantarum (In press).

19. Singh, A.L., 1994. Screening of groundnut cultivars for tolerance to lime-induced iron-chlorosis. In Karan Singh and S.S.Purohit (Ed.) Plant Productivity Under Environmental Stress. Agro Botanical Publishers India, Bikaner India pp. 289-294.

20. Singh, A.L., 1994. Micronutrient nutrition and crop productivity in groundnut. In Karan Singh and S.S.Purohit (Ed.) Plant Productivity Under Environmental Stress. Agro Botanical Publishers India, Bikaner, India. pp. 67-72.

21. Yadav, S.K., Bandyopadhyay, A., and Misra, J.B. 1994. Quality traits of some advanced breeding lines and cultivars of groundnut (Arachis hypogaea L.). In Sustainability in Oilseeds. Papers and Proceedings of National Seminar on Oilseeds Research and Development in India: Status and Strategies, August 2-5, 1993, CRIDA, Hyderabad (India). pp 495-500.

22. Yadav, S.K., Singh, A.L., Mathur, R.S. and Misra, J.B. 1994. Effect of mid-day stress on chemical constituents of groundnut leaves. Groundnut News 6(2): p 7-8.

23. Yadav, S.K. and Misra, J.B. 1994. Evaluation of predictability of oil-content of groundnut kernels on the basis of their specific gravity. J. Oilseeds Res. 11: 222-228.

24. Yadav, S.K., Misra, J.B. and Mathur, R.S. 1995. Diurnal variations in carbohydrates, amino acids and phenolic contents of groundnut leaves. Groundnut News 7(1): p 8.

(b) Papers presented at Symposia/Meetings/Workshops

1. Desai, S. 1995. Biological control of Sclerotium rolfsii through Trichoderma sp. - A new Dimension. For late Prof. M.J.Narasimhan Academic Award at the 47th Annual Meet of IPs held at NDUA & T., Faizabad, January 18-20, 1995.

2. Desai, S. 1995. Biological control of Sclerotium rolfsii using Trichoderma sp. - Evaluation of carrier systems. At the Global conference on Advances in Research on Plant Diseases and their Management. RAU, Udaipur, Feb. 12-17, 1995.

3. Devidayal, Dongre, B. N., Naik, P. R. and Ghosh, P. K. 1995. Integrated approach of organic and synthetic mulching on the yield of Rabi - Summer groundnut. Paper presented in second agricultural science congress held at A.P.A.U., Hydreabad, India, January, 19-21,1995.

4. Ghewande, M.P. and Misra, J.B. 1994. Screening of groundnut genotypes for resistance to Aspergillus flavus seed colonization and less aflatoxin production. In VII Zonal Meeting (WZ), Indian Phytopathological Society, GAU, Anand 16-17 December, 1994.

5. Yadav, S.K., Radhakrishnan, T. and Misra, J.B. 1995. Role of sucrose synthase in metabolism of sucrose in callus of groundnut (Arachis hypogaea L.). National Symposium on the Role of Plant Biotechnology in Improving Agriculture - Challenges and Opportunities and Physiological and Biochemical Basis of Crop Yield. March 23-25, Jaipur (India). Abstract of papers p 3.

Participation in Meetings/ Conferences/ Symposia/ Workshops/Training (out side NRCG)

Dr.P.S Reddy Dr. P. K. Ghosh	Silver Jubilee Seminar of GEEDA, on 9 July, 1994 at Summer Sports Club, Jamnagar, Gujarat.
Dr. P. S. Reddy	ICAR Directors and Project Directors' meeting, New Delhi, September 22, 1994
Dr. P.S. Reddy Dr. M.S Basu	Group discussion on Strategy development for increasing groundnut production in Northern States, ARS, RAU,Durgapura,December 16-17, 1994.
	Seed review meetingof ICAR, New Delhi, December 28-29, 1994.
	ICAR - ICRISAT collaborative project meeting held at DRR, Hyderabad. January 23-24. 1995.
	Review meeting of Micro-mission under Technology Mission on Oilseeds, IIPR, Kanpur, January 4-5, 1995.
Dr. P.S. Reddy Dr. M.P. Ghewande Dr. M.S. Basu Dr.T.G.K. Murthy	Regional Committee Meeting No.VI of the ICAR, at GAU, Anand, January 30-31, 1995.
Dr. A. Bandyopadhyay	Research Advisory Council Meeting on the NARP funded project. July 21, 1994; March 9, 1995, IARI, New Delhi.
Dr. M.S. Basu	Meeting of International working group on groundnut viruses held in Khonkaen, Thailand, March 13-15, 1995.
Dr. M.S. Basu Dr. M.P. Ghewande Dr. P. Paria	A Meeting on Peanut Bud necrosis Disease, at ICRISAT Asia Centre, Patancheru, Hyderabad, March 20, 1995
Dr. M.P. Ghewande	ICAR Directors' Conference, New Delhi, November 7 8, 1994.

Dr. J.B. Misra	An Advanced Course on Agricultural Research Project Management at NAARM, Hyderabad April, 4-16, 1994.
Dr. T.G.K. Murthy	Fifth All India Conference on Cytology and Genetics, Kurukshetra,
Sh. T. Radhakrishnan	Research Advisory Council Meeting on the NARP funded project March 9, 1995, IARI, New Delhi.
Dr. S. Desai	Annual Meeting of Indian Phytopathological society, January 18-20, 1995 at NDUA&T, Faizabad.
	Global Conference on Advances in Research on Plant Diseases and their management, February 12-17, 1995 at RAU, Udaipur.
Dr. S.K. Yadav	National Symposium on the Role of Plant Biotechnology in Improving Agriculture - Challenges and Opportunities and Physiological and Biochemical Basis of Crop Yield, Jaipur, on March 23-25, 1995.
Sh. K. Chandran	A training on Ex-situ conservation of plant genetic resources at NBPGR, New Delhi, November 8-23, 1994.
Dr. M. S. Basu Dr. A. Bandyopadhyay Dr. P. Paria Dr. P. K. Joshi Dr. P. C. Nautiyal Dr. V. Nandagopal Dr. P. K. Ghosh	First Annual Rabi - Summer Groundnut Research Workers Group Meeting helt at IIT, Kharagpur, 12-14 Sept. 1994.

VISIT TO FOREIGN COUNTRIES

Dr. M.S. Basu	Meeting of International working group on groundnut viruses and diseases held in Thailand (organised by ICRISAT), March 13-15, 1995
Sh.Y.C. Joshi	To Australia under the ACIAR - ICAR - ICRISAT collaborative programme on water use effeciency (8-23.3.95)

INSTITUTE MEETING/ SEMINARS

MEETINGS

9 Feb. 1995	Departmental promotion committeee
21-24 April '94	First Annual Groundnut workers group meeting

SEMINARS

Dr.A.L Singh	Diagnosis of mineral chlorosis in plants, a biochemical approach, 17.9.94
Dr. S. Desai	The genomic manipulation of Trichoderma spp. for enhanced biocontrol activity. 21.10.94
Dr.Vijendra Singh	Breeding for biotic stresses in groundnut. 2.1.95

DISTINGUISHED VISITORS TO NARCG

15.5.1994	David Williams, U.S. Embassy, New Delhi.
10.1.1995	A fifteen-member European deligation on the behest of IOPEA, Bombay.

PERSONNEL

STAFF LIST - NRCG

Dr.P.S.Reddy	Director (till 04.02.95)
Dr.M.P.Ghewande	Director I/C (05.02.95 to 22.02.95)
Dr.M.S.Basu	Director (actg.) from 23.02.95

SCIENTIFIC

Dr.A.Bandyopadhyay	Principal Scientist
Dr.M.P.Ghewande	Sr.Scientist
Dr.N.R.Bhagat	—do—
Dr.A.Shome	—do—
Dr.P.Paria	—do—
Sh.Y.C.Joshi	Scientist (SG)
Dr.J.B.Misra	Sr.Scientist
Dr.P.K.Joshi	—do—
Sh.Devi Dayal	Scientist (SS) (on study leave)
Dr.P.C.Nautiyal	—do—
Dr.A.L.Singh	—do—
Dr.T.G.K.Murthy	—do—
Dr.V.Ravindra	—do—
Sh.T.Radhakrishnan	—do—
Sh .K.Rajgopal	—do—
Dr.S.Desai	—do—
Dr.Vijendra Singh	—do—

	Scientist
Dr. V.Nandagopal	—do—
Dr.S.K.Yadav	—do—
Dr.P.K.Ghosh	—do—
Dr.Ajay	—do—
Dr.R.K.Mathur	—do—
Sh. K.Chandran	

TECHNICAL

Dr.R.S.Tomar	Farm Supdt. (T-6)
Sh.N.Karthikeyan	Info.&Doc.Officer (T-6)
Sh.H.B.Lalwani	Tech.Officer (T-5)
Sh.V.K.Sojitra	—do—
Ku.S.M. Chauhan	—do—
Sh.V.G.Koradia	—do—
Sh.C.P.Singh	Farm Manager (T-4)
Sh.H.M.Hingrajia	—do—
Sh.D.M.Bhatt	Tech.Asstt. (T-4)
Sh.P.R.Naik	—do—
Sh.N.R.Ghetia	—do—
Sh.P.K.Bhalodia	—do—
Sh.P.V.Zala	—do— (on study leave)
Sh.B.M.Chikani	—do—
Smt.V.S.Chaudhari	—do—
Sh.Virendra Singh	—do—
Sh.M.A.Khan	—do—
Sh.R.S.Mathur	—do—
Sh.M.V.Gedia	—do—
Sh.H.K.Gor	—do—
Sh.B.N.Dongre	—do—
Sh.J.R.Dobaria	—do—

Sh.S.D.Savalia	—do—
Sh.D.R.Bhatt	—do— (T-II-3)
Ku.P.U.Pandit	—do—
Ku.T.T.Samarthia	—do—
Sh.A.D.Makwana	Field-cum-Lab.Asst. T-2
Sh.G.J.Solanki	—do—
Sh.Sugad Singh	—do—
Sh.H.V.Patel	—do—
Sh.Prabhu Dayal	—do—
Sh.R.D. Padvi	—do—
Sh.C.B. Patel	—do—
Sh.A.M.Vakharia	Artist-cum-Photographer
Sh.P.B.Garchar	Electrician
Sh.J.G.Kalaria	Tractor Driver T-2
Sh.K.H.Koradia	Driver T-2

ADMINISTRATIVE

Sh.Shyam Narayan	Admn.Officer
Sh.Devendra Kumar	Fin.& Accts.Officer
Sh.T.K.Sen Gupta	Office Supdt. (on deputation)
Sh.J.Ramani	Assistant (on deputation)
Sh.J.B.Bhatt	—do—
Sh.R.T.Thakar	—do—
Smt.Rosamma Joseph	Stenographer
Smt.S.Venugopalan	Sr. Clerk
Sh.A.D.Parmar	Jr. Clerk
Sh.C.G.Makwana	—do—
Sh.H.S.Mistry	—do—
Sh.R.D.Nagawadia	—do—
Sh.L.V.Tilwani	Jr. Stenographer
Smt.M.N.Vaghasia	Hindi Typist

AUXILIARY	
Sh.R.K.Singh	Security Supervisor
Sh.G.Mookherjee	Hindi Translator
Sh.B.M.Solanki	Tractor Driver
Sh.G.G.Bhalani	Driver
Sh.N.M.Safi	—do—
SUPPORTING	
Sh.N.M.Pandya	Field Asst.SSG.III
Sh.D.M.Sachania	—do—
Sh.R.B.Chawda	Chowkidar SSG.II
Sh.C.N.Jethwa	Safaiwala SSG.II
Sh.B.K.Bariya	—do—
Sh.R.V.Purohit	Chowkidar SSG.I
Sh.M.B.Sheikh	—do—
Sh.J.G.Agrawat	—do—
Sh.G.D.Moradia	—do—
Sh.V.N.Kodiatar	—do—
Sh.R.P.Sondarwa	—do—
Sh.D.K.Odedara	—do—
Sh.A.D.Makwana	—do—
Sh.P.N.Solanki	Dupli.Mach.Operator SSG.I
Sh.G.S.Mori	Lab.Cleaner SSG.I
Sh.K.T.Kapadia	Bullockman SSG.I
Sh.P.M.Solanki	Auto Cleaner SSG.I
Sh.N.G.Vadher	Messenger SSG.I
Ku.D.C.Sachania	—do—

b. All India Co-ordinated Research Project On Groundnut (AICRP-G'Nut)

Scientific

Dr.M.S.Basu	Project Co-ordinator (Groundnut)
Sh.A.L.Rathna Kumar	Scientist

TECHNICAL

Sh.D.L.Parmar	Tech. Asstt. (T-4)
Sh.Prem Narayan	—do—
Sh.Ranvir Singh	—do— (T-II-3)
Sh.V.K.Jain	Research Associate

ESTABLISHMENT

Ku.K.A.Vasani	Sr. Clerk
Sh.Y.S.Karia	Jr. Stenographer

SUPPORTING

Sh.V.M.Chavada	Messenger SSG.I

PROMOTIONS

Dr.S.Desai	Scientist(SS)	from 30.05.92
Dr.Vijendra Singh	—do—	13.04.93
Sh.T.Radhakrishnan	—do—	13.05.93
Sh.K.Rajgopal	—do—	03.07.94
Sh.D.L.Parmar,	T-5	01.07.94
Sh.Virendra Singh	T-4	—do—
Sh.M.A.Khan	—do—	—do—
Sh.R.S.Mathur	—do—	—do—
Sh.J.R.Dobaria	—do—	28.02.95
Sh.S.D.Savalia	—do—	05.03.95
Sh.J.G.Kalaria	T-1-3	01.07.93
Sh.K.H.Koradia	—do—	—do—
Sh.Prabhu Dayal	T-2	01.07.94

APPOINTMENTS

Dr. M.S.Basu as Project Coordinator (G) from 23.02.95

Sh. A.L.Rathna Kumar as Scientist (Gen.& Cytogen.) from 22.08.94

Sh. N.Karthikeyan as Information & Documentation Officer from 31.05.94

Sh.V.K.Jain as Research Associate from 17.01.95

TRANSFERS

Dr.P.S.Reddy, Director to DOR, Hyderabad, 04.02.95

Dr.P.K.Joshi, Sr.Scientist to CSSRI, Karnal

Mr.Devendra Kumar, F.A.O. to Delhi Institute of Technology, 19.12.94 (on deputation)

Sh.R.K.Singh, Security Supervisor to IGFRI, Jhansi, 30.11.94 (on selection)

Ms.P.U.Pundit, T II-3 to NRCMP, Boriavi, 20.03.95

Dr.A.Shome, Sr.Scientist from CRIJAF, Barrackpore, 18.11.94