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PREFACE

It gives me great pleasure in bringing out the annual report of the National Research Centre for Groundnut, for the year 1992 - 93. Since its establishment in 1979, the NRCG has come of age and now stands firmly as the premier centre for groundnut research in India.

During the year under report the centre concentrated efforts on containing the peanut stripe virus which has reportedly made its presence in the Saurashtra region. An exclusive laboratory with ELISA facility for detection of this virus was established at the centre. Seed stocks of the important breeding and germplasm lines were screened for the virus. Grow-out tests were conducted in specially erected poly houses and the infected plants, if any, were destroyed. Because of the apprehensions of spread of PStV, experimental crop was confined only to the poly houses besides planning several experiments on laboratory - oriented research. To safeguard the important genotypes from losing viability, seed samples of the same were stored at the NBPGR cold storage facility at New Delhi. The fact of existence of several collateral hosts for PStV has put on us the burden of exercising utmost care and constant monitoring to contain the virus.

This twelfth Annual Report contains the highlights of research and the developmental activities at the NRCG during the year 1992-93. I shall be grateful to receive suggestions, if any, that would help us to improve the quality and content of the future annual reports.

Junagadh
10 September 1993

(P.S. REDDY)
Director
National Research Centre for groundnut

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DIRECTOR'S STATEMENT

The National Research Centre for Groundnut was established at Junagadh in 1979 to undertake and coordinate basic, strategic and mission-oriented researches in groundnut.

The aims and objectives and the organizational set-up of the centre are as follows:

NRCG's Objectives

1. To collect, maintain, evaluate, document and utilize the primary, secondary and tertiary gene-pools of groundnut
2. To breed varieties for high yield, high oil content, earliness, fresh seed dormancy, high biological nitrogen fixing efficiency, high peg strength, toleance to drought and cold, resistance to major diseases and insect-pests, and bold-seeded varieties with resistance to seed colonization by *Aspergillus* spp. and with less load of aflatoxin.
3. To supply segregating material in early generation to groundnut researchers in different parts of the country.
4. To incorporate desirable genes from wild to cultivated species for genetic improvement of groundnut.
5. To study different groundnut-based farming systems
6. To investigate on mycotoxins with special reference to aflatoxins.
7. To conduct basic studies on economically important diseases and insect-pests, oil biogenesis, and inheritance ot different qualitative and quantitative traits.
8. To study fundamental and applied aspects of productivity, mineral nutrition, water and temperature stress, seed dormancy and seed viability.
9. To study nitrogen fixation in relation to *Rhizobium,* host and mycorrhizae
10. To produce breeder seed of certain released varieties.

Organizational set-up

The centre functions through nine scientific sections- Genetic Resources, Plant Breeding, Genetics and Cytogenetics, Agronomy, Plant Pathology, Entomology, Biochemistry, Plant Physiology and Microbiology. The four supporting sections are Library, Farm, Establishment and Finance and Accounts.

A brief account of the major accomplishments of the centre during the year 1992-93 is presented below:

Research Accomplishments

1. *Confectionery groundnuts :*

Four genotypes, NRCGs 530, 540, 1039 and 2646, having less than 45% oil and more than 23% seed protein and 11% sugars, were identified among the bold-seeded germplasm of the Centre.

2. *Aflatoxin resistant bold-seeded types :*

Seven bold-seeded genotypes, NRCGs 316, 7211, 8955, 8970, 8972, 8973 and 8974, possessing resistance to seed colonization by *Aspergillus flavus,* were identified.

3. *Collar rot resistant types :*

Two advanced derivatives, one each in crosses, Robut 33-1 x EC 76446(292) and JL 24 x NCAc 17090, were identified as having resistance to collar rot pathogen, *A. niger.*

4. *Sources of resistance to insect-pests :*

Laboratory screening of 15 promising breeding lines and released varieties against the insect-pests, *Spodoptera* and *Helicoverpa* revealed that the variety BG 2 is a reliable source of resistance to both the pests whereas two varieties, Kadiri 3 and Girnar 1, and three breeding lines, IR 29, NRGS 9 and PBS 105 are useful as donors of resistance to *Spodoptera.*

5. *Transmission of peanut stripe virus (PStV):*

In sap inoculation studies it was found that the average seed transmission rates of the PStV were 10.4% and 12% respectively when the plants were inoculated at flowering stage and pod filling stage.

The PStV transmission efficiency of the aphid species, *Aphis craccivora* was found to be around 14% in laboratory studies.

6. *Developing suitable schedules for controlling aphids :*

A mixture of 0.02% phosphomidon + 0.04% endosulfan + 2% crude neem oil was found to be effective in controlling aphids, the vectors of the PStV.

7. *Possible collateral hosts for PStV :*

Using the enzyme linked immunosorbant assay (ELISA) technique, it was found that four cultivated legumes(pigeon pea, kidney bean, cow pea and gram) and five non-cultivated legumes *(Cassia siamea, Samanea saman, Prosopis juliflora, Parkinsonia aculeata* and *Clitoria ternatea)* serve as carriers of the virus. Besides these, seven other weed species were also identified as carriers.

8. *Elimination of PStV through meristem culture :*

In vitro shoot tip meristem culture

method was successfully employed to eliminate PStV from four interspecific F1 hybrids, viz. cv J 11 x *A. villosa*, cv J 11 x *A. otavioi*, cv J 11 x *A.* sp. KSSc 36025-1 and cv J 11 x*A.* sp. 30085.

9. Developing high oil types :

Three advanced interspecific derivatives of cross cv GG 2 x *A. chacoense* were found to contain more than 54% seed oil.

10. Relationship between oil content and specific gravity of groundnut kernels:

The biochemists at NRCG have discovered a high negaitive correlation between oil content and the specific gravity of split kernels of groundnut genotypes. The principle has a potential of being developed into a simple method of oil estimation.

11. Biochemical basis of disease resistance :

The resistance of groundnut plant to early leaf spot was found to be associated with high phenol content of leaves.

12. Genotypes with prolonged seed viability :

The Rabi-summer produce of the following germplasm lines was found to retain seed viability, when stored in ambient conditions: ICGs 3749, 3780, 4630, 4652, 4709, 4839 and 4849; NRCGs 8415 8433 and 8733

13. Iron-efficient genotypes :

After repeated screening, NRCG has identified ten realeased varieties, ten advanced derivatives of intra- and interspecific crosses and two germplasm lines, as having tolerance to chlorosis resulting from iron deficiency.

The peroxidase activity in roots was found to be a reliable parameter for identifying iron-efficient genotypes of groundnut.

14. Moisture-stress tolerant genotypes :

Two released varieties (Girnar 1 and GG 2) and seven advanced breeding lines (PBS nos. 2,8,15,19 and 27; NRGD(E)2 and NDT 10) were identified as resistant to moisture stress both in Rabi-summer and Kharif seasons.

15. Heat tolerant genotypes :

Three germplasm lines (NRCGs 1116, 7140 and 7141), five advanced breeding lines (PBS nos. 2,15,19 and 27; NDT 10) and two released varieties, GG 2 and Girnar 1 were found to be resistant to heat during pod filling stage.

16. Physical basis for seed dormancy :

In-vitro culture of (i) whole seed (with and without testa) and (ii) the embryonic axes of seed, at four maturity stages,indicated dominant role of testa, followed by cotyledons, on dormancy.

17. Genetic basis for seed dormancy :

Segregation of dormant and nondormant progeny in F3 and F4 in different dormant x nondormant crosses indicated quantitative genetic nature of seed dormancy, with confounding effects of maturity.

18. Induction of autotetraploidy :

For the first time, autotetraploidy was induced in two diploid wild species, *A. otavioi* and *A.* sp. 'GK 30008, to facilitate gene transfer to cultivated groundnut.

19. In-vitro rapid multiplication :

A method for in vitro multiple shoot generation from groundnut seed explants was standardized.

20. Studies on mulching :

Wheat straw mulch was found to increase both pod and fodder yield by enhancing seed germination, crop growth and availability of optimal quantities of nutrients and soil moisture to the groundnut plant.

Developmental activities

1. An exclusive laboratory for carrying out enzyme linked immunosorbant assays for detection of groundnut viruses was established.
2. Four staff quarters of type I were constructed by the CPWD.
3. The construction work of the NRCG farm structures was initiated.
4. Five garages were constructed for parking of vehicles.
5. Six poly houses were constructed for conducting grow-out tests and detect PStV-infected genetic stocks.
6. The equipments procured by the centre during the year include one high performance liquid chromatography system, two high precision electronic analytical balances, one tissue homogeniser, a seed germinator, a BOD incubator, an uninterrupted power supply system, one orbital shaker-incubator and a high output water distillation system.

GENETIC RESOURCES

A. Management of national resources of cultivated groundnuts in totality at NRCG, Junagadh (N.R. Bhagat and K. Rajgopal)

1. Collection of germplasm :

Fifty three special-feature accessions (31 drought and temperature tolerant, 2 salt tolerant and 20 iron-efficient), identified by the Plant Physiology Section, NRCG, were collected from the ICRISAT, Patancheru for further use.

2. Exploration :

The joint NPBGR/NRCG exploration was organized in Dandakaranya region for the collection of indigenous land races of cultivated groundnut. During this exploration, four districts in Bihar (Rachi, Singhbhum, Lohardaga and Gumla), four districts in Madhya Pradesh (Raigarh, Ambikapur, Bilaspur and Raipur) and three districts in Orissa (Sambalpur, Sundergarh and Rourkela) were surveyed from October 27 to November 6, 1992 and thirty variable land races belonging to Spanish (VUL), Valencia (FST), Virginia Bunch (HYB) and Virginia Runner (HYR) habit forms were collected, mainly from farmers fields and market yards. The groundnuts in these areas showed variation for seed colour and shape, pod shape and size, stem pigmentation, and agronomic characters like number of pods, seeds per pod . A duplicate set of this collection was conserved as a base collection at the NBPGR Gene Bank, New Delhi.

3. Maintenance and multiplication of germplasm :

Regeneration of the germplasm was done in polyhouse as two separate sets (70 HYR and 186 VUL in first set and 158 HYR and 86 FST in the second). The PStV-free nature of the germplasm was confirmed by both visual observation and ELISA test of leaf/seed samples.

4. Evaluation of germplasm :

a. Seed viability in conserved germplasm :

The germplasm conserved in December 1990 under ambient storage conditions (18 to 40oC, 25-99% RH) in water-proof seed envelopes was screened for germination after 24 months of storage. Random samples of 741 HYR and 361 VUL accessions were scored for germination and normal and abnormal seedlings. The results are presented in Table 1.

The germination percentage ranged from zero to 100% in both the collections. The germination was satisfactory (70-95%), as defined by ISTA, in 355 HYR and 267 VUL accessions. The germination was low to moderate in 386 HYR and 94 VUL accessions.

Table 1. Frequency of distribution of HYR and VUL resources scored for germination and normal seedlings after two years of storage.

Range	HYR		VUL	
	Germination (%)	Normal seedlings (%)	Germination (%)	Normal seedlings (%)
0-10.0	23 (3.1)	93 (12.6)	0	25 (6.9)
10.1-20.0	36 (4.9)	82 (11.0)	6 (1.7)	38 (10.6)
20.1-30.0	40 (5.4)	71 (9.6)	12 (3.4)	30 (8.3)
30.1-40.0	45 (6.1)	109 (14.7)	17 (4.7)	33 (9.1)
40.1-50.0	70 (9.4)	99 (13.6)	18 (4.9)	45 (12.5)
50.1-60.0	67 (9.0)	92 (12.4)	17 (4.7)	48 (13.3)
60.1-70.0	105 (14.1)	74 (10.0)	24 (6.6)	69 (19.1)
70.1-80.0	115 (15.5)	72 (9.7)	41 (11.3)	42 (11.7)
80.1-90.0	149 (20.1)	41 (5.5)	85 (23.6)	25 (6.9)
90.1-100.0	91 (12.4)	8 (1.0)	141 (39.1)	6 (1.6)

The percentage of normal seedling was 70 to 100 in 121 (17%) HYR and 73 (12%) VUL accessions. Out of the 1002 accessions studied, only 16 HYR and 8 VUL accessions exhibited good seed germination with normal seedling.

b. Screening germplasm for peanut stripe virus (PStV) :

It was proposed to screen the conserved germplasm for the presence/absence of PStV by ELISA technique. All the random seed samples of 65 HYB, 80 HYR and 23 FST accessions screened were found to be free from the virus.

c. Agronomic evaluation of germplasm :

Three hundred accessions, culled out at random from the genetic resources and representing all the four habit forms introduced from 37 countries, were field-planted by adopting an augmented block design and screened for seven economically important characters. The mean and range values are presented in Table 2. Severe drought conditions affected the overall performance of the accessions.

A wide variability for flowering dates existed in HYB and HYR collections, as anticipated. The earliest lines flowered in 23 days and the latest in 37 days. A similar trend was evident in days to maturity.

Table 3. Simple correlation coefficents(r) among twelve characters of virginia bunch germplasm.

Trait	PHT	PBP	PYD	PPP	PWP	HSW	SHP	SMK	OSP	TSP	PPL
DTM	0.025	-0.004	0.017	-0.015	0.001	-0.090*	-0.106*	-0.80*	-0.034	-0.126**	-0.048
PHT	-	0.051	0.054	-0.087*	0.028	0.198**	-0.015	0.014	-0.107*	0.116**	0.060
PB	-	-	0.153**	-0.068-	0.060	-0.085*	0.051	0.095*	-0.100*	0.043	-0.029
PYD	-	-	-	0.0508**	0.723**	0.258**	0.352**	0.164**	-0.222**	0.112**	-0.001
PPP	-	-	-	-	0.720**	0.121**	0.195**	0.054	-0.062	0.048	-0.117**
PWP	-	-	-	-	-	0.337**	0.279**	0.139**	-0.094	0.065	0.060
HSW	-	-	-	-	-	-	0.237**	0.130**	0.098**	0.079*	0.218**
SHP	-	-	-	-	-	-	-	0.272**	-0.263**	0.193**	0.002
SMK	-	-	-	-	-	-	-	-	-0.042	0.063	0.065
OSP	-	-	-	-	-	-	-	-	-	0.676**	0.052
TSP	-	-	-	-	-	-	-	-	-	-	0.004

* = P 0.05 ; ** = P 0.01

d. Evaluation results of virginia bunch groundnut germplasm :

Data on nine economically important characters of 653 Virginia bunch accessions, evaluated during the rainy seasons of 1985, 1986, 1988 and 1989 were used to calculate mean and standard deviation values. Climatic conditions varied considerably among and between years, provoking different plant responses for these quantitative characters. However, standard deviation values are expected to give an indication of stability across years. In the following paragraphs, salient findings are presented.

I. RANGE OF VARIABILITY

i. Percentage of pod bearing plants :

The mean and standard deviation values ranged, respectively, from 71.0 to 98.9% and 0.9 to 33.9 with general means of 91.5% and 8.6%. Percentage of pod bearing plants in 527 accessions was good with low standard deviation, as was evident from the two-way distribution of 653 accessions. Accessions with 71-76% pod bearing plants were NRCGs, 1008 (USA), 1873 (IND), 4809 (USA) and 4952 (USA).

ii. Pod yield :

There was a high variation for mean and standard deviation values of pod yield (g/m2). Pod yield was poor in 303 accessions, moderate in 272 and good in only 78 accessions.

The pod yields of 101 to 149 g/m2 were recorded in 78 accessions with high (31.0-125.4) standard deviation values. Seven accessions registering pod yield of 129-149 g/m2 came from Sudan, USA, Brazil, Tanzania and India. The germplasm accessions, R 7-1-1 (SDN), Florispan Runner (USA), S 7-1-5 (BRA), S 7-2-19(TZA) and 2592 appeared promising for further use.

iii. Number of mature pods/plant :

The pod number in different accessions ranged from 2.5 to 17.2 per plant. As many as 635 accessions gave poor (2.5) to moderate (12.9) number of pods/plant. Only 18 accessions registered good bearing; among these, five accessions introduced from USA, Senegal and Sudan were comparable with the released variety G 201 (Kaushal). The promising accessions were - NRCGs 583 (Florispan), 593 (Florispan Runner), 1929 (S 7-1-18), 1932 (U 4-7-13) and 4202 (2685).

iv. Pod yield per plant :

The collection showed wide variation for mean and standard deviation values. The mean pod mass and standard deviation values for the collection were 7.8 g and 5.9 g, respectively. Only two exotic accessions (NRCGs 583, 593) gave good pod number (16.5) and mass (15.5 g). Besides, NRCGs 860 (NCAc 38), 5190 (NCAc 2242) and 7288 (MA 10) also appeared promising.

v. 100-seed mass :

Though the collection showed variability for 100-seed mass (g), as many as 536 accessions recorded seed mass of 24 to 45 g/100 seeds. Among these, 479 accessions exhibited low standard deviation of 0.4 to 16.4, thus showing fairly consistent characteristic. Accessions with 100-seed mass of 24-27 g and 3.5-6.8 standard deviation were -NRCGs 1045 (NCAc 17603), 1475 (Makanga Spanish), 2979 (Ah 334-1), 4499 (NCAc 17668) and 4768 (NCAc 16922). Similarly, medium bold-seeded accessions with seed mass of 54-57 g with a standard deviation of 7.0-22.0 were- NRCGs 547 (S 7-1-6), 655 (West Nile), 2713 (S 7-1-5), 2745 (U 4-7-13) and 6453 (RPM 044).

vi. Shelling percentage :

The mean shelling outturn varied from 44.7% to 74.5% with standard deviation values of 0.3 to 23.0. Seed outturn, however, was not encouraging in 146 accessions, whereas moderate shelling was realized in 501 accessions. The accessions, NRCGs 593 (Florispan Runner), 1913 (R 7-1-1), 7362 (B 138), 7410 (S 7-2-18), 7451 (EC 21288) and 7499 (G.K. 19) gave good shelling outturn of 70-75% with low standard deviation values (2.7-8.3).

vii. Sound mature seed percentagae :

This character exhibited wide variation with respect to mean (66.2-95.5%) and standard deviation (0.6-25.3). The general mean and standard deviation for the collection were 82.8% and 9.3 respectively. Accessions with good seed recovery with low standard deviation values were only 51; of which only five accessions, namely, NRCGs 710 (NCAc 1312), 1049 (NCAc 17749), 1185 (NCAc 1248), 1473 (S.Am.Coll. 66) and 2713 (S 7-1-5) gave good recovery of 93 to 96% with low standard deviation (4.8-5.9).

viii. Percentage of pods with 1,2,3 seeds :

Although the occurrence of one and two-seeded pods was most common, three-seeded pods were found in 173 acessions. Inter- plant variation for this trait was high. Seventy nine accessions recorded high percentage of single-seeded pods. Similarly, higher percentage of two-seeded pods was observed in 227 accesions and only 43 recorded good seed set of three-seeded pods. The list of promising accessions is given below.

Accessions with 52-71% single-seeded pods:

NRCGs 2047(India), 4429, 4757 (Nigeria), 4770(USA) and 4809(USA)

Accessions with 87-92% two-seeded pods:

NRCGs 616(Uganda), 976(USA), 1019(Bolivia), 4768,4977(Zimbabwe)

Accessions with 28-38% three-seeded pods:

NRCGs 5529, 5758(USA), 6546, 7148(IND), 7362

ix. Pod loss (%) (weight basis) :

Besides the tensile strength of gynophore, the indeterminate nature of the flowering, various environmental factors and the maturation differences between varieties influence pod loss at harvest. In order to know the varietal differences in pod loss, the resources were examined every year at harvest and the frequency distribution of the mean and standard deviation for pod loss are presented below.

Mean pod Loss	Standard deviation					Total
	1.1-7.9	8.0-14.9	15.0-21.9	22.0-28.9	29.0-33.0	
3.3-11.4	107	34	2	-	-	143
11.5-19.9	138	153	29	2	-	322
20.0-28.4	22	64	52	10	-	148
28.5-36.9	2	13	13	5	-	33
37.0-44.6	1	1	4	-	1	7
Total	270	265	100	17	1	653

As many as 465 accessions showed pod loss of 3 to 20%, whereas five accessions (NRCGs 616, 748, 3124, 4797, 7668) showed average pod loss of 4% with low standard deviation(4.3) and 40 accessions showed high loss. Some of the accessions with high pod loss (37-45%) were- NRCGs 482 (VRR 318), 1949 (Florispan), 2603(Ah 330), 2740 (S 7-24-6), 5373 (NCAc 17027), 5774 (6697) and 5994 (Ah 3).

The detailed information on the frequency distribution of accessions for all the traits can be obtained from the NRCGs catalogue entitled Virginia Bunch Groundnut Germplasm Evaluation Catalogue.

II. DISTRIBUTION OF CHARACTERS BY COUNTRY OF ORIGIN

Range and means were calculated for ten agronomic characters in 520 virginia bunch accessions, collected from the following countries:

Argentina (10 accessions), Brazil (9), China (11), India (128), Malawi (9), Nigeria (44), Sudan (19), Senegal (11), Tanzania (18), Uganda (9), USA (232) and Zimbabwe (20). A thorough perusal of the data showed no stratified occurrence of characters. Accessions of only certain countries, where introgression has not taken place, appeared genetically distinct for certain specific traits. A brief account on these is presented below :

i. Brazil appeared to be a good source for accessions with high pod number and weight, 100-seed mass and shelling outturn. Majority of these accessions were derivatives of S 7-1-5 and, appeared stable across years.

ii. Accessions from China had tall plant

height but produced less number of pods with high percentage of one-seeded pods. This material was least influenced by climate and gave fairly consistent performance.

iii. Malawian material, in general, was unadapted to Junagadh conditions and produced fewer pods with poor shelling. The percentage of pod bearing plants was also low.

iv. Majority of the indigenous accessions appeared productive (number and mass of pods) with good 100-seed mass, shelling and sound mature seed percentage.

III. ANALYSIS OF CORRELATION

The mean values of twelve continously varying characters were used in calculation of simple correlation coefficients (Table 3). The correlation matrix designed on the basis of these correlations is expected to be useful in answering certain relevant complex queries from the data base developed by the NRCG Genetic Resources Section. The analysis revealed that more than 50% of the values were statistically significant as population size was large (653). Therefore, in order to identify correlations with relatively higher magnitude, three groups of characters were considered, having strong correlation ($r = >0.3$), moderate correlation ($r = 0.2$ to 0.3) and weak correlation ($r = <0.2$). Some of the important observations which may be useful to the breeders are given below.

i. Days to maturity (DTM), height of main axis (PHT) and percentage of pod bearing plants (PBP) showed no strong correlation among themselves or with other nine characters, although the correlations, in general, were with positive or negative signs. An increase in PBP would contribute in increased pod yield per unit area.

ii. Estimated pod yield (g/m2) (PYD) had strong positive correlation with number of mature pods/plant (PPP), pod mass/plant (g) (PWP), 100-seed mass (g) (HSW) and shelling percentage (SHP). These characters were also intercorrelated among themselves.

iii. The correlation of sound mature seed percentage (SMK) was moderately positive with shelling percentage.

iv. Two-seeded pods (TSP) exhibited significant positive relationship with PHT, SHP, PYD and HSW.

v. Pod loss (%) (PPL) showed moderately positive association only with 100-seed mass and seems to have no association with other characters.

Sub-project: Evaluation of bold-seeded groundnut germplasm for desirable agronomic traits and confectionery characteristics

(K. Rajgopal, M. P. Ghewande and N.R.Bhagat)

1. Biochemical analysis :

To identify the bold-seeded accessions with desirable confectionery properties, seeds were analysed for contents of protein, oil and sugar and the results are described in the following paragraphs.

Table 2. Mean (M) and range (R) in collections of four botanical forms (Acc.) and respective checks (C) for seven characters.

Trait	FST		VUL		HYB		HYR	
	Acc.	C	Acc.	C	Acc.	C	Acc.	C
Days to 50% flowering	M 24.7 R 23-28	24.8 24-28	25.3 22-28	28.1 27-30	29.3 24-37	25.4 23-37	28.6 24-35	27.2 26-28
Days to maturity	M 105.9 R 103-110	105.1 100-108	105.6 100-124	121.6 106-126	129.2 117-138	106.5 103-112	130.2 124-138	127.1 118-136
Pod number	M 2.7 R 0.5-5.6	2.9 1.4-4.6	4.0 0.3-7.6	5.2 2.3-7.2	3.0 0.3-9.0	4.7 2.0-8.1	3.7 10.6-7.3	5.2 2.8-6.4
Pod mass (g)	M 2.3 R 0.3-5.6	3.0 1.0-5.1	2.3 0.1-6.0	4.3 2.4-6.2	2.4 0.4-6.2	3.4 2.3-5.3	2.9 0.4-6.2	4.9 2.9-6.4
100-seed mass (g)	M 31.1 R 15-41	33.2 22-41	29.2 17-42	43.8 36-55	36.6 20-60	35.9 32-41	36.2 20-58	43.7 37-53
Shelling (%)	M 58.5 R 37-69	63.2 52-69	59.8 37-75	65.4 56-71	58.5 38-66	66.1 53-73	60.1 39-72	62.1 55-73
Haulm yield (g/m^2)	M 144.4 R 38-233	158.4 93-283	117.6 50-200	109.3 83-133	185.3 40-326	68.2 33-133	177.5 50-326	142.0 67-127

The protein content (%) in 44 accessions ranged from 17.7 to 25.6 with a general mean of 22.6 (Table 4). Similarly, the mean values for oil and sugar contents were 45.7% and 10.8%, exhibiting a wide range (38.8-52.4% and 5.2-15.9%) for both the traits, respectively. The collection showed significant differences among varieties for all the three attributes. Ten genotypes with low oil (less than 45.0%) and high protein (over 20%) and sugar (10.0%) contents were identified. The genotypes with better yield and yield related traits coupled with desirable confectionery qualities were : NRCGs 2863, 5505, 8939 and 8941.

The crude protein content in 198 accessions(VUL-19;HYB-95;HYR-84), estimated using auto nitrogen analyser, was in the range of 15.8-16.9% with a mean values of 22.6%, 22.3% and 21.9% in spanish, virginia bunch and virginia runner collections, respectively (Table 5). The genotypes, NRCGs 749, 1118, 1171 and 2794, revealed more than 26% protein content in the seeds.

The oil content (%) estimated with Soxhlet method in 112 bold-seeded genotypes(HYB-55; HYR-57), also showed wide variation with a mean value of 45.3%. The virginia bunch collection had 46.1% oil against 45.3% in Virginia runner. The genotypes with less than 42.0% oil content were NRCGs 733, 3111, 7676, 8946, 8954, 8963 and 8970.

The anthrone reagent method was used to estimate total sugar content in the seeds of 90 genotypes(HYB-44; HYR-46). It showed a wide range in both virginia bunch (4.6-18.1%) and virginia runner (3.8-16.2%). The NRCGs 723, 3026, 7676, 8656, 8954 contained more than 14% sugar.

Of the genotypes analysed for the three biochemical attributes, seeds of the accessions, NRCGs 530, 540, 1039 and 2646 had less than 45.0% oil content and more than 23.0% protein and 11.0% sugar contents.

Table 4. Variation for three biochemical constituents in 44 promising bold- seeded genotypes

Trait	Mean	Range	MSS	CD(5%)	CV
Protein content	22.6	17.7-25.6	9.38**	2.41	6.7
Oil content	45.7	38.8-52.4	19.05**	2.65	3.5
Total sugars	10.8	5.2-15.9	16.70**	3.15	17.5

**significant at 1 %

Table 5. Variation in protein, oil and sugar contents in some bold-seeded germplasm accessons.

Habit	Variable	Content (%) of		
		Protein	Oil	Sugar
VUL	M	22.6	-	-
	R	16.9-26.3	-	-
	SD	2.38	-	-
HYB	M	22.3	46.1	9.9
	R	15.8-26.9	41.6-52.0	4.6-18.1
	SD	1.80	2.30	2.80
HYR	M	21.9	45.3	10.1
	R	16.5-26.7	39.7-49.9	3.8-16.2
	SD	1.91	2.38	2.64

M = mean, R = range, SD = standard deviation
Number of accessions tested : protein - 198, oil - 112, sugar - 90

2. Screening of bold-seeded genotypes for resistance to A.flavus colonization:

Ninety seven bold-seeded genotypes were screened for resistance to *A.flavus* under artificially inoculated conditions. Five genotypes, NRCGs 316, 7211, 8970, 8973, 8974 were found to be resistant while three genotypes, NRCGs 878,8968 and 8972 were moderately resistant.

PLANT BREEDING

A. Breeding and genetic studies for Improving yield and other quantitative and qualitative attributes in groundnut.

1.Experiment on photosynthesis:
(V. Ravindra, P. C. Nautiyal and A. Bandyopadhyay)

A pilot experiment was conducted during summer 1992 to assess the feasibility of studying the inheritance pattern of photosynthetic rates. The F3 generation segregants of the crosses J 11(spanish) x M 13(virginia runner) and M 13 x J 11 were grown (date of sowing was 5.2.92) in 5 m rows , along with the parents, cultivars M 13 and J 11. Row-to-row and plant-to-plant distances were 60 cm and 15 cm respectively. The plants were always kept well irrigated. Observations on apparent photosysnthetic rate(APR) was taken on 26.4.92 (pegging and pod formation stage) and 2.5.92 (pod filling stage). The time of observation was between 9 a.m. to 10 a.m. which was found to give the peak photosynthetic rate in detailed studies on released varieties. Observations on three plants of each parent and eleven healthy F_3 plants from the cross J 11 x M 13 and 29 from M 13 x J 11)were taken. Apparent photosynthetic rate ($\mu M\ cm^{-2}\ s^{-1}$) of two newly opened leaflets of each plant was measured by LICOR 6200 Portable Photosynthesis System. Total dry matter of each plant on which observations were taken earlier was measured at harvest. The major points of results were the following:

a. Even with the sophisticated instrument and a small number of segregants it was very difficult to take observation on more than one leaf on each plant because even the time lag of one hour caused difference in APR. The two readings on the same leaflet gave some times very high differences. For example, in M 13 on 26.4.92 the reading on a plant were 11.77 and 17.27.

b. The range of APR values for the segregants (on both dates) fell outside the parental ranges (Table 1). The values of the segregants (from both the reciprocal and direct cross) were continuous over the range even though the number of segeregants was low. These possibly give the hint of the quantitative nature of inheritance of photosysntesis.

c. The coefficients of correlation (all segregants and parental values considered together) between the APR values of 26.4.92 and 2.592 (-0.04872),APR on 26.4.92 and total dry matter(-0.1362) and between APR on 2.5.92 and total dry matter were non- significant. In other words, classification of genotypes on the degree of their photosnthetic capability may be difficult at least, in the segregating material because the relative rates may vary stage to stage and even day to day. However, the

Table 1. The apparent photosynthetic rates of two groundnut genotypes and their reciprocal crosses

Genotype/cross	Date of observation			
	26.4.92		2.5.92	
	Range	Mean	Range	Mean
J 11	9.06-11.61	9.97	9.84-12.57	11.20
M 13	10.53-14.79	13.29	10.30-12.20	11.17
J 11 x M 13	0.72-11.86	7.18	7.52-22.10	11.08
M 13 x J 11	4.24-17.01	9.26	4.00-19.51	10.18

relationship between APR and TDM may become more apparent if the measurement of photosynthesis was made on the whole-plants and integrated over the whole growing period.

2. Experiments on seed dormancy:

(A. Bandyopadhyay, P. C. Nautiyal and V. Ravindra)

Two experiments on dormancy of groundnut were conducted in the summer 1992. The experiments were: i) to determine the role of the components of groundnut seed in dormancy and ii) to study the distribution pattern of dormancy in the F_3 generation of groundnut.

In the first study two spanish (non-dormant),two virginia runner and nine virginia bunch (more or less dormant) type cultivars were involved. Seeds from each sampled plant (harvested at four stages of maturity) were tested for germination with and without testa and the excised embryonic axes were tested for germination in MS culture medium. Testa appeared to have the dominant role in dormancy of groundnut followed by cotyledons. The details of this experiment will be found in the report of the Plant Physiology Section.

For the second study the F_3 segregants of the crosses M 13 x J 11 (14 plants), J 11 x BAU 12 (18 plants), and BAU 12 x J 11 (10 plants) were grown along with their parents in summmer 1992. J 11 is a spanish type cultivar with no dormancy, M 13 and BAU 12 are virginia type cultivars with dormancy. The number of plants were small because plants showing PStV symptoms were regularly rogued out. The plants were harvested 115 days after sowing. The number of mature pods(showing blackening of the inside of the shell) and immature pods from each plant were counted. Then, one half of the seeds (from all pods together)were put for germination in incubator directly and the other half was put for germination after removing the testa. Germination was observed after five days.

Despite the limitation in the number of segregating plants the range of germination percentage for the

segregants transgressed the ranges of the parents (Table 2). Moreover, the coefficients of variation of the segregants were much higher than those of the parents. The means of the three segregating crosses were much lower than the parent with dormancy. Though the number of segregants was not sufficient to form a good idea about the distribution, at least in M 13 x J 11 no large gaps in the distribution was found to make qualitative classification possible. However, the frequency distribution in all the three crosses was skewed towards the lower side. In M 13 x J 11 the frequency of plants in the 0 to 10% germination range was the highest(18/41), while in J 11 x BAU 12 it was 8/18 and in BAU 12 x J 11 it was 3/10 (Table 3). Hence dormancy in this study appeared to be of a quantitative nature but an indication of dominance of dormancy over non-dormancy was there from the mean and skewness of distribution. However, previous studies including the first experiment mentioned above have brought out the possibility of the confounding effect of degree of maturity on dormancy. In the present eperiment the correlations between percentage mature pods and germination percentge were non-significant. A possible reasons for this were the known fact that physiological maturity of seed and that of pods(as determined in this experiment) are not always concurrent and that germination in this study was observed in the seeds from mature and immature pods together.

The correlation between germination percentage of seeds with and without coat were significant for the crosses M 13 x J 11 (0.52) and J 11 x BAU 12(0.49). Although the valuue for BAU 12 x J11 was 0.60, it was not significant because of the low degree of freedom.. Thus, the cotyledons do have some role in determination of dormancy, as found in the first experiment also.

Table 2. Mean, range and coefficient of variation of germination percentage in parents and F3 generation of crosses

Material	N	Mean	Range	CV(%)
J 11	19	53.27	10.5-100.0	50
M 13	13	01.50	00.0-020.0	*
BAU 12	8	01.79	00.0-014.3	*
M 13 x J 11	41	26.74	00.0-100.0	127
J 11 x BAU 12	18	17.93	00.0-071.4	126
BAU 12 x J 11	10	27.17	00.0-100.0	100

N = number of plants; * = only one non-zero value; CV = coefficient of variation

Table 3. Frequency distribution of germination percentage in three crosses in F_3

Class	Frequency in cross		
	M 13 x J 11	J 11 x BAU 12	BAU 12 x J 11
0- 10	18	9	3
>10- 20	6	4	2
>20- 30	5	0	1
>30- 40	3	1	3
>40- 50	0	3	-
>50- 60	0	0	-
>60- 70	2	1	-
>70- 80	2	0	-
>80- 90	1	0	-
>90-100	4	0	1
	41	18	10

B. Breeding for resistance to biotic and abiotic stresses

(V. Singh, A. Bandyopadhyay, M.P.Ghewande, Y.C.Joshi and V. Nandagopal)

1.Screening of groundnut genotypes against *Helicoverpa* and *Spodoptera:* Fifteen groundnut genotypes (eleven breeding lines,three cultivars and one germplasm line) were screened against *Helicoverpa armigera* (Hub.) (third instar) and *Spodoptera litura* (F.) (first, third and fifth instars) in Kharif 1992 in the laboratory under choice test by putting the genotypes in pairs in all possible combinations(105). Two leaflets of similar maturity of each genotype were allowed for feeding for 24 hours for each instar. Leaf area eaten was recorded (in cm^2). The genotypes were categorised based on the mean(over all 15 combinations) of percentage of leaf area eaten for third and fifth instars, and on zero to nine scale for first instar of *Spodoptera.* The pooled(over genotypes) mean and variance of leaf area eaten by *Helicoverpa* was significantly higher than *Spodoptera* (first, third and fifth instars) indicating that *Helicoverpa* was a more damaging pest. Third and fifth instars of *Spodoptera* were equal in causing foliage damage and caused significantly higher foliage damage than the first instar. Nitrogen and potassium content of leaves showed no relationship with the foliage damage by Helicoverpa and Spodoptera.The cv. BG 2 and breeding line IR 17 were moderately resistant to *Helicoverpa* and *Spodoptera* (third instars) and highly resistant to first instar of *Spodoptera*(Table 4). BG 2 had also less foliage damage than IR 17 due to fifth instar of *Spodoptera*, and hence, may be a good donor parent for resistance to both

Helicoverpa and *Spodoptera*. Kadiri 3,Girnar 1, IR 29, NRGS 9 and PBS 105 may be good donor parents for *Spodoptera*, since all these genotypes were moderately resistant to third and fifth instars of *Spodoptera* and highly

Table 4. Reaction of groundnut genotypes to different instars of *Helicoverpa* and *Spodoptera*

Insect	Highly resistant	Moderately resistant	Susceptible
Helicoverpa (third instar)	--	IR 13 A,BG 2 and IR 17	IR 30,IR 1,IR 29, PBS 105, PBS 48, IR 18,Girnar 1, NCAc 17090, IR 28, Kadiri 3,NRGS 9, PBS 118
Spodoptera (first instar)	Kadiri 3,IR 30, IR 17,PBS 48, PBS 118,Girnar 1, NRGS 9,IR 28,BG 2, NCAc 17090,IR 18, IR 1,IR 29,PBS 105	IR 13 A	---
Spodoptera (third instar)	---	IR 29,IR 17, BG 2,PBS 48, PBS 105,IR 28, IR 13A, Kadiri 3,IR 30, PBS 118,NRGS 9, IR 18,Girnar 1	IR 1,NCAc 17090
Spodoptera (fifth instar)	---	Kadiri 3,IR 29, PBS 105,NRGS 9, Girnar 1, NCAc 17090	BG 2,IR 30, IR 28,PBS 48, IR 18,IR 13 A, IR 17,IR 1, PBS 118

Genotypes printed in bold face had < 10% leaf area damage.

resistant to its first instar.

2.Experiment on combined action of salinity and drought on groundnut genotypes:

(V. Singh, Y. C. Joshi and A. L. Singh)

Ten genotypes of groundnut were grown in pots in Kharif 1992, in factorial combinations with three levels of salinity(control,4 EC and 8 EC)and three levels of drought (control, watering three days after control and six days after control). In all 90 treatments were there. Three plants were grown per pot and the experiment was laid out in a CRD with three replications. Plants were harvested after the majority of the plants flowered. Observations were made on seedling emergence, days to first flowering (in one treatment), plant height (cm), shoot dry matter(g) and sodium and potassium contents of shoots. A preliminary study of the data showed the following :

a. There was no consistent difference among the treatments with respect to time taken for emergence.

b. With respect to shoot dry matter the treatment combination (8 EC soil + watering six days after control), as expected caused the severest stress. The genotypes differed very widely with respect to reduction of dry matter due to this stress when compared with control. Based on the per cent reduction values the genotypes NRCG 609, ICGS 11 and NRCG 168 appeared to be more tolerant.

c. Flowering appeared to be delayed due to stress(mainly in the severest salinity and drought). In some cases there was no flowering till the time of harvest of the plants.

The experiment was repeated in summer 1993 and the combined data are being consolidated.

C. Breeder seed production (V. Singh and A. Bandyopadhyay)

Because of PStV problem no breeder seed production programme was undertaken during the year. Only nucleus seed was maintained.

Variety Girnar 1 was grown in summer 1992 for the purpose of cleaning the seed of PStV by rogueing. Six quintals of nucleus seed was produced.

Nucleus seed of Girnar 1 was grown at Navsari campus of GUjarat Agriculture University during Rabi - summer 1993 and 16.2 quintals of seed was produced.

D. Maintenance of material and making new crosses (A. Bandyopadhyay and V. Singh)

In Kharif 1992 and summer 1993, 178 and 253 breeding lines respectively, were grown in polyhouses for maintenance.

Six crosses viz. Kadiri 3 x NCAc 17090, Girnar 1 x GG 2, Kadiri 3 x Chico , JL 24 x NCAc 17149, Girnar 1 x BG 2 and BG2 x 5S were made in polyhouse as a test attempt in summer 1993. Only one hundred and twenty pods of F0 could be harvested.

GENETICS AND CYTOGENETICS

A. Collection, maintenance and characterization of wild *Arachis* species (P.Sen and T.G.K. Murthy)

1. Collection and maintenance of species :

Peanut stripe virus resistant species, viz. *A.* spp. PI 276235, PI 476012, 476013, 476004,468170 and 468176 were collected from ICRISAT. Two species, PI 475998,PI 468363 are being grown in a net house for further use.

B. Utilization of species of section *Arachis* in genetic improvement of groundnut (T.G.K.Murthy, P. Sen and T.Radhakrishnan)

1. Characterization of species:

a. Seed proteins :

A modified Laemmli(1970) SDS polyacrylamide gel electrophoresis method was standardized for groundnut seed proteins. Using this method, electrophoretic patterns of seed proteins of three species, namely *A. hypogaea, A. monticola* and *A. duranensis* were studied.

b. Seed oil content :

Fifty four interspecific advanced derivatives of crosses cv. GG 2 x *A. chacoense* and cv. M 13 x *A. villosa* were analysed by the Biochemistry section for kernel oil content using Soxhlet method. Four genotypes with more than 53% oil content were found among the derivatives. They were 7-2-26(55.5%), 1-10-1(54.0%), 7-6 (54.0%) and 2-21b(53.0%).

2. Induced autotetraploidy:

By treating the seedlings of *A.otavioi* and *A.* sp.GK 30008 with 0.1 and 0.2% colchicine, four plants with autotetraploid branches were identified.

4x A.sp GK 30008: The 4x branches were robust but late growing. The size of flower and trichomes showed 30% increase over normal. The pollen fertility varied from 13% to 82%. The chromosome associations at metaphase I were 15.66 II + 0.17 chain IV + 2 ring IV per cell. The selfed pods collected from these branches varied from 1.0 to 1.7 cm in length(normal - 0.8 cm).

4x *A. otavioi* : The tetraploid branches were gigas in nature. The mean pollen fertility was 77% as against 94% in diploids. The metaphase I chromosome associations were 0.6 I + 15 II + 0.4 chain IV + 1.8 ring IV + 0.1 VI per pollen mother cell. The 4x branches produced pods of 1.0 to 1.9 cm length (normal - 0.8 cm).

3. Isolation of interspecific hybrids :

From the hybridizations attempted in Kharif 1991, following interspecific hybrids were identified.

cv. J 11 x *A.* sp. GK 30085 - 1 hybrid
cv. J 11 x 3x (J 11 x *A.otavioi*) - 1 (BC1F1)
cv. J 11 x 3x (J 11 x *A. villosa*) - 1 (BC1F1)
cv. J 11 x 3 x (J 11 x *A.stenosperma*) - 1 (BC1F1)
cv. J 11 x 3 x (J 11 x *A.* sp.GK 30008) - 1 (BC1F1)

4. Charcterization of interspecific hybrid :

cv. J 11 x A. sp. GKBSPScZ 30085: The hybrid was spreading like the wild parent and sequentially flowering like J 11. Other morphological traits like leaflet size, disease resistance, size of standard, hypanthium length etc. were intermediate between the parents. The hybrid showed 9.5% pollen fertility and total seed sterility. The metaphase I chromosome associations per PMC in this hybrid were 14.68 I + 0.44 ring II + 6.56 rod II + 0.44 III. The meiosis was arrested at dyad stage in 55% of the cells. At anaphase I 50% of cells showed division of univalents.

5. Generation advancement:

Two hundred fifty interspecific derivatives(F2 to F9,BC1F1 to BC1F7), developed using *A. chacoense, A. villosa, A. cardenasii, A. duranensis, A. sp.* Manfredi 5, *A. otavioi* and *A. stenosperma* as donors of disease resistance, were grown in the field in Rabi-summer 1992. The crop showed secondary symptoms due to PStV. After thoroughly rogueing out the infected plants, selfed pods were collected. Pod samples, varying from 30 g to 500 g, of 110 genotypes were sent to NBPGR for medium-term cold storage.

In Kharif 1992, 90 interspecific derivatives were raised in polyhouse for seed multiplication. All the lots were cleared of PStV through thorough rogueing of infected plants. Over 300 samples of interspecific hybrid derivatives were got screened by the Plant Pathology section for the presence of PStV. Twenty nine of them were reported to be infected and hence were destroyed. The PStV free samples were sown in the field in Rabi-summer 1993 for seed multiplication. Also, 11 interspecific derivatives procured from ICRISAT were sown. The crop showed severe secondary symptoms due to PStV. Most of the genotypes had to be destroyed because of the virus infection. Transplantation of two plants in each genotype was made in polyhouse to rescue at least a representative plant.

6. Tissue culture studies :

a. Meristem culture :

With an intention to eliminate the PStV from the interspecific hybrids, shoot tip culture of 10 interspecific hybrids was done on MS medium with two hormonal concentrations. Calli could be generated in six hybrids. The calli of four hybrids were got screened for presence of PStV by ELISA test and

were found free. So far, plantlets have been regenerated from three interspecific hybrids -cv. J 11 x *A.Villosa*, cv. J 11 x *A. otavioi* and cv. J 11 x *A.* sp. GK 30085. The virus-free plants of cross cv. J 11 x *A. otavioi* have been transplanted in pots.

b. Rapid multiplication :

A method to induce multiple shoots from seed explants was tested successfully on cultivar GG 2. The culture medium for this purpose consisted of MS salts and vitamins + 3% sucrose + 50 ppm benzylaminopurine. All the explants produced multiple shoots by this method. On an average, 9.3 shoots per explant were obtained.

c. Anther culture:

A high sucrose(6%) MS medium with 4 ppm each of 2,4-D, NAA and kinetin was found suitable for callogenesis of anthers of *A. hypogaea.* cv.JL 24. Both haploid and diploid cells were found in the callus.

7. Chromosome banding :

Giemsa C-banding of somatic chromosomes of *A. hypogaea* cv. GG 2 and Girnar 1 was studied using 26 different methods. Out of these, one method gave reproducible results. It involves the following schedule.

1 Squashing root tips in 45% acetic acid
2. Treatment with 0.07 M Ba(OH)2 at room temperature for 20 mts,
3. Incubation in 2 x SSC for 30 mts at pH 7 and
4. Staining in 2% freshly prepared Giemsa in Sorensen phosphate buffer at pH 6.8.

The method is being tried with diploid wild species.

B. Genetics and breeding for high peg strength in groundnut (P. Sen and T.G.K. Murthy)

1. Generation advancement :

Rabi- summer 1992 :

Two advanced derivatives, code 8 (GAUG 10 x PI 393523) and code 44 (M 13 x PI 393523) were grown along with checks GAUG 10 and GG 11 in a split plot design with an intention to study pod losses under two soil moisture regimes. Most of the plants had to be rogued out due to PStV secondary infection. Hence the experiment was abandoned. Forty two single plant selections in F6 of 14 crosses, having high peg strength, were multiplied and after rogueing out the PStV infected plants, the produce was harvested.

Kharif 1992 :

Seeds of 50 cultures (2 advanced and 48 F6-F7) were sent to NBPGR for medium term storage. Twenty five selections from thirteen crosses were grown in polyhouse for seed multiplication. Seeds of 140 different selections were got screened for presence of PStV by ELISA and all

were reported to be free from the virus.

Rabi- summer 1993 :

Forty three high peg strength selections(F7-F11) were sown in field for seed multiplication. But due to PStV secondary infection, most of the plants had to be destroyed. Sixteen promising lines were sown in polyhouse for seed multiplication.

C.Maintenance, multiplication and utilization of wild species belonging to sections other than *Arachis* in groundnut improvement (P. Sen and T. Radhakrishnan)

1. Collection and maintenance of species :

Six accessions of four wild species, namely *A. prostrata, A. marginata, A. hagenbeckii* and *A. glabrata* which were resistant to PStV were maintained in a net house. Seed protein patterns of two species, *A. paraguariensis* and *A.* sp GKP 9993 were studied using polyacrylamide gel electrophoresis.

2. Tissue culture studies :

Apical meristem culture of shoot tips of the hybrid cv. J 11 x *A.* sp. KSSc 36025-1 was done and plantlets free from peanut stripe virus were regenerated. Callus was generated from anthers of *A. marginata.* After subculturing, it will be tested for haploidy and regeneration of plantlets.

D. Genetic studies on certain qualitative characters in groundnut (T. Radhakrishnan and T.G.K. Murthy)

1. Growing F1 hybrids:

F_1 generation of the following reciprocal crosses was grown in Rabi-summer 1992 :

a) GAUG 1 x GG 2, b) JL 24 x 2-16-1, c) Senegal 1120 x EC 24402, d) USSS x Senegal 1120, e) U 2-1-2-6 x EC 24402, f) U 2-1-2-6 x ICG 6016, g)Ah 1336 x M 13, h) MH 1 x Lax Giant, i) 7-6 x Lax Giant. F_1 hybrids in all cross combinations were identified. All the F_1 hybrids of red testa x red testa (c,d,e,f) crosses produced seeds with red testa. Therefore, it was presumed that the red testa colour in these genotypes might be under similar genetic control.

2. Growing F_2 generation:

The F_2 generation of all except the first cross were grown in poly houses in two consecutive cycles. All the F_2 plants in red x red testa crosses produced seeds with red testa only, threby confirming the assumption that the genetic nature of red testa in the lines EC 24402, USSS, Senegal 1120, U 2-1-2-6 and ICG 6016 is similar.

The expected F_2 segregation ratios for 15 different characters studied during the year are given below.

No.	Character	Cross	F_2 ratio
1.	1-3 seeded pod	Ah 1336 x M 13 (1-3) (1-2)	15(1-2 seeded) : 1(1-3 seeded)
2.	White testa	Ah 1336 x M 13 (white x flesh)	15 red : 1 white
3.	Stem pigment	Ah 1336 x M 13) (green x purple)	15 purple : 1 green
4.	Brachytic sterile	Ah 1336 x M 13 (normal x normal)	15 normal : 1 sterile
5.	Pod reticulation	Ah 1336 x M 13 (slight) (deep)	15 deep : 1 slight
6.	Flowers on main axis	a.Ah 1336 x M 13 (present) (absent)	15 absent : 1 present
		b.JL 24 x 2-16-1 (present) (absent)	3 absent : 1 present
7.	Stem thickness	Ah 1336 x M 13 (thick) (normal)	9 normal : 7 thick
8.	Lax giant plant type	a.MH 1 x Lax giant b.7-6 x Lax giant	1 normal : 2 intermediate : 1 lax giant
9.	Length of primary	7-6 x Lax giant (25-40 cm)(75-110)	Quantitative
10.	Height of main axis	7-6 x Lax giant (45 cm) (70 cm)	Quantitative
11.	Virescent	a.Ah 1336 x M 13 (green) (green)	15 green : 1 virescent
		b.JL 24 x 2-16-1 (green) (green)	15 green : 1 virescent
12.	Fertile dwarf	L 24 x 2-16-1 (normal) (normal)	15 normal : 1 dwarf
13.	Small leaf	JL 24 x 2-16-1 (normal) (small)	3 normal : 1 small
14.	Flowering habit	JL 24 x 2-16-1	3 alternate : 1 sequential
15.	Compact spreading	JL 24 x 2-16-1 (SB) (CSP)	9CSP : 3SSP : 3VB : 1SB

The inheritance of lax giant plant type, compact spreading habit and thick stem was studied for the first time in groundnut.

A. Development of suitable agronomic practices in groundnut (Devi Dayal)

1. Groundnut growth and productivity under different sowing patterns :

Two sowing patterns, viz. criss-cross(30 cm x 20 cm for either direction) and normal (30 cm x 10 cm) with four fertility levels were tested using cultivars GG 2 and Girnar 1 during Rabi- summer 1992. Growth studies revealed that crop sown in criss- cross pattern recorded significantly higher dry matter production and leaf area index(LAI) (at 50, 75, 100 and 125 days after seedling emergence-DAE), relative growth rate (RGR) (at 75-100 DAE) and net assimilation rate (NAR) (at 75-100 and 100-125 DAE), than the normal sown crop (Table 1). The criss-cross pattern also increased number of pods (by 18.4%) and pod weight (24.4%) per plant which resulted in increase in pod yield by 19.7% over normal planting (Table 2). Significantly higher net monetary returns (Rs.10560/ha) were also recorded by criss-cross pattern than normal sowing pattern (Rs.7769/ha.)

Application of recommended dose of fertiliser and gypsum resulted in maximum drymatter at 75, 100 and 125 DAE and a pod yield of 2318 kg/ha (net monetary returns - Rs.10842). The variety GG 2 recorded significantly higher dry matter at 100 and 125 DAE and pod yield than Girnar 1.

Groundnut seeds sown in plots which received recommended fertilizer and potassium doses had high germinability recorded at 100, 150, 200 and 240 days after harvesting. The fresh weight of root and shoot were, however, maximum in the treatment comprising recommended fertilizer dose + potassium. The seeds of variety Girnar 1 showed higher germination percentage than GG 2 in all the sampling dates.

2. Effect of mulching on growth and yield of summer groundnut :

In a field experiment, four dates of sowing (1, 10, 20 and 30 January) and three mulches (wheat straw, black polyethylene and control) were evaluated. Groundnut seeds under polyethylene mulch germinataed 6-8 days earlier than the remaining mulch treatments. Flowering began 36.4, 44.4 and 37.4 DAE in polyethylene, wheat straw and no mulch treatments, respectively. The corresponding days for 50% flowering were 46.6, 56.2 and 50.8 DAE. However, the total number of flowers produced were maximum in wheat straw followed by polyethylene and no mulch treatments.

Groundnut plants under wheat straw mulch showed nitrogen deficiency in early growth stage due

Table 1. Growth and dry matter production of groundnut under different sowing patterns and fertility levels.

Treatment	Dry matter / plant (g)				Relative growth Rate (g/g/day)			Net assimilation Rate (g/cm2/day)			Leaf Area Index			
	Days after emergence				Days after emergence			Days after emergence			Days after emergence			
	50	75	100	125	50-75	75-100	100-125	50-75	75-100	100-125	50	75	100	125
Sowing pattern														
Criss-cross	1.0	5.0	14.4	18.7	0.64	0.04	0.015	7.80	6.31	3.18	0.18	1.33	2.04	1.54
Normal	0.9	4.3	11.5	15.4	0.63	0.04	0.018	7.75	5.25	4.14	0.14	1.22	1.77	1.67
CD (P 0.05)	0.06	0.4	0.7	1.8	NS	0.004	0.002	1.21	0.76	0.72	0.03	0.12	0.20	0.23
Variety														
Girnar 1	0.9	4.5	12.2	16.0	0.06	0.04	0.017	7.41	5.77	3.92	0.17	1.20	1.74	1.73
GG 2	0.9	4.8	13.7	18.2	0.07	0.04	0.014	8.15	5.78	3.93	0.15	1.35	2.07	1.49
CD (P 0.05)	0.06	0.4	0.7	1.8	0.004	NS	0.002	1.22	0.76	0.72	0.03	0.12	0.20	0.23
Fertility level														
R	0.9	4.2	11.7	16.4	0.06	0.04	0.017	7.62	6.11	4.27	0.14	1.15	1.59	1.34
R + G	0.9	5.0	13.6	18.3	0.07	0.04	0.015	8.32	5.99	3.73	0.16	1.34	1.96	1.62
R + G + K	1.0	4.9	13.2	16.2	0.06	0.04	0.015	7.58	5.36	3.31	0.17	1.33	2.12	1.77
1.5 R +G+K	0.9	4.6	13.3	17.5	0.06	0.04	0.014	5.58	5.66	3.31	0.16	1.28	1.95	1.62
CD (P 0.05)	0.08	0.6	1.2	2.6	NS	NS	0.003	1.71	1.08	1.02	0.04	0.17	0.28	0.33

R = recommended fertilizer dose; G = gypsum; K = potassium; NS = not significant

Table 2. Effect of sowing pattern, fertility level and variety on yield and economics of Rabi-summer groundnut

Treatment	No.of pods/ plant	Pod weight/ plant(g)	Pod yield (kg/ha)	Haulm yield (kg/ha)	Net returns (Rs.000/ha)
Sowing pattern					
Criss-cross	11.21	8.04	2394	3680	10.560
Normal	9.47	6.46	2000	3574	7.796
CD(P 0.05)	0.56	0.67	160	NS	1.120
Variety					
Girnar 1	10.81	6.87	2067	3429	8.645
GG 2	9.87	7.63	2327	3825	9.795
CD(P 0.05)	0.56	0.67	160	264	1.120
Fertility level					
R	9.36	6.75	2007	3451	8.363
R+G	10.87	7.65	2318	3729	10.482
R+G+K	10.65	7.62	2240	3626	9.497
1.5 R+G+K	10.48	6.98	2224	3704	8.371
CD (P 0.05)	0.80	0.96	225	374	1.580

R = recommended fertilizer, G = gypsum, K= potassium, NS = not significant

to immobilization of nitrogen in the soil. However, after 45 days of emergence, the plants recovered from nitrogen deficiency and had higher chlorophyll content at 60 DAE and at harvest. When compared with the control and polyethylene mulch, the availability of NO3 nitrogen in the soil was less in wheat straw mulch upto 45 DAE. However, the same increased and was maximum at 60 DAE and at harvest. Similarly, availability of Fe, Cu, Mn and Zn increased at 60 DAE and at harvest under the wheat straw mulch as comparaed to the control and polyethylene mulch. Considerable increase in organic carbon content in the soil was observed under wheat straw mulch at harvest as compared to the remaining mulch treatments.

The available soil moisture (at 0-10 cm depth) was consistently higher in wheat straw mulch than in polyethylene and control treatments throughout the crop season. However, the soil temperatures recorded at 8 a.m. and 2 p.m. at 0-10 cm soil depth were higher in polyethylene mulch than in remaining mulch treatments. The bulk density of soil (0-10 cm) recorded at the time of harvest was the lowest in wheat straw mulch and the highest in polyethylene mulch.

Wheat straw mulch gave 23% higher

pod yield than the control whereas the pod yield under polyethylene mulch did not vary much from the control. The 100-kernel weight and 100-pod weight were significantly higher in wheat straw mulch, followed by polyethylene mulch and the control treatments.

The post harvest observations on seed germination showed that groundnut seed from wheat straw mulch had highest germinability and those from polyethylene mulch had the lowest germinability when recorded at 60, 130, 200 and 235 days after harvest. The electrical conductivity of seed leachate showed reverse trend and the seed from polyethylene mulch recorded the highest EC values.

The methods of drying x mulch interaction was significant in respect of seed germination. Wheat straw mulch along with shade drying or DOR method of drying gave maximum germination. However, under sun drying method, no significant differences were observed for germination due to mulch treatment.

3. Residual and cumulative effect of gypsum on the yield of Kharif groundnut :

The experiment to test the effect of gypsum on the pod yield of groundnut was initiated during Kharif 1990 and was repeated on the same site in Kharif 1991. Taking the soil from plots which received different treatments in this experiment, a pot experiment was conducted to know the residual and cumulative effect of gypsum after third year of experimentation, using the variety GG 2. It was observed that the cumulative effect of three years application increased pod yield by 24.3% over the control whereas direct application of gypsum increased pod yield only by 14.3% over the control. However, residual effect of gypsum either of one year or two years was not evident.

Among the doses and methods of application, a dose of 500 kg/ha and the top dressing, were found optimum and higher doses of gypsum reduced pod yield significantly. Root volume and root mass were significantly affected by the gypsum application. Regular application of gypsum increased root volume and root mass significantly but high doses (1000 and 1500 kg/ha) were detrimental to the root growth. Basal application was superior to top dressing for root growth.

B. Yield variation through plant population in groundnut
(Devi Dayal and V.Ravindra)

A field experiment was conducted with different maturity groups of seeds of cv. M 13 to know the effect of seed maturity on germination and plant growth. Seeds were grouped into six classes(A to F) on the basis of inner face of shell and seed size, starting from immature shrivelled seeds to over-mature seeds. These groups varied considerably for 100-seed mass

and shelling percentage (Table 3). Colonization by seed borne fungi were tested using blotter test method. The lowest infection (10%) was recorded in group C while the highest (79%) was in group A (immature). Seed germination recorded after 16 days of sowing (DAS) in the field showed that group C, D and E recorded germination of 80-82% while group A and B recorded 72-74%. Plant biomass recorded at 60 DAS showed significant variation due to seed grouping. The maximum biomass of 15-16 g/plant were recorded in C, D and E groups followed by F, B and A groups. Definite conclusions will be drawn after repeating the experiment.

Table 3. Effect of seed maturity on seed quality, germination and plant growth in groundnut

Seed maturity category	100-seed mass (g)	Shelling (%)	Fungal infection (%)	Germination (%)	Plant biomass (g/plant)
A	42	69.2	79.0	72.0	11.9
B	52	70.3	53.3	73.9	13.2
C	67	72.6	10.0	79.8	14.8
D	72	73.4	40.0	81.4	16.3
E	76	72.8	25.0	82.0	15.6
F	86	73.4	53.3	78.0	14.0

PLANT PATHOLOGY

A. Studies on important soil-borne diseases of groundnut (M.P.Ghewande)

1. Screening for dry seed resistance to A.niger :

Seeds of 26 genotypes, including resistant and susceptible checks, were evaluated for resistance to collar rot fungus *Aspergillus niger,* under artificially inoculated condition. Two advanced breeding lines, PPS 1-1(a derivative of cross Robut 33-1 x EC 76446-292) and PPS 5-3(JL 24 x NCAc 17090), were found resistant. Incidentally, both the cultures are resistant to foliar diseases (ELS, LLS and Rust) and high yielding.

Another set comprising 46 bold-seeded lines, two susceptible varieties (M 13, GG 11) and a resistant cultivar (J 11), were also screened for dry seed resistance to *A. niger* under artificially inoculated condition. Out of these, five genotypes - ICGV 87280, ICGV 86020, ICGV 86564, NRCG 8956 and NRCG 6054 were resistant to seed colonization also.

B. Studies on mycotoxins with special reference to aflatoxins in groundnut(M.P.Ghewande and J.B.Misra)

1. Screening bold-seeded genotypes for resistance to A.flavus seed colonization :

A total of 87 bold-seeded genotypes, alongwith two released varieties (M13 and G 11) were screened for dry-seed resistance to *A.flavus* under artificially inoculated condition. Out of these, NRCGs 8970, 8972, 8973 and 8974 were resistant whereas NRCGs 8955, 8966, 8968, 8977, 7211 and 634 were moderately resistant to seed colonization.

C. Studies on peanut stripe virus (PStV) disease (M.P.Ghewande)

1. Detection of PStV :

A laboratory was set up for detection of PStV in important groundnut material. The enzyme linked immunosorbant assay (ELISA) technique was standardized for this purpose. A total of 2950 groundnut seed and leaf samples, including some leaf samples of other cultivated and non-cultivated legumes, weeds and other plant species, were screened for the presence or absence of PStV. Out of these, 314 samples showed positive reaction.

2. Seed transmission of PStV:

Four genotypes, viz., JL 24, GG 2, GG 11 and M 13 were grown during Kharif 1992 in polyhouse. They were sap-inoculated with PStV at flowering and pod formation stages. Results indicated a strong genotypic variation in seed transmission of the virus. The transmission was zero in M 13 at both the stages of inoculation

In GG 2 and GG 11, it was 0.79%and 29.60% respectively when inoculated at flowering stage while in JL 24, it was maximum (69.44%) when inoculated at pod formation stage. On an average, the seed transmission rate was 10.4% when inoculated at flowering atage and 12.04% when inoculated at pod formation stage. The studies on the effect of season on seed transmission of PStV are underway. Seed transmission rate would also be worked out after inoculation at the vegetative stage of crop.

3. Study on latent infection of PStV in groundnut :

Ten released varieties (J 11, JL 24, Girnar 1, GG 2, Kadiri 3, GAUG 1, GG 11, M 13, ICG (FDRS) 10, GAUG 10), seven advanced breeding lines and three germplasm lines were grown in polyhouse and sap-inoculated with PStV. Symptoms of PStV were perceptible after a minimum of five days and a maximum of 32 days of inoculation. Presence of the virus in these samples was confirmed by ELISA test. However, in GG 2 the symptoms could not be detected even after 60 days of inoculation. Genotypic variation (3 to 60 days) for latent period was observed. This study would be repeated under different temperature conditions.

4. Identifying collateral hosts of PStV :

A search for collateral hosts of PStV was made during Rabi- summer 1993 in and around Junagadh. Suspected samples with PStV- like symptoms were collected from verious plant species including cultivated and non-cultivated legumes. These were tested by ELISA for the presence of the PStV. Among the cultivated legumes, pigeonpea, kidney bean, cowpea and gram tested positive for PStV. Among the non-cultivated *legumes, Cassia siamea, Samanea saman, Prosopis juliflora, Parkinsonia aculeata* and *Clitoria ternatea* were tested positive Among the other plant species tested, *Ipomea cepeiria, Pergularia daemia, Cocculus hirsutus, Euphorbia hirta* (a common weed in groundnut crop), *Crinum* sp., *Phyllanthus amarus* and *Tecoma stans* showed positive reaction. Thus, the possibility of perpetuation of the PStV through these plant species can not be ruled out. However, these results would be confirmed by conducting artificial inoculation test in proper containment.

5. Screening for resistance/tolerance to PStV:

In all, 56 genotypes (34 advanced breeding lines, 18 germplasm lines and four released varieties) were screened for PStV during summer 1992 under field condition. The incidence of virus ranged from 2.7% to 74.8%. The genotypes which recorded below 10% incidence were as follows :

Advanced breeding lines:

PPS 1 (Robut 33-1 x EC 76446 -292),
PPS 5 - 1 (JL 24 x NCAc 17090),

PPS 8 (GAUG 1 x NCAc 17090)

Germplasm lines : 29-5-2, NCAc 2656, PI 341879, EC 21150

Released variety : J 11

During summer, 1993, fifteen genotypes were grown in field. The incidence of PStV was considerable. All genotypes tested showed secondary infection due to the virus.

Milestone 5. To identify bold-seeded varieties possessing desirable agronomic traits but less load of aflatoxin (M.P.Ghewande and J.B.Misra)

In summer 1992, the promising bold - seeded genotypes were grown. B 99-1 recorded the highest pod yield(2049 kg/ha) followed by B 95 (1891 kg/ha). B 95 had highest shelling(68.31%) and 100 kernel weight (70.5 g). These bold-seeded lines were also grown in polyhouse during Kharif 1992. B 95 recorded the highest pod yield(72 g/plant) while it was 43 g/plant in the case of B 99-1.

In summer 1993, B 95 was grown both in field and polyhouse. It recorded 47g of pods/plant under field condition and 72 g per plant under polyhouse condition.

A. Integrated Pest Management in Groundnut (V.Nandagopal)

1. Identification of pheromones in groundnut leaf miner :

This experiment was conducted in collaboration with the Tamil Nadu Agricultural University Regional Station, Tindivanam. Two vials, one big and one small, with 2 and 1 mg (approximately) of pheromones, were arranged in four treatments and four replications. The vials were changed at weekly interval in one set of treatments and in the other, they were unchanged until the completion of the experiment. The traps were rotated daily in the column. The results showed that the big vial, when changed once in a week, recorded 34.27 males / trap/week while the one without change trapped only 5.19 males. The small vial with weekly change attracted 15.89 males whereas the one without change could trap only 4.54 males (Table 1).

2. Monitoring of flux in the aphid population:

The monitoring has been continuing since 27 March, 1992. Two types of traps viz., the conventional water trap and the sticky trap(fabricated by using a polysterine sheet of 175 µm thickness and having castor oil as glue on both the sides of the sheet) were used for trapping aphids. The population of aphids was high during the second and third weeks of April. It ranged from 0 to 249 per day per trap. *Aphis craccivora* was the predominant species trapped. The glue trap was found to be superior to water trap. High temperatures were found to negatively correlate with the population density of aphids($r = -0.532$).

3. Developing effective insecticide schedules for aphid control:

Among the insecticides tested, a mixture of insecticides with crude neem oil (0.02% phosphamidon + 0.04% endosulfan + 2% crude neem oil) were found to be efficient in controlling aphids.

4. Different aphid species as vectors of PStV:

Different aphid species, collected from 25 plant species, including various crops, ornamentals, and cultivated and non- cultivated legumes, growing around Junagadh were sent for identification to the Commonwealth Agricultural Bureau, London. One species, collected from *Phyllanthus emblica*, was identified as *Schoutedenia ralumensis.*

5. Studies on aphid transmission of PStV:

A total number of 1102 seedlings, grouped under 22 different samples, were subjected to in situ feeding by the aphid species, *Aphis craccivora.* The aphids were allowed a one minute acquisition time on the PStV infected leaflet and then allowed to feed on healthy seedlings and effect transmission. A mean PStV transmission efficiency of 14% was recorded for the aphid species.

Table 1. Interaction between chemicals,location and period in the trapping of male moths of leaf miner

		Period						
Chemical	Location	p1	p2	p3	p4	p5	p6	Mean
C 1	L 1	11.53	34.5	17.25	78.25	21.0	96.5	47.13
C 1	L 2	17.01	33.0	14.25	32.5	20.75	71.75	31.54
C 1	L 3	23.0	36.01	13.25	28.0	16.5	80.75	32.92
C 1	L 4	23.0	30.5	15.75	33.0	18.25	56.25	29.45
Chemical mean								**34.27**
C 2	L 1	21.0	4.28	2.28	2.04	2.75	0.05	5.40
C 2	L 2	15.5	3.51	4.0	4.29	2.51	0.05	5.0
C 2	L 3	14.25	13.0	2.0	0.05	3.0	0.05	5.39
C 2	L 4	07.75	12.0	3.25	1.29	5.5	0.05	4.97
Chemical mean								**5.19**
C 3	L 1	24.26	22.25	5.75	3.5	4.78	39.25	16.63
C 3	L 2	22.75	23.75	8.26	4.01	11.0	41.5	18.55
C 3	L 3	11.25	14.75	6.25	3.0	12.0	44.75	15.33
C 3	L 4	19.0	18.0	3.53	4.51	10.75	22.5	13.05
Chemical mean								**15.89**
C 4	L 1	03.78	6.78	3.5	0.05	2.51	1.54	3.03
C 4	L 2	27.25	3.78	1.78	0.05	2.25	0.05	5.86
C 4	L 3	24.5	7.5	1.53	0.05	3.0	0.05	6.10
C 4	L 4	07.26	5.26	2.5	0.05	4.01	0.05	4.54
Chemical mean								**4.54**
Grand mean		17.07	16.80	6.57	12.17	8.79	28.45	

Significance		CD(P 0.05)	
Between	chemicals (c)	= 0.29	**
Between	locations (l)	=	ns
Between	period (p)	= 0.44	**
Between	(c) X (l)	=	ns
Between	(c) X (p)	= 1.74	**
Between	(l) X (p)	=	ns
Between	(c) X (l) X (p)	=	ns

C1 = small vial replaced every week; C2 = small vial continued
C3 = big vial replaced every week ; C4 = big vial continued
L1 to L4 = locations; p1 to p6 = period (weekly); ** = significant at P 0.01

BIOCHEMISTRY

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

1. Oil content of groundnut genotypes:

Kernels of 240 genotypes received from Genetic Resources, Plant Breeding, and Genetics & Cytogenetics sections were analysed for their oil content by Soxhlet method. The oil content ranged from 38.8 (NRCG 994) to 55.5 (code no. 28). The genotypes which were found to contain more than 52% oil were:

Code no. 28(55.5), NCAc 17500 (54.1),Code no. 45(54.0), Code no. 7 (54.0), HO 24 Red(53.6), Code no. 11 (53.0), NFP 101(52.8), HPS 17(52.7), RB 90(52.5), NFP 140(52.5), Code no. 85(52.5), RB 46(52.4), Code no. 62 (52.4), 5 S(52.1).

2.Protein content:

Kernels of 80 genotypes received from Plant Breeding and Genetics & Cytogenetics sections were analysed for their protein content (N X 5.46). The protein content ranged from 15.1 (DH 3- 30) to 30.5% (JL 24). The genotypes identified to contain more than 27% protein were:

JL 24 (30.5), HO 31 (29.9), HO 42 (29.1), Gangapuri (29.0), J 11 (28.4), Kadiri 3 (28.3), HO 17 (28.1), Jyoti (27.9), S.Am. Col. 79 (27.6), HO 25 A (27.5), TMV 2 (27.4), TG 12 (27.4), HO 24(27.4), Code no. 11 (27.2), Somnath(27.1), PBS 8 (27.1).

3. Relationship between oil and protein contents of groundnut kernels:

The statistical analysis of the data on 141 kernel samples indicated that there exists a significant negative correlation (r= -0.316*) between the oil and protein contents. The functional relationships between oil and protein contents of kernels were estimated to be:

Protein^ (%) = 38.71 - (0.29 X Oil %)

Oil ^ (%) = 57.09 - (0.35 X Protein%)

4. Relationship between oil content and the specific gravity of groundnut kernels:

Thirty-two samples of groundnut kernels representing 21 genotypes were analysed for oil content by the standard Soxhlet extraction procedure The oil content ranged between 42.6 to 54.9%. The specific gravity of groundnut kernels was determined both for whole kernels and split kernels (cotyledons with testa) by determining the weight of kerosene displaced by about 10g kernels in a 100 ml volumetric flask. The specific gravity of whole kernels varied between 0.9358 and 1.0730 with mean ± SE of 1.0412 ± 0.0047. The specific gravity of split kernels varied between 1.0547 and 1.1227 with a mean ± SE of 1.0793 ± 0.0029. There was no significant correlation between the oil content and

the specific gravity of whole kernels. However, a highly significant correlation ($r = -0.946^{**}$) was found between oil content and specific gravity of split kernels (figure 1). The linear regression function with the specific gravity of split kernels (SGS) as the predictor variable and oil as the response variable was estimated to be:

$$\text{Oil } \hat{} (\%) = 239.65 - (176.81 \times \text{SGS})$$

The equation can profitably be used for predicting oil content of kernels of groundnut genotypes.

B. Biochemical basis of resistance to biotic and abiotic stresses

(J.B. Misra, M.P. Ghewande, V. Nandagopal, A.L. Singh and S.K. Yadav)

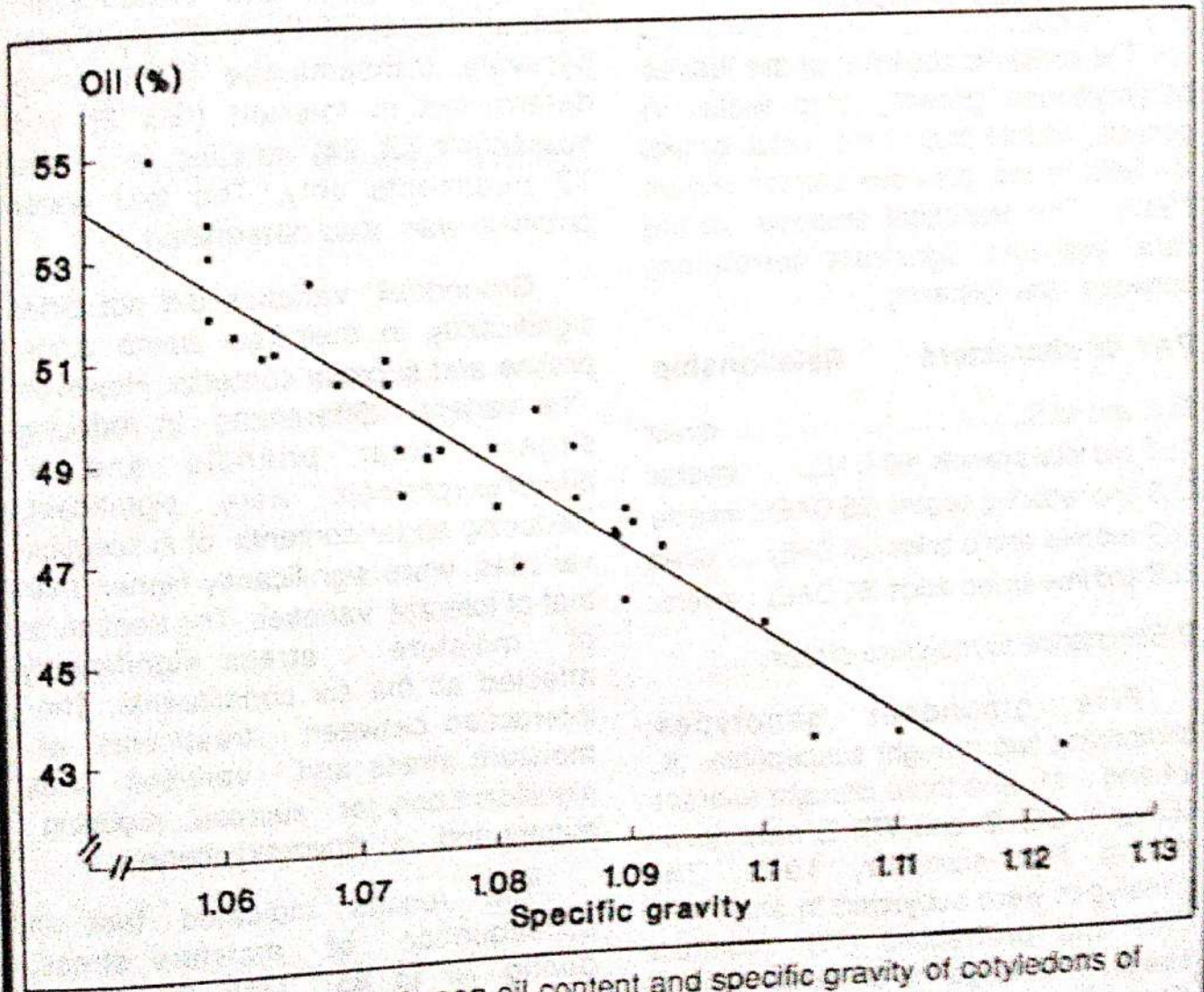

Figure 1. Relationship between oil content and specific gravity of cotyledons of groundnut genotypes.

1.Resistance to leaf spots:

Twelve groundnut genotypes were grown in a polyhouse in Kharif 1992. The leaves of the genotypes were sampled at 25 and 60 days after emergence (DAE) and analysed for total phenols, o- dihydroxyphenols and bound phenols. The contents of ketoses, reducing sugars, sucrose and free amino acids were also analysed. The observations on the incidence of early leafspot (ELS) and late leafspot (LLS) were also recorded.

The phenolic contents of the leaves of polyhouse grown crop were, in general, double that of the crop grown in field in the previous season (Kharif 1991). The statistical analysis of the data indicated significant correlations between the following:

Pair of characters	Relationship
ELS and LLS.....	direct
ELS and total phenols (60 DAE). . . .	inverse
LLS and reducing sugars (25 DAE)..	inverse
LLS and free amino acids (25 DAE) .. .	direct
LLS and free amino acids (60 DAE) .	inverse

2.Resistance to moisture stress:

Five groundnut genotypes, comprising two drought susceptible- JL 24 and J 11, and three drought tolerant- Girnar 1, GG 2 and VRI 2, were grown during Rabi-summer, 1992. The genotypes were subjected to short-term (T2) and protracted (T3) moisture stress. The irrigation schedule upto 21 days after emergence was the same for the control (T1) and the stressed crops (T2 and T3). Subsequently, in T2 the crop was irrigated only at 1[illegible] days' intervals while in T3 only once a[illegible] an interval of 75 days. The leaves o[illegible] all the genotypes were sampled at 40, 55, 70, 85 and 100 DAE and analysed for their sucrose, reducing sugars, free amino acids, proline, tota[illegible] phenols and o-dihydroxyphenols. The activity of nitrate reductase was determined only at 65 and 93 DAE. Activities of glutamate oxaloacetate transaminase(GOT) and glutamate pyruvate transaminase (GPT) were determined in tolerant (GG 2) and susceptible (JL 24) varieties in T1 and T3 treatments only. The leaf water potential was also determined.

Groundnut varieties did not differ significantly in their free amino acids, proline and sucrose contents. However, the varietal differences in reducing sugars, total phenols and o-dihydroxyphenols were significant. Reducing sugar contents of susceptible varieties were significantly higher than that of tolerant varieties. The treatments of moisture stress significantly affected all the six constituents. The interaction between treatments of moisture stress and varieties was significant only for sucrose, reducing sugars and o- dihydroxyphenols.

The results indicated that in consequence of moisture stress, during 70 to 85 DAE the leaves accumulated free amino acids. The effect of moisture stress was most

pronounced on proline content which increased 3-6 folds while the reducing sugars and sucrose contents decreased, and total and o-dihydroxyphenols remained rather unaffected. The proline content of leaves tended to reach normal levels when sampled two days after relieving the plants of 75 days' protracted stress. Leaf water potential (measured only in T1 and T3) and proline content of leaves showed a highly significant negative correlation ($r = -0.896^{**}$ and -0.928^{**}, for JL 24 and GG 2, respectively).

The extent of reduction in both sucrose and reducing sugars due to stress was more in susceptible varieties than that in tolerant varieties.

GOT increased steadily upto 85 DAE in the stressed crop while there was a only a slight decline at 70 DAE in the control crop. GPT increased continuously upto 85 DAE in JL 24 in both stressed and control crop but in GG 2 it did not show any definite pattern. Under stress conditions, a significant positive correlation ($r= 0.826^{**}$) was observed between the variations in proline content and the GOT activity.

PLANT PHYSIOLOGY

A. Studies on water, temperature and salt stresses in groundnut

(Y .C Joshi, V. Ravindra and P. C. Nautiyal)

1. Screening for drought tolerance:

Forty genotypes including selected germplasm lines, advanced breeding lines and a few released varieties were tested for their drought tolerance during two rainy seasons (in 1990 and 1991) and two summer seasons(1991 and 1992) under field conditions in randomised block designs. The screening was concluded after summer 1992 and the consolidated report is presented here.

a. Screening under rainfed conditions:The crop faced severe end-season drought coinciding with the pod filling phase in 1991 while in 1990 there was only a mild stress during late vegetative phase. The mean pod yield (g/pant) under rainfed conditions ranged between 0.61 to 4.64 against 1.52 to 4.81 under no stress conditions. The lines which gave more than 3 g pod yield along with their total dry matter(TDM), harvest index (HI) and reproductive to vegetative ratio (RVR) are listed in Table 1.

b.Screening under simulated conditions during Rabi-summer :

The same lines were screened for drought tolerance during summer under simulated soil moisture stress conditions. The soil moisture stress of the same duration was imposed during the same phenophase at which the crop faced drought in the rainy season. About 16 lines were considered drought tolerant based on

Table 1. Yield and partitioning efficiency of groundnut genotypes tolerant to drought under rainfed conditions

Genotype	Pod yield (g/plant)	TDM (g/plant)	HI	RVR
Girnar 1	4.64	10.97	0.42	0.70
VRI 2	3.99	11.40	0.35	0.50
PBS 2	3.81	10.91	0.35	0.42
PBS 27	3.61	7.73	0.47	0.48
PBS 15	3.55	8.60	0.41	0.70
NRGS (E)2	3.42	8.51	0.40	0.69
NRCG 7070	3.37	12.21	0.28	0.38
PBS 13	3.32	10.30	0.32	0.29
PBS 8	3.25	10.31	0.32	0.27
PBS 17	3.16	9.15	0.35	0.36
NRCG 7015	3.07	10.01	0.31	0.22

pod yield. These lines are listed in Table 2. The pod yield differences among the lines appeared to be more due to partitioning of dry matter in to the pods than total dry matter per-se. The pod yield (g/plant) ranged between 1.6 - 5.0 under stress and 4.5 - 9.9 under no stress conditions. The lines differed in their tolerance to drought with respect to season.

From these experiments it becomes amply clear that screening for rainfed and summer conditions has to be taken up independently and the results can not be superimposed, since the varieties respond differentially to the season.

The mean values through the two seasons are presented in Table 3. Only 10 lines yielded 3g or more pods per plant and hence considered as relatively drought tolerant. Genotypic differences for the HI and RVR(the partitioning parameters) were observed. As the pod yield

Table 2. Yield and partitioning efficiency of lines tolerant to drought during Rabi-summer

Genotype	Pod yield (g/plant)	TDM (g/plant)	HI	RVR
NDT 10	5.05	24.14	0.21	0.30
Girnar 1	4.91	23.28	0.21	0.32
PBS 19	4.86	22.55	0.22	0.30
PBS 2	4.79	24.28	0.20	0.27
GG2	4.74	25.76	0.18	0.23
PBS 15	4.74	19.64	0.24	0.40
PBS 8	4.44	22.31	0.20	0.24
PBS 14	4.15	24.96	0.17	0.25
PBS 27	4.15	19.37	0.21	0.29
PBS 18	4.05	24.69	0.16	0.21
NRCG 7140	3.98	26.40	0.15	0.22
PBS 6	3.89	23.88	0.16	0.21
NRGS(E) 2	3.86	18.67	0.21	0.27
NRCG 6748	3.80	21.80	0.17	0.25
PBS 17	3.72	20.80	0.18	0.24
NRCG 1116	3.64	23.18	0.16	0.20

variation under stress and normal conditions appeared to be accounted by variation in HI and RVR, it would be appropriate to consider HI and RVR also as parameters for screening for drought tolerance. On the other hand, considering only total dry matter as a parameter for screening for drought tolerance would lead to selection of genotypes which can survive under stress conditions.

2. Screening for heat tolerance during pod filling phase:

The day temperatures (around 40° C) prevailing during the pod filling stage in Rabi-summer season adversely effect the pod yield. The lines which perform better and yield more under such situations could be considered tolerant to heat for that particular phenophase. Considering this assumption, the material screened for moisture stress conditions was also screened for heat tolerance at pod filling phase for two consecutive summer seasons (1991-92). Those lines recording a per plant yield of 7g or more were considered as heat tolerant under normal irrigated conditions (Table 4). It was in deed noticed that most of the drought tolerant lines were heat tolerant also. Among the lines screened, the pod yield (g/plant) ranged between 4.5 -9.9. In this case also the differences in pod yield among the genotypes were due to HI and RVR rather than the dry matter *per-se*.

Table 3 : Yield and partitioning efficiency of lines tolerant to drought both in Rabi-summer and Kharif seasons

Genotype	Pod yield (g/plant)	TDM (g/plant)	HI	RVR
Girnar 1	4.90	17.13	0.29	0.59
PBS 2	4.30	17.60	0.24	0.42
PBS 15	4.15	14.12	0.29	0.61
PBS 27	3.88	13.55	0.29	0.45
NDT 10	3.85	16.74	0.23	0.37
PBS 8	3.85	16.31	0.24	0.35
PBS 19	3.78	15.82	0.24	0.39
GG 2	3.70	17.34	0.21	0.35
NRGS (E)2	3.64	13.59	0.29	0.49
PBS 18	3.50	16.84	0.21	0.37

Table 4: Yield and partitioning efficiency of lines tolerant to heat at pod filling phase

Genotype	Pod yield (g/plant)	TDM (g/plant)	HI	RVR
Girnar 1	9.90	26.04	0.38	0.61
PBS 15	7.97	22.29	0.36	0.61
NDT 10	7.92	24.95	0.32	0.48
PBS 2	7.86	28.31	0.28	0.44
KRG 1	7.84	28.22	0.28	0.40
PBS 19	7.81	23.52	0.33	0.57
PBS 27	7.78	24.55	0.32	0.49
GG 2	7.49	23.59	0.32	0.52
NRCG 7141	7.42	26.78	0.28	0.42
NRCG 7140	7.38	25.60	0.29	0.41
NRGS (E) 2	7.36	24.93	0.30	0.43
NRCG 1116	7.06	27.79	0.25	0.37

3. Screening for cold tolerance:

A total of 105 spanish and 50 valencia germplasm lines were screened for cold tolerance at a day/night temperature of 18/12 °C for 8/16 hours respectively under laboratory conditions. The days to radicle emergence was taken as a criterion to select for cold tolerance. The root length and hypocotyl length were also recorded to take note of the subsequent growth under cold conditions. The lines tolerant based on the above study are listed in Table 5.

B. Studies on seed viability and dormancy in groundnut (P. C. Nautiyal, A. L. Singh and J. B. Misra)

1. Studies on seed viability:

a. Screening for viability :

During Rabi-summer 1992, 30 spanish bunch varieties, 100 germplasm lines and cultures which were found to be promising in earlier studies, were tested for seed viability. The released varieties were screened for viability during the Rabi-summer

Table 5. Seed germination and seedling growth in groundnut genotypes tolerant to cold

Genotyp	Germination (%)	Root length (cm)	Hypocotyl length (cm)
Spanish			
NRCG 4255	98	3.0	1.0
NRCG 9528	96	7.5	1.5
ICGS 11	92	3.0	1.3
NRCG 9555	88	8.0	2,0
Valencia			
NRCG 6901	100	7.0	2.5
NRCG 2514	98	3.5	1.5
NRCG 4095	98	8.0	2.0
NRCG 6974	98	6.5	2.0
NRCG 4659	92	7.0	1.5

and Kharif seasons. Germination percentages of promising cultivars after 10 months of storage in case of Rabi-summer and 14 months in Kharif are given in Table 6.

The germplasm lines which could retain 80 to 90% seed viability after 12 months of storage were: ICGs 4709, 4658, 4839, 4849, 3788, 3749 and 4630, and NRCGs 8433, 8415 and 8763.

b. Drying and storage vs seed viability :

This experiment was conducted to assess the effect of drying and storage methods on seed viability. Rabi-summer produce of cv. GG 2 was dried by three methods viz. windrow, windrow shading and DOR method. In windrow shading, the plants were dried in such a way that the haulms of one row cover the pods of the previous row. The pods were dried in the respective methods for six days and thereafter picked-up and dried in open sun. Samples of 1 kg pods were stored in polyethylene-lined gunny bags at the moisture level of 5 to 6%, by the following methods.

Table 6. Seed germination of produce of Rabi-summer and the Kharif in some spanish bunch cultivars

Variety	Seed germination(%) after		
	10 months1	14 months2	10 months3
TMV 2	71	87	90
RSHY 1	72	78	85
Spanish Improved	62	76	81
Jyoti	69	93	83
ICGS 44	60	86	81
TMV 7	66	86	81
S 206	70	85	77
AK 12-24	-	84	77
SB 11	79	89	76
KRG 1	72	85	77
ICGS 11	66	94	74
Girnar 1	54	82	72

1 = Produce of Rabi-summer 1991; 2 = Produce of Kharif 1991; 3 = Produce of Rabi-summer 1992

T1 = Stored in the bag.
T2 = Stored with 10 g Ca Cl_2
T3 = Stored with 10 g silica gel

The pods dried by windrow method showed reduction in germination percentage immediately after drying(Table 7). The viability of this produce dropped below 50% after four months of storage. None of the storage methods could help in retaining seed viability of the produce dried by windrow. The produce dried by DOR-method could retain significantly higher viability in all the storage methods. After 10 months of storage the maximum germination percentage was recorded in the pods dried by DOR-method and stored with $CaCl_2$ (T2 DOR). Thus, the viability of Rabi-summer produce can be maintained by following the DOR method of drying and storing the pods along with $CaCl_2$.

Table 7. Viability of seeds dried and stored by different methods

Treatment	Seed viability(%) after months of storage			
	0	4	7	10
T 1 W	83	31	18	10
T 1 WS	94	48	36	29
T 1 DOR	95	58	55	48
T 2 W	83	38	34	20
T 2 WS	94	50	47	38
T 2 DOR	95	74	74	72
T 3 W	83	33	28	17
T 3 WS	94	58	45	34
T 3 DOR	95	73	65	55

Methods of drying : W=Windrow, WS= Windrow shading , DOR= Directorate o oilseeds research method, T1, T2 and T3 are explained in the text

c. Water content and respiration in germinating seeds:

Two spanish varieties, ICGS 11 (dormant) and GG 2(non-dormant) were used for studying the respiration and seed water content during germination. The respiration rate was calculated with the help of portable photosynthesis system LI 6200 equipped with 250 ml cuvette. The increase in CO_2 concentration(in ppm)was measured and respiration rate was expressed as CO_2 µg/g dr.wt./sec. (Fig.1). The respiration rate in the non-dormant cultivar was higher than that in the dormant cultivar. It was maximum at 55 h and 75 h after imbibition in the non-dormant (GG 2) and the dormant (ICGS 11) cultivars, respectively. However, the seed water content was maximum at 90 hours after imbibition in both the cultivars. The radicle protrusion and the initial growth was rapid in cv. GG 2. However, at 60-100 hours after imbibation the hypoctyl-radicle length was more in the cv.ICGS 11 than in cv. GG 2. Further studies are in progress.

2. Studies on seed dormancy:

a. Role of different seed parts i dormancy: In order to understan the influence of seed parts like testa cotyledons and embryonic axis on th dormancy of groundnut seed, a study wa conducted with two spanish, two virgini runner and nine virginia bunch typ cultivars. The seeds of individual plant of each cultivar were tested fo germination, with or without testa a four stages(1 to 4) of maturity(Table 8).

The germination percentages in both seeds with testa (GST) and thos without testa (GSW) were higher in th stage 3 and 4 than the stage 1 and 2 The increase in the germinatio percentage due to the removal of testa irrespective of the stage of harvest, wa due to predominant role of testa i dormancy. But the role of cotyledons and/or the embryonic axis in the dormancy, was also evident by the fact that removal of testa rsulted in more than 50 % germination only in six cultivars

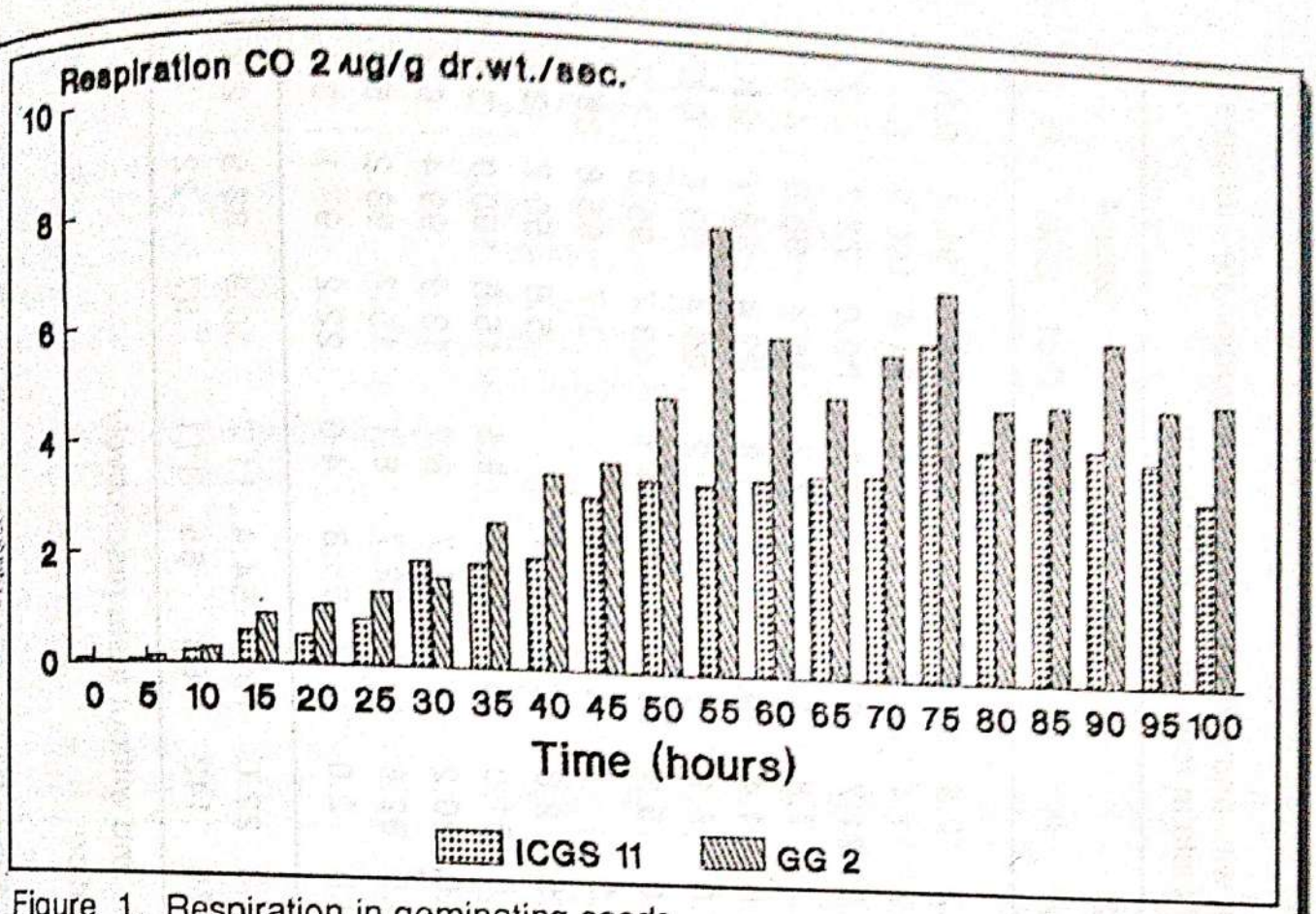

Figure 1. Respiration in geminating seeds

and only ethrel treatment could result in 100 % germination in seeds without testa. The significant coefficents of correlation between GSW and GST at stage 1 and 3 would point to the underlying common factor(s) in seeds with or without testa and those factors in the cotyledons and/or the embryonic axis. Thus, this study reveals that the testa had the dominant role in dormancy followed by the cotyledons and the embryonic axis.

C. Inorganic nutrient requirements and their disorders in groundnut (A.L.Singh and Y.C.Joshi)

1.Screening for tolerance to iron chlorosis:

One hundred and twenty nine selected groundnut genotypes comprising 55 released varieties, 62 advanced breeding lines belonging to Cytogenetics and Plant Breeding sections, and 12 germplasm accessions were screened for their tolerance to iron chlorosis during dry season by growing them in two replicates of two 5 m rows. The visual chlorotic rating (VCR) based on the performance of top five leaves of groundnut were noted at an interval of 20 days, beginning from 20 days after emergence. Based on five observations recorded during entire cropping season the genotypes were classified into three different categories, tolerant, moderately tolerant and highly susceptible(Table 9).

Table 8. Germination percentage of groundnut seeds with and without testa and proportionate increase in germination percentage due to removal of testa at four stages of maturity

Cultivar	Stage 1			Stage 2			Stage 3			Stage 4		
	GST	GSW	PI	GST	GSW	PI	GST	GSW	PI	GST	GSW	PI
ICGV 86590	15.1	75.0	4.0	22.8	86.7	2.8	17.9	87.1	3.9	94.1	98.3	0.0
ICGS (FDRS) 10	52.5	100.0	0.9	35.1	85.7	1.4	46.7	98.2	1.1	94.6	100.0	0.1
ICGS 5	3.7	45.4	11.4	0.2	16.0	71.7	2.2	48.0	20.8	20.0	73.7	2.7
ICGS 11	2.6	35.4	12.6	4.4	38.7	7.8	0.5	23.1	47.2	16.4	95.0	4.8
ICGS 37	2.4	36.0	14.3	9.4	23.0	1.4	9.9	57.2	14.8	22.4	68.7	2.1
ICGS 44	1.7	4.9	1.9	2.4	17.0	6.1	5.1	47.1	8.2	35.4	53.6	0.5
ICGS 21	14.2	28.2	1.0	4.0	25.0	5.3	11.4	58.0	4.1	43.7	95.0	1.2
M 13	2.9	0.0	-	0.0	1.3	-	0.0	3.3	-	1.7	65.8	38.4
GAUG 10	0.0	0.0	-	2.9	9.5	2.3	0.0	1.4	-	5.6	50.7	3.7
Kadiri 3	2.2	77.8	34.4	1.3	40.0	31.0	6.5	68.0	9.5	15.6	100.0	5.4
5S	1.7	44.8	24.8	2.0	43.0	20.2	7.7	74.7	8.7	13.9	99.4	6.2
NEP 140	1.9	37.7	19.3	0.7	66.5	92.6	11.7	82.7	6.1	15.7	93.2	5.0
RB 90	4.5	3.0	0.3	6.4	19.0	2.0	11.7	58.3	4.0	22.2	97.1	3.4
Mean	8.1	37.5	11.3	7.4	36.3	22.0	10.3	54.4	11.7	30.9	83.9	2.8
CV%	175	85	100	138	76	142	83	55	111	97	22	79

GST & GSW = germination percentage of seeds with and without testa respectively
PI = (GSW-GST); CV% = per cent coefficient of variation

Table 9. Groundnut genotypes showing tolerance to iron chlorosis

Tolerant	Moderately tolerant	Highly susceptible
1.Varieties GG 2, JL 24, MH 2, MH 4, TG 17, VRI 2, ICGV 86522, TAG 24, SG 84	TG 1, G 201, Somnath Chandra, M 37, M 13 UF 70-103, Jyoti, TMV 7, MA 10, Jawan, ICGV 86008	VRI 3, ICGS 65, ICGV 87276
2.Advanced breeding lines PKVG 8, Akola Sel. CSMG 84-1, I 1, Kadiri 3(Sel), PBS 70, 89, 189, PBDR 41, 4-9-1, 7-6-13 B, 7-6-26	CGC 3, NDN 19, PBSs 13, 145,90 and 91, PBDR 39, 7-6-17	NRCG 1, I 2, 2-21, PBDRs 13 and 36
3.Germplasm accessions NRCGs 4255, 5389	NRCGs 4015, 4659,7110,	NRCGs 162 and 7472

2. Yield potential of the iron-efficient genotypes:

Of the 25 high yielding Fe-efficient genotypes tested during 1991, seven were tested for yield and other related characters during Rabi-summer season, along with the check GG 2. It was observed that out of the seven genotypes two outyielded GG 2 and three were at par. The pod and haulm yields, shelling percentage and 100 seed weight of these genotypes are given in Table 10. Results of experiments conducted for two years revealed that at least two genotypes, NRCGs 7085-1 and 7085-3(spanish) and NRCG 7599(valencia) could be tested at multilocations under AICORPO.

3. Studies on the mechanism of tolerance to iron chlorosis :

The Fe-efficient and inefficient genotypes grown in the field were subjected to the estimation of total and active iron content, chloroplhyll, total nutrient uptake and their concentration, and enzymatic activities of peroxidase, ascorbic acid oxidase and nitrate reductase. It was noticed that the Fe- efficient genotypes contained 2-3 times more active iron content and higher uptake of other nutrients than the inefficient ones. The chlorophyll content and the peroxidase and nitrate reductase activities in leaves of Fe-efficient plant were also appreciably higher than those in the inefficient one. The peroxidase

Table 10. Yield attributes of iron-efficient genotypes

Genotypes (NRCG nos.)	Pod yield (kg/ha)	Haulm yield (kg/ha)	Shelling (%)	100-seed weight(g)
7607	2060	2742	70	35.9
5118	1554	1220	66	33.1
389	1772	3557	63	35.0
7599	2136	4017	58	44.9
7085-1	2256	3355	63	37.0
7085-3	2612	3415	69	32.0
6919	1608	3215	72	38.5
GG 2	2229	3499	66	42.3
LSD(0.05)	110	160	2	2.6

activity in roots was ten times higher than that in stem. Thus, the root peroxidase activity can indicate the iron status of the plant and might help identifying the Fe-efficient (iron chlorosis tolerant) lines.

4. Studies on critical levels of micronutrients :

A field experiment was conducted with the variety GG 2 in microplots by applying different doses of micronutrients to find out the sufficiency and deficiency levels of Fe, Mn, Zn, Cu, B and Mo in both plant and soil. The plant and soil samples at 30-days intervals were collected and analysed. Based on the soil analysis the critical sufficiency levels of Fe, Mn, Zn, Cu, B and Mo were found to be 2-5, 4-6, 0.5-0.8, 0.2-0.5, 0.2-0.5 and 0.04-0.05 ppm respectively. The concentrations above 200, 50, 20, 5 and 1 ppm of Mn,Zn,Cu, B and Mo were toxic to the groundnut plant. The leaf concentration of Fe,Mn,Zn,B and Mo below 40, 25, 20, 5, 15 and 0.5 ppm, respectively showed deficiency symptoms. The analysis of mature leaf of healthy plants sampled at 50-60 days after emergence showed an average concentration of 300,150, 50, 15, 40, 0.3 ppm of Fe, Mn, Zn, Cu, B and Mo, respectively.

5. Concentration and uptake of nutrients :

The leaves, stems, pods and shells of 50 groundnut genotypes, comprising both runner and bunch groups, were analysed for macro and micronutrient concentration and their uptakes. In general the concentration and uptake of both

macro and micronutrients in runner genotypes were more than the bunch, which is probably due to more efficient mining system in the runner group. It was observed that on an average the chlorotic plants having average chlorophyll content of 0.38 mg chl/g f.wt. contained 2.04%N, 0.15% P, 1.7% K, 2.9% Ca, 0.46% Mg, 0.18% S and 500, 199, 31,and 23 ppm Fe, Mn, Zn, and Cu, respectively. On the other hand the normal green plants with 2.62 mg chl/g f.wt. contained 2.5% N, 0.21% P, 1.7% K, 3.2% Ca, 0.69% Mg, 0.19% S and 1024, 283, 31 and 25 ppm Fe, Mn,Zn and Cu, respectively. The differences in the uptake were also larger between the chlorotic and non-chlorotic plants. It was estimated that for producing 2.0 to 2.5 t/ha of pod yield the groundnut crop requires 160-180 kg N, 20-25 kg P, 80-100 kg K, 60-80 kg Ca, 15-20 kg S, 30-45 kg Mg, 3-4 kg Fe, 300-400 g Mn, 150-200 g Zn, 140-180 g B, 30-40 g Cu, and 8-10 g Mo. As the groundnut plant can fix atmospheric nitrogen, the order of nutrient requirement of the crop is K, Ca, Mg, P and S. However, in calcareous soil the order of limiting nutrients was found to be N, P, S, Fe,K, Zn and B.

A. Collection, isolation and evaluation of effectiveness of rhizobial strains for groundnut and their improvement

(P.K.Joshi)

(Also activity milestone 15 - Identification of factors associated with *Rhizobium*, host and environment for high groundnut productivity)

1. *Survey of farmers' fields for nodulation :*

A large number of farmers' fields were surveyed for nodulation in Rajkot, Jamnagar and Junagadh districts of Saurashtra during Kharif. The crop was found sufficiently nodulated with effective strains of rhizobia except in a few fields where soil fertility and soil moisture were less than optimum.

2. *Standardization of nodulation technique :*

Nodulation by effective *Rhizobium* strains such as IGR 40, NC 92, TAL 1371, TAL 1000 under sterilized conditions was tested in leonard jars, test tubes and polythene bags to standardize the procedure. Polythene bags were found to be most convenient and effective for testing nodulation and effectiveness of groundnut rhizobia.

3. *Multilocational testing of Rhizobium cultures under AICORPO in non traditional areas :*

Testing of effective cultures like IGR 6, IGR 40, TAL 1000, TAL 1371, TAL 169 and NC 92 in nontraditional areas at Chiplima and Khargone indicated better performance of *Rhizobium* cultures NC 92, TAL 169, TAL 1371 over others.

4. *Maintenance of effective rhizobial cultures:*

The two effective cultures, developed at NRCG, IGR 6 and IGR 40, and those procured from outside agencies like ICRISAT, Niftal, TNAU, were maintained for further use in research and development. These were supplied free of cost to indentors.

5. *Effect of mulching on nodulation:*

A field experiment was conducted during Rabi-summer seasons of 1991-92 and 1992-93 to test the effect of wheat straw and polythene mulch (both transparent and black) on nodulation. Data on nodulation, plant biomass and pod yield indicated better performance of plants having black polythene as mulch treatment followed by transparent polythene mulching. Polythene mulching (both transparent and black) also encouraged early germination and increased nodulation, probably due to increased temperature by 2-3^{o}C and conservation of moisture.

6. *Study of rhizosphere microflora*

Rhizosphere and non-rhizosphere microflora were studied in samples of varieties, GG 2, GAUG 10 and Sandhdi brought from farmers' fields in Kharif 1992. Results indicated higher population of bacteria, fungi and actinomycetes in rhizosphere than non-rhizosphere. The difference was more pronounced in Sandhdi than in the other two cultivars.

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Yadav, S. K., Singh, A. L., Misra, J. B. and Mathur, R. S. 1993. Effect of protracted moisture stress on biochemical constituents of groundnut leaves. In : *Intern. Conference on Biotechnology in Agriculture and Forestry*, IARI, New Delhi, 15-18 February, 1993

PARTICIPATION OF NRCG SCIENTISTS IN WORKSHOPS / SEMINARS / MEETINGS

Dr. P. S. Reddy	Meeting on Search for Control Measures for PStV, ICAR, New Delhi, 5-6 April1992
	Seed Review and Management of Change Meeting, ICAR, New Delhi, 21-24 June, 1992
	Review Meeting of Micro-Mission-I under the Technology Mission on Oilseeds and Pulses, Hyderabad, 1-4 July, 1992
	Academic Council Meeting, GAU, Anand, 28-29 July 1992
	Directors' Conference, ICAR, New Delhi, 11-113 August 1992
	Rabi-summer Oilseeds Research Workers' Group Meeting, Nagpur, 17-21 August 1992
	Meeting of Oils and Oilseeds Secretarial Committee FAD 44, New Delhi, 7-9 October 1992
	Crash Programme on Groundnut Seed Production, New Delhi, 24-27 Noveber 1992
	Germplasm Advisory Committee Meeting, Hyderabad, 23-24 December 1992
	PIC Meeting of the All India Coordinated Research Project on Groundnut, ICAR, New Delhi, 31 December 1992 - 2 January 1993
Drs.P.S.Reddy,K.S.Amin, N. R. Bhagat, M. S. Basu, Y. C. Joshi, J. B. Misra, A. Bandyopadhyay, P. Sen, P. K. Joshi, V. Nandagopal	XL Annual Kharif Oilseeds Workshop, University of Agricultural Sciences, Dharwad, 21-24 April 1992

Dr. M.P.Ghewande	Zonal Research and Extension Advisory Committee Meeting, GAU, Junagadh, 2-3 April and 16-17 October 1992; 26-27 March 1993
	Workshop on Hybrid Seed Production and Oilseeds Production, SFCI, Suratgarh, 25-28 June 1992
	XIV Meeting of the ICAR Regional Committee No.VI, HAU, Hisar, 21-22 October 1992
	PStV Expert Committee Meeting, ICAR, New Delhi, 4 November 1992
	V Zonal (WZ) Meeting and Annual Meeting of IPS, Akola, 18-21 January 1993

INSTITUTE MEETINGS/SEMINARS

MEETINGS

7-12 April 1992	Quinquennial Review Team
7-8 May 1992	XXI Scientific Research Council
1 June 1992	Departmental Promotion Committee
15 July 1992	Institute Advisory Committee
8-9 August 1992	Selection Committee
6-7 November 1992	XXII Scientific Research Council
5 December 1992	Five-yearly Assessment Committee
16 March 1993	Departmental promotion Committee

SEMINARS

Pro. C. P. Malik, PAU, Ludhiana	Some new aspects of carbon acquisition in groundnut, 9-4-92
Dr. M. P. Ghewande	Molecular biology of plant viruses, 18-4-92
Dr. K. S. Amin	Disease resistance in groundnut, 3-9-92
Dr. A. Bandyopadhyay	Ozone hole, 15-9-92
Prof. M.Parameswaran, GAU, Junagadh	Biochemical studies on groundnut crop, 29-9-92
Dr. N. R. Bhagat	Bird's eye view on research contributions of Dr. K.S.Amin, Plant Pathologist in Indian Agriculture, 30-10-92
Shri Devi Dayal	The scientific basis of and scope for further improvement in intercropping systems, 20-11-92
Dr. R. A. Pai, M/s. Nulab, Bombay	Microwave digestion: theory and practice 3-12-92
Dr. M. P. Ghewande	Trees- a diversity of uses, 17-12-92
Shri Y. C. Joshi	Physiological approaches to improving crop productivity in salinity and moisture stress conditions, 8-1-93
Dr. P. K. Joshi	Exploitation of micro-organisms by man 10-2-93
Dr. S. S. Rajan, (Sr. Advisor, FAO)	How green is the green revolution 16-3-93

DISTINGUISHED VISITORS TO NRCG

9-10 April 1992	QRT Team with Dr. J.V.Goud as Chairman and Dr.G.P.Chennabasavanna, Dr. J. N. Chand, Dr. C. P. Malik and Dr. B. G. Jaisani as members
21 May 1992	Dr. M.K.Nair, Director, CPCRI, Kasaragod
	Dr. P. K. Koshy, Jt. Director, CPCRI, Kayangulam
3 December 1992	Dr. E. V. V. B. Rao, PC (Cashew), NRCC, Puttur
	Dr. M. V. Rao, Vice Chancellor, APAU, Hyderabad
5 December 1992	Dr. G. R. Nayan, Chairman, Oil orissa (ERU),Khurda
	Dr. N. N. Dholakia, Mng. Director, JUREUN, Junagadh
16 March 1993	Dr. S. S. Rajan, PC (Oilseeds) (Retd)
	Dr. M. V. R. Prasad, Project Director, DOR, Hyderabad

Dr. S. Nagarajan, DDG (CS) in discussions with NRCG Scientiests

The NRCG management committee meeting

NRCG STAFF (AS ON 31.3.1993)

Dr. P. S. Reddy,	**Director**

SCIENTIFIC

Dr. M. P. Ghewande,	Sr. Scientist
Dr.N.R.Bhagat,	Sr. Scientist
Sh. Y. C. Johi,	Scientist (SG)
DR. M. S. Basu,	Sr. Scientist & PC(I/C)(Groundnut)
Sh. J. B. Misra,	Scientist (SG)
Dr. A. Bandyopadhyay,	Sr. Scientist
Dr. P. Sen,	Sr. Scientist
Dr. P. K. Joshi,	Sr.Scientist
Sh. Devi Dayal,	Scientist
Dr. P. C. Nautiyal,	Scientist
Dr. A. L. Singh,	Scientist
Dr. T. G. K. Murthy,	Scientist
Dr. V. Ravindra,	Scientist
Sh. T. Radhakrishnan,	Scientist
Sh. V. Nandagopal,	Scientist
Sh. K. Rajgopal,	Scientist
Dr. S. Desai,	Scientist (on study leave)
Dr. Vijendra Singh,	Scientist
Dr. S. K. Yadav,	Scientist

TECHNICAL

Dr. R. S. Tomar,	Farm Superintendent T-6
Sh. V. K. Sojitra,	Technical Officer T-5
Sh. C. P. Singh,	Farm Manager T-4
Sh. H. M. Hingrajia,	Farm Manager T-4
Ku. Sheela M. Chauhan,	Technical Assistant T-4
Sh. V. G. Koradia,	Technical Assistant T-4
Sh. D. M. Bhatt,	Technical Assistant T-4
Sh. D. L. Parmar,	Technical Assistant T-4
Sh. Prem Narayan,	Technical Assistant T-4

Sh. P. R. Naik,	Technical Assistant T-4
Sh. N. R. Ghetia,	Technical assistant T-4
Sh. P. K. Bhalodia,	Technical Assistant T-4
Sh. P. V. Zala,	Technical Assistant T-II-3
Sh. B. M. Chikani,	Technical Assistant T-II-3
Sh. R. K. Jaroli,	Technical Assistant T-II-3
Smt. Vidya S. Chaudhari,	Technical Assistant T-II-3
Sh. Virendra Singh,	Technical Assistant T-II-3
Sh. M. A. Khan,	Technical Assistant T-II-3
Sh. R. S. Mathur,	Technical Assistant T-II-3
Sh. Gedia Maheshkumar,	Technical Assistant T-II-3
Sh. Gor Harsukhbhai,	Technical Assistant T-II-3
Sh. Ranvir Singh,	Technical Assistant T-II-3
Sh. B. N. Dongre,	Technical Assistant T-II-3
Sh. J. R. Dobaria,	Technical Assistant T-II-3
Sh. S. D. Savalia,	Technical Assistant T-II-3
Sh. D. R. Bhatt,	Technical Assistant T-II-3
Ku. P. U. Pandit,	Technical Assistant T-II-3
Sh. P. R. Mehta,	Field-cum-Lab. Asst. T-1
Sh. A. D. Makwana,	Field-cum-Lab. Asst. T-1
Sh. G. J. Solanki,	Field-cum-Lab. Asst. T-1
Sh. Sugad Singh,	Field-cum-Lab. Asst. T-1
Sh. H. V. Patel,	Field-cum-Lab. Asst. T-1
Sh. Prabhu Dayal,	Field-cum-Lab. Asst. T-1
Sh. Padvi Rameshbhai,	Field-cum-Lab. Asst. T-1
Sh. C. B. Patel,	Artist-cum-Photographer T-1
Sh. A. M. Vakharia,	Electrician T-1
Sh. P. B. Garchar,	Tractor Driver T-2
Sh. J. G. Kalaria,	Driver T-2
Sh. K. H. Koradia,	

ADMINISTRATIVE

Sh. S. K. Mitra,	Administrative Officer
Sh. J. Ramani,	Assistant
Sh. J. B. Bhatt,	Assistant

Smt. Rosamma Joseph,	Stenographer
Sh. Y. S. Karia,	Jr. Stenographer
Sh. L. V. Tilwani,	Jr. Stenographer
Sh. R. T. Thakar,	Sr. Clerk
Ku. K. A. Vasani,	Jr. Clerk
Smt. Santha Venugopalan,	Jr. Clerk
Sh. A. D. Parmar,	Jr. Clerk
Sh. C. G. Makwana,	Jr. Clerk

AUXILIARY

Sh. R. K. Singh,	Security Supervisor
Sh. G. Mookherjea,	Hindi Translator (Under suspension)
Ku. M. J. Vora,	Hindi Typist
Sh. B. M. Solanki,	Tractor Driver
Sh. G. G. Bhalani,	Driver
Sh. N. M. Safi,	Driver

SUPPORTING

Sh. D. M. Sachania,	Field Assistant, SSG.III
Sh. N. M. Pandya,	Field Assistant, SSG.III
Sh. R. B. Chawda,	Chowkidar, SSG.II
Sh. C. N. Jethwa,	Safaiwala, SSG.II
Sh. B. K. Bariya,	Safaiwala, SSG.II
Sh. R. D. Nagwadia,	Messenger, SSG.II
Sh. R. V. Purohit,	Chowkidar, SSG.I
Sh. M. B. Sheikh,	Chowkidar, SSG.I
Sh. J. G. Agrawat,	Chowkidar, SSG.I
Sh. G. D. Moradia,	Chowkidar, SSG.I
Sh. V. N. Kodiatar,	Chowkidar, SSG.I
Sh. R. P. Sondarwa,	Chowkidar, SSG.I
Sh. P. N. Solanki,	Dup. Mach. Operator SSG. I
Sh. V. M. Chavada,	Messenger, 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

Ku. Daya C. Sachania,	Messenger, SSG. I
Sh. Alji D. Makwana,	Chowkidar, SSG. I
Sh. A. M. Tarakhala,	Messenger, SSG. I

NEW APPOINTMENT

Sh. P. R. Mehta,	T.A.T-II-3
Sh. C. G. Makwana,	Jr.Clerk
Sh. A. M. Tarakhala,	Messenger, SSG. I

TRANSFER

Sh. N. Vishwambharan,	Office Supdt.	-	31.10.92 to	DWMR, Rahuri
Smt. P. Vishwambharan,	Sr.Clerk	-	4.11.92 to	DWMR, Rahuri
Smt. Gauri Harindran,	Jr.Clerk	-	14.8.92 to	CMFRI, Cochin

PROMOTION

Sh. V. K. Sojitra,	Tech. Officer T-5	-	1.1.92
Sh. P. R. Naik,	Tech. Asst. T-4	-	1.7.92
Sh. N. R. Ghetia,	Tech.Asst. T-4	-	1.7.92
Sh. P. K. Bhalodia,	Tech.Asst. T-4	-	1.7.92

RESIGNATION

Sh. Net Ram Meena,	Tech.Asst.	T-II-3	-	31.7.92
Sh. Anil Kumar P. Ingle,	Tech.Asst.	T-II-3	-	22.6.92
Sh. A. M. Tarkhala,	Messenger,	SSG. I	-	26.2.93

RETIREMENT ON SUPERANNUATION

Dr. K. S. Amin,	Principal Scientist	-	31.10.92

VOLUNTARY RETIREMENT

Sh. S. B. Surolia,	Assistant	-	1.7.92