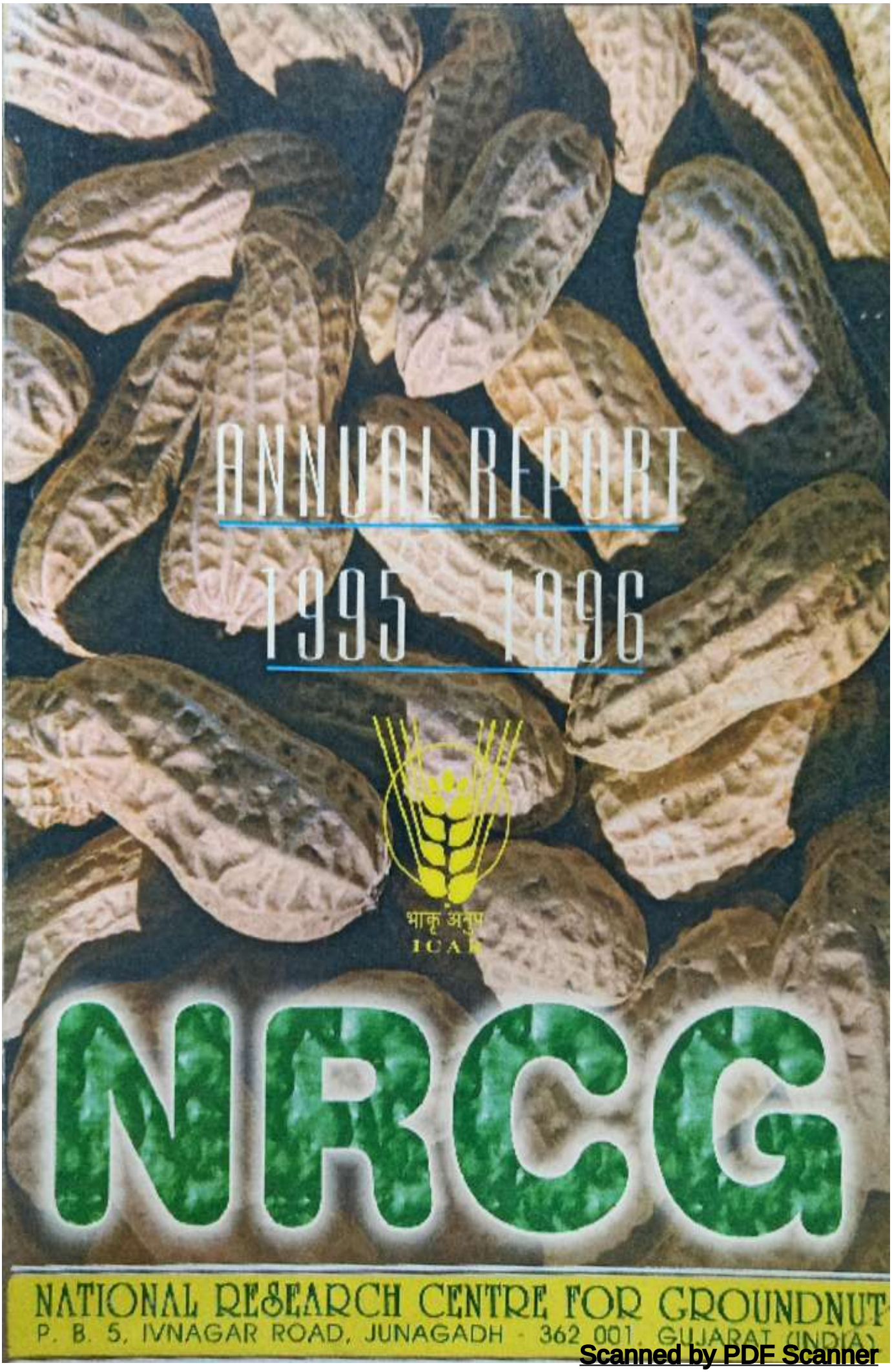

ANNUAL REPORT 1995-96

NATIONAL RESEARCH CENTRE FOR GROUNDNUT

P. B. NO. 5, IVNAGAR ROAD,

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FOREWORD

With the release of the annual report for 1995-96, the Centre has completed seventeen years of its existence. During these years, the Centre has transformed itself from a minimal leased tiled-shelter with basic facilities to a well furnished own research setup to cater to the needs of the National Agricultural Research Systems.

During the period of report, the Centre has developed among others, some cost-effective technologies for the estimation of oil, storage techniques for germplasm accessions, and drying and storing for bulk produce. An integrated pest management package is being fine-tuned for on-farm demonstration. A novel protocol has been developed for the direct regeneration of multiple shoots from somatic embryos. A number of genotypes resistant/tolerant to various stresses were identified. Long-term experiments on groundnut based cropping systems have been initiated. The Centre has now modern communication facilities including E-mail.

Some strong winds of change were initiated by our Director General. One of the most important ones was initiation of drafting a Perspective Plan of Research till the year 2020 AD. This Centre had initiated the preparation of the plan keeping in view the whole scenario, present and future of groundnut in view in consultation with the experts.

The NRCG has been recognised as a centre for the implementation of the pilot project on Technology Assessment and Refinement through Institute Village Linkage Programme. Some of the promising farm technologies for increasing and sustaining the productivity and income in selected villages by involving the scientists of the Centre and Gujarat Agricultural University, Junagadh campus are being demonstrated under this programme.

I am thankful to my colleagues for their valuable contribution in accomplishing the mandate for the year. I acknowledge the help of all my colleagues in preparation of the annual report.

I look forward to any suggestions and advice to achieve our objectives more effectively and efficiently, with in the mandate of the Centre.

January, 1997

Junagadh

A. BANDYOPADHYAY

Director

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I. SUMMARY

अनुसंधान उपलब्धियों का सारांश

मूंगफली के 4861 ऐक्सेशनों का रखरखाव, मूल्यांकन तथा पुनर्वौवनान्वयन किया गया। अट्ठाईस प्रजातियों को विभिन्न कृषि विश्वविद्यालयों तथा 1500 जीनोटाइपों को ICRISAT से संग्रहित किया गया तथा अतिरिक्त ऐक्सेशनों को प्रलेखित कर वस्तुसूची को अद्यतन किया गया। भुवनेश्वर स्थित विमोचनी केंद्र से 307 जीनोटाइपों की पूर्ति विभिन्न अनुसंधान कर्ताओं को उनकी विशिष्ट आवश्यकतानुसार करी गयी। भुवनेश्वर केंद्र पर 1500 जीनोटाइपों का प्रारंभिक मूल्यांकन भी किया गया। सन् 1905 से 1995 के दौरान विमोचित 56 प्रजातियों का लक्षण-निश्चयन किया गया। ICRISAT – ICAR सहयोग कार्यक्रम के अंतर्गत जर्मप्लास्म का मूल्यांकन किया गया।

साधारण पोलिथीन अथवा प्लास्टिक के थैलों की अपेक्षा ऐल्यूमिनियम की तीन परतों वाली थैलियों में जर्मप्लास्म का भण्डारण करने पर उनकी बीज-जीवन क्षमता लम्बे समय तक परिरक्षित की जा सकी।

ऐक्सेशन NRCG 6927 जो कि Jassid कीट के लिए एक ज्ञात प्रतिरोधी है, को रस्ट एवम् टिक्का के प्रतिरोधी भी पाया गया। बड़े-बीज-वाले, 3 जीनोटाइपों में कन्फेक्शनरी के लिए वांछनीय गुण पाये गये। अन्य 3 जीनोटाइपों ने एस्पर्जिलस फ्लेवस (*Aspergillus flavus*) के विकास को कम समर्थन दिया।

रबी-ग्रीष्म के उत्पादकता परीक्षणों में, 16 अंतिम स्पेनिश कल्चरों में से PBS 10 तथा PBS 18 ने, चेक (Check) किस्मों Girnar 1 तथा GG 2 को पीछे छोड़ दिया। अन्य 18 वर्जीनिया कल्चरों में PBS 19 की उपज, चेक किस्मों ICGS 44 तथा Kadiri 3 के बराबर थी तथापि इसकी सौ फलियों एवं सौ बीजों का भार अधिक था।

खरीफ में, 32 स्पेनिश कल्चरों के साथ जो उपज परीक्षण किए गये, उनमें PBS 171 में सर्वाधिक तेल अवयव पाया गया तथापि उपज में यह चेक प्रजातियों के बराबर था। वर्जीनिया किस्म के 23 कल्चरों में, CS 21, PBS 101, एवम् M 13 X Robot 33 - 1D ने चेक प्रजाति Kadiri 3 से क्रमशः 24%, 20%, एवम् 16% अधिक उपज दी। अन्य कल्चर जिनकी उपज चेक से अधिक थी इस प्रकार हैं - PBS 181, PBS 185, PBS 190 एवम् PBS 191। म्यूटेशन - प्रजनन (Mutation breeding) प्रयोगों से ज्ञात हुआ कि Girnar 1 प्रजाति की शेलिंग (Shelling) में सुधार की संभावना है।

रबी-ग्रीष्म के परीक्षणों में, 53.5% का अधिकतम तेल अवयव Starr में मिला, जिसका अनुसरण JL 24 (53.3%) तथा PBS 10 (53.2%) ने किया।

जैविक तथा अजैविक विक्रियाओं के प्रतिरोध के लिये प्रजनन प्रयोगों में 7 जीनोटाइपों (PBS 33, 70, 136, 185, 190, Girnar 1, एवम् Selection B 19) को लौह की कमी के कारण आये पीलेपन के लिये सहिष्णु पाया गया, एक Co 1 X PI 259747 प्रसंकरण से प्राप्त जीनोटाइप ने BND को सबसे कम समर्थन दिया, एक अधिक उपज देनेवाली स्पैनिश जीनोटाइप (PBDR 94-1) में रस्ट के लिए सामान्य प्रतिरोध मिला तथा एक अन्य अधिक उपज देनेवाली वर्जीनिया जीनोटाइप (PBS

48) से रस्ट के लिए उच्च प्रतिरोध मिला । पर्ण सुरंगी (leafminer) के लिये, 14 जीनोटाइपों में प्रतिरोध मिला ।

इन विट्रो (in vitro) जन्य पुष्पों से प्राप्त परागकणों को कीटाणु संदूषण से मुक्त पाया गया । इन विट्रो नोडल कल्चर तकनीक द्वारा 6 अंतर्जातीय प्रसंकरों को सफलतापूर्वक संवर्धित कर तदोपरांत उन्हें क्षेत्र में प्रत्यारोपित किया गया । शाखा-कलिकाओं की सुषुप्तावस्था तोड़ने तथा शाखांकुरण को बढ़ावा देने के लिये 5 मि.ग्रा. प्रति लिटर या इससे अधिक सांद्रता में BA का उपयोग सक्षम पाया गया । PStV से मुक्त अंतर्जातीय प्रसंकरों का इन विट्रो नोडल कल्चर विधि से संवर्धन में, कीटाणु संदूषण दूर करने के लिए, जेंटामाइसिन को प्रभावी पाया गया ।

अंतर्जातीय प्रसंकरण से उपलब्ध 42 अग्रणी तथा 143 अन्य चयनों का संवर्धन किया गया । तेरह जंगली प्रजातियों की बीज प्रोटीन तथा 16 जंगली प्रजातियों एवं 10 अंतर्जातीय प्रसंकरों की पर्ण-प्रोटीन का SDS-PAGE द्वारा लक्षण-निश्चयन किया गया ।

अधिक पेग-शक्ति (peg strength) वाले 269 चयनों तथा 29 प्रसंकरों का वंश अनुसरण किया गया ।

NARP द्वारा समर्थित एक परियोजना के अंतर्गत, जो 11 संयोजन प्रयोग किये गये, उनमें MS मिडियम में Gerlite (1.5 मि. ग्रा. प्रति लीटर) तथा GA 3 (0.25 मि.ग्रा. प्रति लीटर) का संयोजन, सोमेटिक भ्रूण परिवर्तन प्रेरित करने में सबसे उपयुक्त रहा । BA (1मि. ग्रा. प्रति लीटर) तथा GA 3 (3 मि. ग्रा. प्रति लीटर) के प्रयोग से एक अनूठा प्रोटोकोल विकसित किया गया जो सोमेटिक भ्रूण से बहु-शाखीय प्ररोहण करने में सक्षम था । MS मिडियम में, 2-4,D (14 मि. ग्रा. प्रति लीटर) तथा NAA (2 मि. ग्रा. प्रति लीटर) के संयोजन ने द्वितीय भ्रूणजनन की आवृत्ति को बढ़ा दिया ।

गेहूँ के भूसे को मल्च की तरह प्रयोग करने के लाभकारी परिणाम की पूर्व जानकारी की संपुष्टि हुई ।

इक्कीस प्रजातियों (11 गुच्छेदार तथा 10 फैलने वाली) का, उनकी निर्यात-योग्यता के लिये मूल्यांकन किया गया । गुच्छेदार प्रजातियों में GG 2, ICGS 11, एवं ICGS 44 तथा फैलने वाली प्रजातियों में Somnath एवं R 141 ने रबी-ग्रीष्म में अधिक उपज दी । खरीफ में, गुच्छेदार प्रजातियों में ICGS 76, GG 2, ICGS 11 एवं CO2 ने अधिक उपज दी तथा फैलने वाली प्रजातियों में M 335 तथा M 37 उल्लेखनीय रहीं गुच्छेदार प्रजातियों में सामान्यतः फली-उपज तथा वरण, फैलनेवाली प्रजातियों से अधिक पाये गये । ICGS 21 एक कम तेल (47.3%) तथा ऊँचे O/L अनुपात (2.1) वाली प्रजाति पायी गयी । अन्य प्रजातियां, जिनका O/L अनुपात >2 था, वह इस प्रकार रहे - ICGS 76 (2.47), BG 2 (2.20) तथा PG1 (2.05) ।

यदि वर्जीनिया किस्म की मूंगफली के बाद, गेहूं की फसल ली जाय तो उसमें ऊपर से डाली गई नत्रजन की आवश्यकता केवल 60 किग्रा प्रति है॰ रह जाती है ।

मूंगफली पर आधारित फसल प्रणालियों का मूल्यांकन करते समय पता चला कि यदि गेहूं को खरीफ की मूंगफली के पश्चात् लेने के अजाय खरीफ की मडती भूमि के पश्चात लिया जाय तो, गेहूं की उपज 10% अधिक होती है ।

बीज की परिपक्वता ने पौध संख्या एवम् उपज दोनो को ही प्रभावित किया । मूंगफली की उपज पर सिर्फ पौधों के घनत्व का ही नहीं बल्कि उनके पौध-से-पौध अंतराल की ज्यामिति का भी प्रभाव देखा गया ।

खरपतवारनाशक, Pendamethalin (निकलने से पूर्व, 1 कि. प्रभावी तत्व प्रति है. की दर से) तथा Flusi-fop-p butyl (निकलने के उपरांत, 0.25 कि प्रभावी तत्व प्रति हें की दर से) एवं बुआई के 35 दिन पश्चात निराई के संयोजित प्रयोग से सर्वाधिक लाभ मिला (लाभ-लागत अनुपात - 3.38) ।

केन्द्र के जर्मप्लास्म एवं कार्यसाधक संग्रह को PStV से मुक्त रखने के लिये सम्मिलित एवं निरंतर प्रयास किये गये । केन्द्र एवम् पडोसी कृषि विश्वविद्यालय के प्रक्षेत्रों का सर्वेक्षण तथा पाए गये संदिग्ध पौधो का नाश, बुआई-पूर्व व्यापक स्तर पर हरेक बीज का ELISA तकनीक द्वारा परीक्षण, सामग्री का जूनागढ के बाहर PStV मुक्त क्षेत्रो मे संवर्धन एवं पुनर्योवनान्वयन, तथा अंतर्जातीय प्रसंकरों एवं अन्य सामग्री का टिश्यूकल्चर तकनीक द्वारा इन विट्रो संवर्धन, इस रणनिति के अंग रहे ।

खरीफ '95 मे, समान-रोग-पौधशाला मे 50 जीनोटाइपों को परखा गया, जिसमे 22 को ELS के लिए, 8 को LLS के लिये, 19 को रस्ट के लिये, तथा 7 को तीनों रोगो के लिये प्रतिरोधी पाया गया । रबी-ग्रीष्म में 72 जीनोटाइपों को परखा गया, जिसने चयन 239 पर कोई भी PBND, 10 जीनोटाइपो पर कोई भी PStV, तथा 13 जीनोटाइपों एवं कुछ जर्मप्लास्म ऐक्सेशनों पर कोइ भी Stem rot नहीं दिखाई दी ।

सस्य प्रणाली मे हेर-फेर करने पर ज्ञात हुआ कि, खरीफ में जल्दी बुआई (लगभग 15 जून) करने पर, दोनो लीफ-स्पॉट तथा रस्ट का प्रभाव कम था, तथा 45 से.मी. x 10 से.मी. का दूरी मे रोपण करने पर लीफ स्पॉट तथा रस्ट का सबसे कम प्रभाव था । रबी-ग्रीष्म मे जल्दी अथवा देर मे बुआई करने पर PStV का कम असर रहा, 22.5 से.मी. x10 से.मी. की दूरी के रोपण में PBND न्यूनतम होने के साथ ही अधिकतम उपज रही । ज्वार के साथ अंत फसल लेने पर Altarnaria लीफ स्पॉट मे 16% की कमी आयी ।

Terminalia पर्ण अथवा नीम-बीज के पाउडर से मूंगफली के बीज का उपचार करने पर प्रारंभिक पौध संख्या अधिक रही ।

खुदाई-पूर्व अफ्लाटॉक्सिन संदूषण के लिये 15 बडे बीज वाले जीनोटाइपों का मूल्यांकन किया गया । इनमे ICG 239 की फलियां एवं बीज, दोनो ही *Aspergillus flavus* के संक्रमण एवम उपनिवेश से मुक्त थे । चौबीस जीनोटाइपों का मूल्यांकन *Aspergillus flavus* के इन-विट्रो संक्रमण, उपनिवेश तथा अफ्लाटॉक्सिन संदूषण के प्रतिरोध के लिये किया गया, इनमे 5 जीनोटाइपों को बीज-उपनिवेश के प्रति सहिष्णु पाया गया ।

परीक्षणों से, इस केन्द्र पर पहले विकसित एकीकृत-पेस्ट-प्रबंधन प्रणाली (जिसमे नीम आधारित कीटनाशक, अंतः तथा ड्योढी फसलें, न्युनतम रसायन तथा Pheromone trap सम्मिलित हैं) की संपुष्टि हुई तथा प्रणाली में रसायनों का न्यूनतम प्रयोग कर, अधिक लाभ देने की क्षमता परिलक्षित हुई ।

Thrips की Oviposition कम करने में नीम-उत्पाद तथा रसायनिक कीटनाशकों का संयोजन लगत रहा ।

वर्ष-दौरान कीट-संख्या के अनुवीक्षण से पता चला कि एफिड-संख्या दिसम्बर में बढ़नी प्रारंभ होकर, जनवरी में शिखर पर पहुँचे, फरवरी और मार्च में तेजी से घट गयी । अप्रैल से नवम्बर के दौरान एफिड-संख्या लगभग नगण्य रही । पर्ण-सुरंगी संख्या सितम्बर में बढ़नी प्रारंभ होकर, दिसम्बर में अधिकतम पहुँच कर, फरवरी में गिर कर, मार्च से सितम्बर के दौरान सबसे कम रही ।

कम नमी की स्थिति में, पत्तियों में नाइट्रेट रिडक्टेज तथा ग्लूटामेट पायरूवेट ट्रांसएमीनेज एन्जाइमों की क्रियाशीलता में गिरावट आई । मूलभूत अध्ययनों से पता चला कि पत्तियों में सुक्रोज के संश्लेषण में सुक्रोज-फास्फेट-सिंथेज एंजाइम के अतिरिक्त, सुक्रोज सिंथेज एंजाइम का भी योगदान हो सकता है ।

रबी-ग्रीष्म के उत्पाद में बीज-जीवनी शक्ति के ह्रास में, जीनोटाइपों में व्यापक अंतर देखे गये । Jyoti, KRG 1 तथा SB 11 के बीजों में 12 माह के भण्डारण के उपरांत भी, 80% या अधिक अंकुरण मिला, जब कि 15 अन्य जीनोटाइपों में 50% या इससे भी अधिक अंकुरण का ह्रास हुआ । केन्द्र द्वारा विकसित सुखाने तथा भण्डारण तकनीक के प्रयोग से GG 2 किस्म के बीजों में, 12 मास के भण्डारण उपरांत भी, 75% अंकुरण तथा 470-500 SVI संचित रही, जबकि किसानों की सुखाने एवं भण्डारण रीति में केवल 45% अंकुरण तथा 20 SVI ही शेष रहे ।

दो सौ जर्मप्लास्म एक्सैशनों की जांच करने पर, 6 एक्सैशनों के नये बीजों में अत्यधिक सुषुप्तावस्था मिली । बीज की सुषुप्तावस्था नियंत्रण में, बीज के विभिन्न भागों की भूमिकाओं में, वर्जीनिया किस्म के जीनोटाइपों ने व्यापक भिन्नता दिखाई । कुछ में, बीज सुषुप्तावस्था नियंत्रण-घटक पूरी तरह बीज-पत्र में, कुछ में बीज-कवच में, तथा अन्य कुछ में बीजे-पत्र तथा बीज-कवच में बराबर-बराबर विद्यमान थे ।

नौ स्पेनिश जीनोटाइपों में, Girnar 1 तथा ICGS 11 ने नमी की कमी को सहन करने में अपने सापेक्ष जल अवयव तथा प्रकाश संश्लेषण की दर को अधिक बनाये रखा ।

ऊष्मा-सहिष्णुता के लिए 12 स्पेनिश जीनोटाइपों का मूल्यांकन किया गया, जिसमें SG 84 तथा ICGS 44 में अधिक ऊष्मा स्थायित्व पाया गया ।

मात्र स्थूल पोषक तत्वों के प्रयोग से 27% फली उपज बढ़ी, तथा सूक्ष्मपोषक तत्वों के संयोजित प्रयोग से 39% फली-उपज बढ़ी तथा फली का भरण भी अधिक हुआ । पोषक तत्वों का यह लाभकारी प्रभाव, अधिक पर्णहरित, बेहतर बाढ़ तथा प्रकाश संश्लेषण की उच्च दर के द्वारा संभव हुआ ।

Lime द्वारा प्रेरित लौह तत्व की कमी के कारण आया हुआ पीलापन, मृदा में लौह तत्व वाहक यौगिकों के प्रयोग से कम हुआ और इस प्रकार अधिक उपज का कारण बना । इसका प्रभाव लौह-दक्ष प्रजातियों पर अधिक था ।

Bradyrhizobium के 40 तथा Phosphorus Soulbilising Microbes के 3 कल्चरों का रख-रखाव किया गया तथा इनमें से कुछ की पूर्ति विभिन्न कृषि विश्वविद्यालयों तथा अन्य अनुसंधान विभागों को करी गई ।

इस केन्द्र को भारतीय कृषि अनुसंधान परिषद् द्वारा एक नई पाइलट परियोजना **संस्थान-ग्राम सहलग्नता परियोजना द्वारा तकनीकी का मूल्यांकन तथा परिष्करण** प्रदान की गई जिसके अंतर्गत जूनागढ जिले में 26 ग्रामों का सर्वेक्षण कर 4 का चयन किया गया । इन ग्रामों में व्यवहार की जा रही तकनीक के आधार पर भविष्य में प्रसार के लिये कार्यक्रम बना कर परिषद् को अनुमोदन के लिए भेज दिया गया ।

The working collection of 4861 accessions was maintained, evaluated, and rejuvenated. Twenty-eight released cultivars were collected from various SAU's and 1500 genotypes were procured from the ICRISAT. The additional accessions acquired were documented and the inventory was updated. To meet the specific research needs, 307 genotypes were supplied from the off-season centre, Bhubaneswar to various groundnut reserch workers. Preliminary evaluation of 1500 genotypes was done at the off-season centre at Bhubaneswar. Characterization of 56 cultivars, released between 1905 and 1995, was done. Germplasm evaluation under ICRISAT-ICAR collaboration was carried out.

Storage of pods in tri-layered aluminium pouches preserved seed viability of germplasm longer than storage in simple polythene bags or plastic containers. The accession, NRCG 6927, known to be tolerant of jassid was found to have resistance against rust and LLS as well. Three large-seeded genotypes were found to have desirable confectionery traits and another three were found to support a low level of *Aspergitus flavus* infection.

In the yield trials conducted in rabi-summer with 16 advanced spanish type cultures, PBS 10 and PBS 18 out-performed the checks Girnar 1 and GG 2 and among 18 advanced virginia type cultures, PBS 19 while being on a par with the checks ICGS 44 and Kadiri 3, gave a higher hundred pod weight (HPW) and hundred seed mass (HSM). In the yield trials conducted in kharif with 32 spanish type cultures, PBS 171 had the highest oil content (55.6 %) while being on a par with the checks in pod yield. Among 23 virginia type cultures, CS 21, PBS 101 and M 13 x Robot 33-1D recorded 24 %, 20 % and 16 % higher pod yield per plant (PYP), respectively, compared to the check Kadiri 3. In another trial with 22 virginia type cultures, PBS 172 recorded 47 % higher pod yield per plant over the check Kadiri 3. Other cultures which recorded PYP higher than check were PBS 181, PBS 185, PBS 190 and PBS 191. Mutation breeding experiments indicated that there was a possibility of improving shelling percent in Girnar-1.

Among the genotypes used in various rabi-summer trials, the highest oil content of 53.5% was recorded in Starr, followed by JL 24 (53.3 %) and PBS 10 (53.2 %). In the experiments conducted for breeding for resistance to abiotic and biotic stresses, seven genotypes (PBS 33, 70, 136, 185, 190, Girnar 1 and selection B 19) were found tolerant of iron-deficiency chlorosis, one genotype derived from Co 1 x

PI 259747, supported the least BND, one high yielding spanish genotype (PBDR 94-1) showed moderate resistance to rust, while another high yielding virginia genotype (PBS 48) showed high resistance to rust. Presence of resistance to lea miner was found in 14 genotypes.

Anthers collected from *in vitro* produced flowers were found to be virtually free from bacterial contamination. Six interspecific hybrids were successfully multiplied by *in vitro* nodal culture technique and subsequently transplanted in the field. Above 5 mg l^{-1} concentrations of BA were found to break shoot-bud dormancy and promote shooting. Gentamicin, effectively checked contamination by systemic bacteria in *in vitro* nodal cultures to multiply PStV-free interspecific hybrids.

Forty-two advanced interspecific derivatives and 143 selections from various interspecific derivatives were multiplied. Characterization of 23 wild species for their seed proteins and of 16 wild species and ten interspecific hybrids for their leaf proteins was done using SDS-PAGE.

Generation advancement of 269 selections from 29 crosses for high peg strength was done.

In an NARP supported project, among 11 combinations tested, a combination Gelrite (1.5 mg.l^{-1}) and GA3 (0.25 mg.l^{-1}) in MS medium was found to be optimum for inducing somatic embryo conversion. A novel protocol using BA (1 mg.l^{-1}) and GA3 (3 mg.l^{-1}) to induce multiple shoots from somatic embryos of groundnut was developed. 2-4,D (14 mg.l^{-1}) and NAA (2 mg.l^{-1}) in MS medium could induce a good frequency of secondary embryogenesis.

Confirmation of the earlier finding of a beneficial effect of wheat straw mulch for summer groundnut was obtained.

Twenty-one cultivars (11 bunch and 10 spreading) were evaluated for their export worthiness. Among the bunch types, GG-2, ICGS 11 and ICGS 44 and among the spreading types Somnath and R 141 gave high yields in rabi-summer. In kharif, ICGS 76, GG 2, ICGS 11 and Co 2 gave high yields among the bunch types whereas M 335 and M 37 were the notable ones among the spreading

types. In general, pod yield and shelling were higher in bunch types than those of spreading types. ICGS 21 was found to be a low oil (47.3 %) and high O/L ratio (2.1) genotype. Other genotypes having O/L ratio >2 were ICGS 76 (2.47), BG 3 (2.20) and PG 1 (2.05).

When wheat crop was taken after virginia type groundnut, its requirement for external application of nitrogen was reduced to only 60 kg N/ha. While evaluating the fertilizer requirement of groundnut based cropping systems, it was observed that there was an increase in yield of wheat and gram by 10% if taken after kharif fallow than after kharif groundnut.

Seed maturity influenced both crop stand and yield. Over-mature and immature seeds were undesirable. The yield of groundnut was influenced not only by plant density but also by plant-to-plant space geometry.

Combined use of herbicides pendimethalin (pre-emergence, @ 1 kg a.i./ha) and fluzi-fop-p butyl (post-emergence, @ 0.25 kg a.i./ha) and interculturing at 35 days after sowing gave the best returns (benefit cost ratio = 3.38).

Concerted and sustained efforts were made to free the NRCG germplasm and working collection from PStV. The strategy comprised survey of NRCG and neighbouring GAU fields and destruction of suspected plants, a large scale testing of individual seeds by ELISA technique before sowing, multiplication and rejuvenation material outside Junagadh in PStV free areas and *in vitro* multiplication of interspecific hybrids and other material by employing tissue culture techniques.

Fifty promising genotypes were screened in uniform disease nursery in kharif 1995; 22 were found to be resistant to ELS, eight to LLS, 19 to rust and seven to all the three diseases. In rabi-summer, among 72 genotypes screened, ICG 239 showed no incidence of PBND, ten genotypes showed no PStV, and 13 genotypes and a few germplasm accessions remained free from stem rot.

Manipulation of cultural practices showed that an early planting in kharif (around 15 June) attracted a low intensity of both leafspot and rust and a spacing of 45 cm x10 cm had the least leafspot and rust. However, in rabi-summer, an early or late sown crop showed a low incidence of PStV, a spacing of 22.5 x 10 cm showed minimum PBND coupled with maximum yield. Intercropping with jowar reduced

the intensity of *Alternaria* leafspot by 16 %.

Seed dressing with powder of *Terminalia* leaf or neem seed improved the initial plant stand.

Among 15 bold-seeded genotypes evaluated for pre-harvest aflatoxin contamination, ICG 239 was found to be free from pod and seed infection and colonization by *Aspergillus falvus*. Among 24 genotypes evaluated for resistance to *in vitro* infection and colonization by *Aspergillus flavus* and aflatoxin contamination, five genotypes were found to be tolerant to seed colonization.

Experiments confirmed that the IPM protocol, developed earlier by the centre (comprising neem based pesticides, inter- and border- cropping, minimal chemicals and pheromone traps), has all the potential of reaping higher profits with minimal use of chemical pesticides.

Neem products were found to be compatible with synthetic insecticides in bringing down oviposition of thrips.

Monitoring of insect population round the year showed that aphid population started building up in December, reached a peak during January and subsequently declined rapidly during February and March. During April to November aphid population remained almost negligible. The leafminer population started building up in September, reached a maximum in December, declined steadly upto February and remained very low between March and September.

There was a reduction in the activities of the enzymes nitrate reductase and glutamate pyruvate transaminase under moisture deficient conditions. Fundamental studies on the mechanism of sucrose biosynthesis in leaves of groundnut gave indication of a positive role of enzyme sucrose synthase in sucrose production, in addition to sucrose phosphate synthase.

Wide genotypic differences were observed in the extent of loss of seed-viability in the produce of rabi-summer. Seeds (rabi-summer produce) of Jyoti, KRG 1 and SB 11 retained 80 % or more germinability even after 12 months storage compared to 15 other genotypes which all lost 50 % or more germinability. If dried and stored by the method developed by NRCG, the seeds of cv. GG 2 retained about

75 % of germinability and an SVI of 470-500 even 12 months after storage, compared to 45 % of germinability and an SVI of 220 if dried and stored the way farmers do.

Six out of 200 germplasm accessions tested were identified to have a high degree of fresh seed dormancy. Virginia genotypes differed widely in respect of role of seed parts in regulating seed-dormancy. In some, the factors regulating seed dormancy were present almost entirely in the cotyledons while in some they were in the testa and in yet another group they were distributed almost equally in cotyledons and testa.

Both, Girnar 1 and ICGS 11 which withstood the moisture deficiency stress the best among nine spanish genotypes tested, were able to maintain high relative water content and photosynthetic rate under stress.

The cultivars SG 84 and ICGS 44 were identified to have higher thermostability among 12 spanish genotypes evaluated for heat tolerance.

Application of macronutrients alone enhanced the pod yield by 27 % and in combination with micronutrients increased yield up to 39% and improved pod filling also. The beneficial effects of the applied nutrients was mediated via a higher chlorophyll content, a better growth and a high photosynthetic rate. Soil application, also of iron-containing compounds, reduced the yellowing of leaves due to lime induced iron-deficiency chlorosis and thus enhanced the pod yield. This effect was more pronounced in Fe-inefficient genotypes.

Cultures of 40 *Bradyrhizobium* and three phosphorus solubilizing microbes were maintained and several of these cultures were supplied to various SAUs and other research organizations on request.

II. ABOUT THE INSTITUTE

The National Research Centre for Groundnut (NRCG) was established in the year 1979 by the Indian Council of Agricultural Research (ICAR) with the following mandate.

- ☆ To conduct basic and strategic research for increased production and quality of groundnut
- ☆ To develop appropriate production technology for different growing situations and systems
- ☆ To supply segregating breeding material to the national network for location specific selections
- ☆ To act as a national repository for groundnut genetic resources
- ☆ To develop linkages with national and international organizations for research on various aspects
- ☆ To extend consultancy and expertise

The research activities of the Centre are carried out by nine scientific sections : Genetics Resources, Plant Breeding, Genetics and Cytogenetics, Agronomy, Biochemistry, Plant Pathology, Entomology, Plant Physiology and Microbiology. Eighteen research Projects have been formulated (annexure 1) to suit the Centre's mandate and appropriate strategies are followed for the successful implementation of these projects. In addition, three externally funded projects are also being implemented at the NRCG. The supporting sections of the Centre are : Library, Farm, Establishment and Audit and Accounts.

The NRCG is located 4 km away from Junagadh main town on the Junagadh-Ivnagar road. Junagadh is connected by road and a meter-gauge railway line to Ahmedabad, which is 376 km away. The nearby airports are Keshod which is 35 km away and Rajkot which is 110 km away.

The Centre lies on 70.36° E longitude and 21.31° N latitude at an altitude of 60 m above mean sea level. The landscape of the are is generally flat. The soils are medium-black and shallow, with depths ranging from 6" to 18".

The climate of this area is semi-arid with a rainfall ranging from 800 to 1000 mm. The rainfall is highly erratic and more than 90 per cent of the rain is received during June to September with several intermittent long dry spells. The monsoon rains generally commence by the third week of June but sometimes delayed till the first week of August. The winter showers are meagre and rare. The drought is a rule rather than an exception not only for Junagadh but for the entire Saurashtra region. The occurrence of frost is rare in this region.

Agro-Meteorological data of Junagadh for the year 1995-96

Month	Temp °C Max.	Min.	RH %	Rain fall mm/rainy day	Soiltemp.C° 5cm	10cm	Wind vel km/hour	Sunshine hrs/day
Apirl'95	38.3	22.1	67	-	35.9	35.2	-	9.78
May	40.0	25.8	75	-	38.5	38.1	-	7.90
June	38.2	27.0	82	303.0/9	37.8	37.3	-	5.80
July	31.9	25.2	90	301.3/20	31.0	31.0	11.4	1.75
August	30.9	24.8	93	46.5/9	30.3	29.8	6.1	2.00
September	33.2	23.6	88	123.8/7	32.9	32.5	2.85	6.63
October	35.4	22.3	77	33.2/2	33.1	32.9	4.80	7.65
November	33.6	15.0	65	—	29.1	29.1	4.96	8.54
December	31.3	13.3	67	—	27.4	27.1	5.13	7.90
January'96	28.9	12.0	70	—	25.8	25.8	6.70	7.85
February	32.4	13.7	65	1.8/1	28.5	28.2	6.28	9.30
March	37.8	20.4	62	—	34.5	32.7	7.98	9.30

III. RESEARCH ACCOMPLISHMENTS

GENETIC RESOURCES

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

A. Collection

Twenty eight released cultivars {8 virginia bunch(HYB), 7 virginia runner(HYR), and 13 spanish(VUL) } were assembled from three groundnut breeding centres of State Agricultural Universities for characterization.

One thousand and five hundred accessions were assembled from the Genetic Resources Division, ICRISAT Asia Centre, Patancheru, and multiplied at the NRCG Off-Season Nursery (OSN), Bhubaneswar, Orissa.

B. Distribution

To support ongoing research programmes, 307 accessions were supplied to the scientists (Plant Pathology (76), Entomology 1, Plant Breeding (64), Physiology (119), and Biochemistry (47), of this Centre.

C. Maintenance of wild *Arachis* species

Pods from 28 wild species were harvested. Field grown plants showing Peanut stripe virus (PStV) infection were destroyed. The accessions which were ELISA negative for PStV were maintained in pots and *in vitro* nodal cultures were initiated for further multiplication.

D. Maintenance and preliminary evaluation of cultivated germplasm

The working collection of 4861 accessions (728 HYB, 1822 HYR, 677 FST, 1807 VUL, 266 Special feature accessions and 101 Large-seeded virginias) was rejuvenated and multiplied. Data on certain

agronomic traits were recorded. The special features of this morphological and agronomical evaluation were :

* Pre-monsoon sowing was advantageous for germplasm rejuvenation and multiplication

* The crop was not protected against diseases and insect pests. The early-sown accessions were moderately free from major diseases and insect pests and did not show yellowing symptoms, while late-sown accessions showed heavy pest load causing up to 75 per cent pod losses.

i. Variation in pod yield in the working collection

The distribution of pod yield (g/plant), among the 728 HYB and 1281 HYR accessions are given in table 1.

Table 1. Pod yield in 728 virginia bunch and 1281 virginia runner accessions

Range (g/plant)	No. of accessions	
	HYB	HYR
1.0 - 5.0	38	199
5.1 - 10.0	281	676
10.0 - 15.0	288	316
15.1 - 20.0	88	70
20.1 - 25.0	21	13
25.1 - 30.0	12	7
Mean	11.2	8.8
CV	41.1	52.3

In HYB collection, the mean pod yield was 11.2 g as against 13.4 g in controls. Only 203 accessions out-yielded the controls. The promising accessions giving pod yield of 26-30 g were NRCG's 365, 857, 2818, 2845, 4414, 4980, 7499, 7719 and 7834.

The mean pod yield in HYR collection was 8.8 g as against 9.5 g in controls. In NRCG's 755, 1892, 3279, 5420, 5887, 5927 and 9507, the pod yield was about 25.0 g/plant.

In 677 valencia type accessions, mean pod yield was 5.2 g with a range of 1.3 to 12.7 g. NRCG's 160, 1067, 1138, 4895, 7784, 9137,and 9739 recorded pod yield of 10.0 - 12.7 g/plant.

The yield in 180 spanish accessions ranged from 10.1 to 163.0 g/3 m row with a mean of 61.5 g. The pod yield in 480 accessions, ranged from 80.0 to 160 g/plot. Among the large-seeded virginias, NRCG's 671, 1014, 1039, 1800 and 4829 were promising with a 100 seed mass of 50-55 g.

Wide variation in these collections offers selective utilization of the genotypes in the enhancement of productivity in groundnuts.

ii. Screening for major foliar diseases

The germplasm collections of HYB, HYR and VUL were screened for resistance to major foliar diseases, viz. early leaf spot, late leaf spot and rust. The NRCG accessions showing moderate resistance under natural epiphytotic condition are presented in table 2.

Table 2. Cultures showing moderate resistance to foliar diseases

Habit group	ELS	LLS	RUST
HYB	9536	9905	9905,4156,9536
HYR	9853,3303	6074,9853	5625,9853,9974,1982,3306,649
VUL	3951,2485,9752	9451,6385	9461,9462,9471,9600,7658,7133
	7863,7552,TG26	9752,7552	3951,2485,9451,6385,6946,9877
		TG26,7863	7552,TG26,7863,4083

iii. Screening for tolerance to iron chlorosis

The HYB collection was screened for iron chlorosis symptoms. The promising iron chlorosis tolerant lines were NRCG's 504, 603, 722, 1003, 1008, 2725, 2910, 3262, 3294, 4155, 4534, 4770, 4783, 4798, 4994, 5186, 5216, 8588, 9062 and 9544.

iv. Preliminary evaluation at Off-Season Nursery, Bhubaneswar

One thousand five hundred accessions were multiplied and rejuvenated at the OSN, Bhubaneswar to obtain PStV free, stock and then distribute to All India Coordinated Research Project (Groundnut) (AICRPG) centres and other indenters. This collection was scored for major foliar diseases and pod yield and promising accessions identified during evaluation were as follows:

- **Pod yield :**
  ICG's 3724, 3730, 4560, 4581, 4597, 4628, 5584, 6021, 10371, 10464, 10481, 10519, 10892, 10896, 10908, 10948, 10954, 11205, 11835, 11998 and 12329.

- **Resistant/tolerant to foliar diseases :**
  ICG's 4976, 4977, 5107, 6156, 6205, 6264, 6432, 6774, 6806, 7012, 7388, 8680, 8853, 10022, 10024, 10026, 10027, 10034, 10041, 10042, 10043, 10045, 10048, 10450, 10910, 10937, 11088 and 11187.

v. Biochemical evaluation of variants of TMV 2

Seed proteins extracted from fresh seeds of 22 variants of TMV 2 cultivar collected from South India were separated on a 15 per cent (T) acrylamide gel by electrophoresis. Breeder seed of TMV2 was taken as control. A combination of coomassie blue and silver staining, showed 24 prominent bands of proteins with molecular weight ranging from 18 to 106 kDa. There was, however, no difference in banding pattern among these variants, though interestingly, previous experiment with one year old seeds showed differences for the same.

vi. Pollen viability in the Virginias

In vitro germination of pollen in five HYB and HYR accessions was studied. Genotypic differences also existed in pollen germination at 15 and 30 days after flowering (DAF) (Table 3).

Table 3. Mean pollen percentage of germination in virginia accessions at two stages flowering.

NRCG Accession	Pollen viability(%)	
	15 DAF	30 DAF
virginia bunch		
623	80.2	81.5
939	64.2	75.1
952	82.9	77.1
5758	74.0	80.0
ICGS11	87.5	83.5
virginia runner		
453	78.7	85.5
1816	69.7	86.6
5725	84.2	85.9
9944	78.5	83.7
GAUG 10	83.8	86.7

The pollen stored at ambient conditions showed normal viability for 6-8 hrs, whereas at 4°C, the viability was retained up to 24 hrs after anthesis.

vii. Characterization of commercial groundnut varieties.

A trial for characterization of released cultivars (1905 to 1995) comprising 30 VUL/FST and 26 HYB/HYR cultivars was carried out in collaboration with Plant Breeding Section in kharif 1995. Data were recorded on flowering pattern, plant type, branching pattern, pod and seed characters, pod and seed yields, shelling per cent (SP) and hundred seed mass (HSM). An attempt was

made to study the trend of change with respect to the major yield characteristics over the successive years of release. The correlation analysis between the major yield characteristics like pod yield/plant (r=0.36), seed yield/plant (r=0.33), SP (r=-0.10), number of pods per plant (r=0.12), HSM (r=0.27) and the year of release could not reveal any trend. However, the experiment needs repetition over time and locations.

viii. Evaluation of special-feature accessions

An yield evaluation trial of 79 accessions (HYB 18, HYR 22, VUL 20 and FST 19) resistant to major biotic and abiotic stresses and promising for pod yield was conducted adopting RBD, against checks of respective habit groups. The collection was scored for reaction to three foliar diseases (ELS, LLS and Rust) and 16 yield-related characters. NRCG 6927, a tolerant accession to jassid, was also found to be resistant to rust and moderately resistant to LLS. The promising accessions for pod yield were NRCG's 7720 (HYB), 1840, 4152, 3123, 3012 (HYR), 4659 1497, 5108, 4590 (FST), 5103, 5150, 2397, 9573 (VUL).

ix. Evaluation of large-seeded virginia accessions

Twelve large-seeded accessions (HYB-6, HYR-6) were evaluated in a RBD with M 13 and GG 11 as controls. The collection showed significant differences for four pod yield and related traits (Table 4). The performance of RS1, JL55, BAU12 (HYB) and NCAc 6755 (HYR) was encouraging for the second year of evaluation.

The oil, protein, and total soluble sugar contents, respectively, ranged from 48.1 to 51.4, 19.3 to 23.5, and 4.7 to 7.1 per cent. JL 55, UF 780-14 and NCAc 6755 showed desirable confectionery traits like low oil, high protein and sugar contents.

x. Screening of large-seeded accessions for resistance to *Aspergillus flavus* colonization

Three bold-seeded virginia accessions, viz. NRCG's 5505, 8938 and 8939 showed low level of *A. flavus* seed colonisation under field condition.

Table 4 Mean values for two years data on four agronomic and three biochemical traits in large-seeded virginia accessions

Variety	Yield/m2 g	SP	SMS %	HSM g	Oil %	Protein %	Soluble Sugar %
JL 55	66.4	68.4	86.5	59.9	49.4	22.2	7.8
Florispan runner	51.6	66.2	78.3	56.1	50.7	21.1	8.6
NCAc2831	59.8	65.7	80.9	51.8	50.3	22.8	8.9
JL 60	62.1	68.7	88.0	56.3	50.6	21.1	9.4
Var 61-R	63.1	60.4	81.9	53.7	48.4	19.4	8.9
NCAc 324	57.1	66.6	79.9	49.4	50.6	22.3	9.2
NCAc 2938	61.9	66.4	78.8	55.4	49.1	19.3	10.4
BAU 12	81.5	65.0	90.6	69.2	50.0	20.3	8.1
RS 1	94.7	66.9	82.7	57.7	50.5	20.7	8.6
NCAc 1855	65.7	68.2	83.1	56.8	51.4	21.1	7.7
NCAc 6755	66.8	66.4	79.7	57.4	48.6	22.0	8.9
UF 780-14	60.9	66.7	81.1	48.6	50.7	23.5	7.7
Controls							
M 13	58.7	65.7	79.0	56.1	48.1	20.8	9.7
GG 11	57.0	67.5	77.5	49.5	51.0	21.1	7.7

xi. Storage studies of groundnuts in different packaging materials

Pods of six released varieties (HYB : GG 20, ICGS 11, HYR : GAUG 10, Punjab 1 and VUL : JL 24, GG 2) were stored in brown paper bag, tar-coated brown paper bag, polythene bag, tri-layered aluminium foil pouch and plastic container. The germination after a storage for a year indicated significant differences in viability in accessions stored in different packaging materials. The viability of seeds was high in accessions stored in tri-layered aluminium pouch (91.8 - 100.0 per cent), followed by polythene bags (87.9 - 100.0 per cent) and the plastic containers ((86.0 - 100.0 per cent). Similar trend was observed after 15 months storage however, with slight fall in germination.

E. Screening of accessions for presence of PStV in seed by ELISA test

The working collection of kharif 1986 (3800 accessions) and 1988 (800 accessions) were conserved at the National Gene Bank, NBPGR, New Delhi. Among them, 700 accessions were culled out from the genebank and tested for the presence of PStV infection using ELISA test. Only eight accessions showed moderate infestation. The produce of kharif 1986 and 1988 was, in general, free from PStV disease.

F. Documentation of evaluation data

The inventory of the germplasm collection was updated with passport information made available by Genetic Resources Division, ICRISAT Asia Centre, Patancheru and the revised accession register was prepared.

PLANT BREEDING

Project : Breeding and genetic studies for improving yield and quality in groundnut (*A. Bandyopadhyay, R.K. Mathur, P. Manivel*)

A. Multiplication, Generation advancement and Selection

In rabi/summer 1995, 250 advanced breeding cultures and 161 germplasm lines were multiplied. Generation advancement from F_2 to F_6 was done in 154 segregating cultures.

In kharif 1995, 142 advanced breeding cultures and 111 germplasm lines were multiplied. Sixteen F_1, 236 F_2 to F_5 cultures, 229 F_7 and 32 F_8 cultures were advanced to next generation and selections were made in F_4 generation onwards.

B. Evaluation of selected advanced cultures

In rabi/summer 1995, two yield evaluation trials were conducted.

i. Trial 1

Out of 16 advanced cultures of spanish type tested along with with Girnar 1 and GG 2 as checks, PBS 10 and PBS 118 recorded pod yield per plant (PYP) and seed yield per plant (SYP) on a par with the checks and had significantly high hundred pod weight (HPW) and hundred seed mass (HSM). The SP was also high (75.0 and 72.2 %, respectively). In rabi/summer 1994 also PBS 10 had significantly out yielded the check while PBS 118 was on a par. PBS 192 recorded the highest oil content of 53.4 per cent. PBS's 1, 10, 11, 24, 171 and 192 had oil content on a par with Girnar 1 (52.8 %).

ii. Trial 2

Among 18 virginia type advanced cultures evaluated with ICGS 44 and Kadiri 3 as checks, the cultures PBS's 38, 41, 181, 187, 190, 191 and 192 recorded PYP and SYP on a par with check cultivars. PBS 190 had significantly higher HPW and HSM (43.9g) over the best check ICGS 44. The cultures PBS's 38, 41, 181, 183, 191 and 192 were on a par with the check during rabi/summer 1994 also. Thirteen cultures had more than 50 per cent oil content.

Four rainfed yield trials were conducted during kharif 1995.

iii. Trial 1

Tirty-two spanish type advanced cultures were tested along with Girnar 1 and JL 24 as checks. The cultures PBS 171, 10 and 170 were on a par with the checks and had more than 70 per cent shelling. PBS 1 recorded the highest oil content of 55.6 per cent followed by SK 8/106 (54.2 %). PBS's 11, 15, 24, 17, 120, 171, 188 and 192 also recorded more than 52 per cent oil content.

iv. Trial 2

Twenty-three virginia type advanced cultures derived both from inter- and intra- specific crosses were tested. The results showed that cultures CS 21, PBS 101 and M 13 x R 33-1 D recorded 24, 20 and 16 per cent increase in PYP and 24, 19 and 11 per cent increase in SYP, respectively, over the check kadiri 3. The HSM of M 13 X R 33-1D was also high (37.11 g). The cultures SK 36 (52.6 %), SK 23 A (51.8 %) and PBS 151 (51.1 %) recorded significantly higher oil content than Kadiri 3 (49.4 %).

v. Trial 3

Out of 22 virginia type advanced cultures, PBS's 172, 181, 185, 190, and 191 recorded significant increase in PYP and SYP over checks, Kadiri 3 and ICGS 44. A maximum increase of 47 per cent for PYP and 45 per cent for SYP over Kadiri 3 was recorded in PBS 172. All the five cultures except PBS 181 recorded higher HSM and SP than the checks. The cultures PBS 190 (55.9 %), PBS 185 (54.9 %) and PBS 187 (54 %) had higher oil content than both the checks. Remaining cultures also recorded oil content more than 52 per cent.

vi. Trial 4

Fifteen HPS cultures were tested in an augmented RBD with three replications. The crop was badly affected by the continuous stagnation of the run-off water, thus, plant stand was poor.

C. Screening for high BNF efficiency

With the objective of screening for high BNF efficiency, 22 entries (20 cultures and 2 cultivars) were raised. Due to unusual monsoon the crop growth was not normal. However, the results pertaining to the sampling done at 45 and 60 DAS showed no significant variation for all the traits studied at 45 DAS whereas fresh root weight, plant height and number of pegs showed significant variation at 60 DAS.

D. Study on reproductive efficiency

A pilot study was undertaken on flowering pattern to know the reproductive efficiency of genotypes belonging to different habit groups. The main objective was to gear up the research efforts for bridging the gap between flower load and pod yields, and to ensure that all the gynophores produced develop into pods through appropriate agronomic manipulations. Eight cultivars belonging to four habit groups viz. valencia (Gangapuri and MH 2), spanish (GG 2 and JL 24), virginia bunch (Kadiri 3 and Somnath) and virginia runner (BG 1 and GAUG 10) were grown in pots. Flowering pattern in different habit groups differed. Valencia was the earliest to flower while, virginia runners were late. Further, flowering had ceased after 50 days of crop growth in valencia types whereas in spanish after 65 days. In virginia types, bunch cultivars flowered up to 75 days while in runner type it continued after 75 days also.

E. Nodal culture of F_1s

In order to increase the population size of hybrids, nodal culture was attempted. Three hundred and eighty six nodes were cultured. Microbial contamination was a serious hindrance in successful establishment of cultures and to overcome this problem modified sterilization protocols are being standardized.

F. Selection for seed viability

The seeds of 72 advanced breeding lines produced in the previous rabi/ summer season and stored at ambient conditions were tested for seed viability by laboratory germination test. IR 6, PBDR 32, PBS 121 and C, IV retained higher seed viability (49, 48, 47 and 46 %, respectively) after 274 days of storing.

G. Mutation breeding

To improve SP of the cultivar Girnar 1, chemical mutagenesis was attempted. The seeds were treated with mutagens diethyl sulphonate (DES) (0.05, 0.1 and 0.2 %) and ethyl methane sulphonate (EMS) (0.05, 0.1 and 0.2 %) either singly or in four combinations of EMS + DES (viz.,0.05+0.1; 0.05+0.05; 0.1+0.1; 0.1+0.05).

i. M_1 Generation

The result of M_1 generation raised during kharif 1994 and rabi/ summer 1995 are summerised here. DES 0.2 per cent was most lethal (20 % germination). No major phenotypic effect of the mutagen on the morphological characters was noticed. Significant differences in different mutagen treatments were observed for number of mature, immature and total pods/plant, number of sound and shriveled seeds, SP, pod width, seed length and seed width characters. EMS at 0.1 per cent induced higher means for SP than control. DES (0.2 %) induced higher mean for total pods/plant, 2- and 3- seeded pods/ plant, total seeds/plant and pod and seed yield/plant than the control.

ii. M_2 Generation

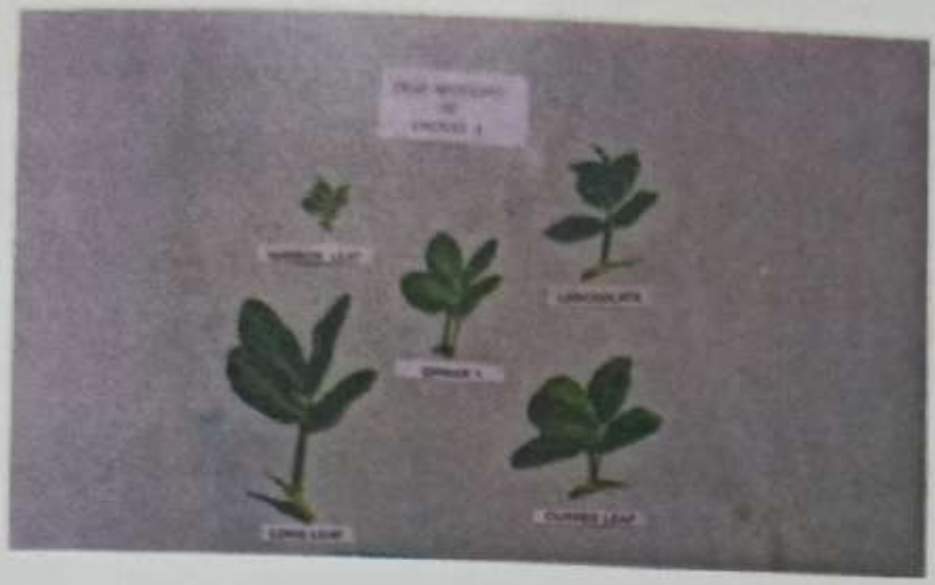
During kharif 1996, 89,762 plants from M_1 generation were raised and characterized for various traits.

a. Types of mutants

Out of 89,762 plants, 11 mutants for leaf colour, 10 for leaf size and shape, 14 for pod size and shape and 7 for plant stature were identified in M_2 generation. Selections were made for good pod bearing (402); clustered bearing (51) and majority of one seeded pods (5), 2 seeded pods (185), 3 seeded pods (105) and 4 seeded pods (2). Fifty-three plants with apparently more than usual pod variation with regard to size and shape were identified.

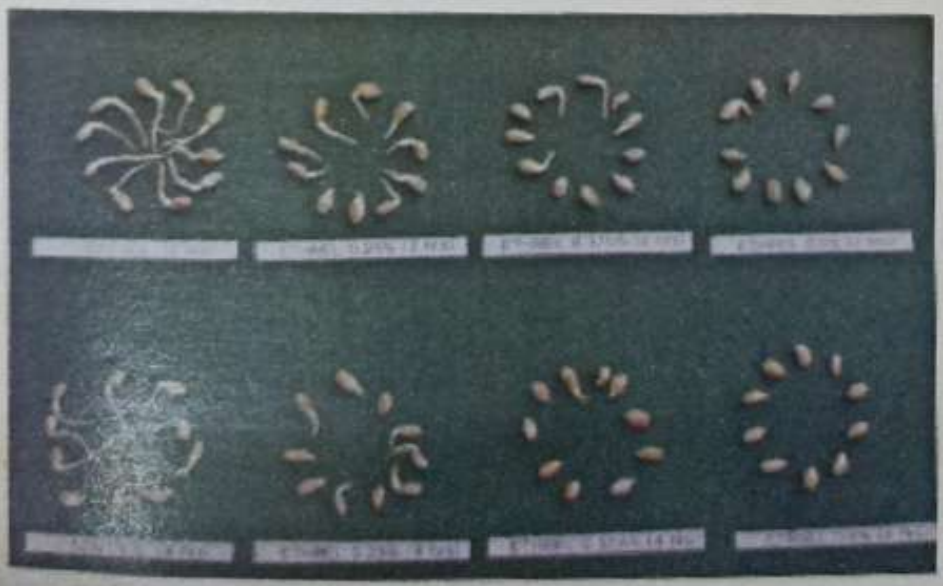
b. Pollen sterility studies

Proportion of sterile pollens to fertile pollens and pollen size was studied on M_2 plants. From each treatment, 80 plants were sampled for pollen sterility, pollen size and anther shape. Distinct variation



a. Leaf mutants of Girnar 1

b. Pod mutants of Girnar 1



c. Germination as influenced by Ethrel treatment

Plate 1. Mutation experiments for improvement of Girnar 1.

(6.5 to 23.4 %) was observed for pollen sterility among the treatments. These results shall be confirmed in the M_3 generation of such selected plants. Significant differences were observed among the treatments for the yield related characters like plant height, number of primary and secondary branches/plant, number of aerial pegs/plant, proportion of 1- , 2- and 3- seeded pods/plant, number of seeds/plant and pod and seed yield/plant.

c. Yield and yield related traits

For all the characters except single seed weight and SP, the means in M_2 were lower than the control as is generally found. Eleven out of 21 M_2 means for SP were higher than control, though statistically not significant. The highest SP was 76.8 per cent for the treatment of 0.05 per cent DES + 0.05 per cent EMS as compared to control (70.1 %). Six of the 11 cultivars had mean seed yield/plant on a par with control. The standard deviation (SD) for SP was higher than the control for seven cases. The highest SD was 31.2 (7.75 in the control) coincided with the highest mean of 76.8 per cent. There seems to be a possibility of selecting for higher SP. The results were more encouraging for single seed weight in which 12 out of 21 treatment means had higher values than the control and as many as seven out of 12 cases had mean seed yield on a par with the control. Seven out of 12 had also higher SP than the control.

H. Hybridization

Five crosses were attempted in summer 1995 (not a normal season for hybridization) to improve SP, earliness and viability in spanish cultivars and to explore the possibility of making crosses in the summer season. The success obtained was 18 per cent. In kharif 1995, a total of 19 crosses were attempted for improving seed viability in spanish (5); earliness in spanish (3) and virginia (5); resistance to aflatoxigenic fungi (4); and high SP (2). The success of harvesting the probable hybrid pods ranged from 11.2 to 45.2 per cent.

I. Oil analysis

Oil content of seed samples of the entries of all trials conducted during rabi/summer 1994 were estimated. The highest oil content (53.5 %) was recorded in Starr followed by JL 24 (53.3 per cent) and PBS 10 (53.2 %). The oil content was more than 51 per cent in PBS's 18, 66, 166, 170, 182 and 192. PBS 190 recorded significantly high oil content (56.7 %) than ICGS 44 and Kadiri 3. In all, ten cultures had oil content more than 54 per cent.

Project: Breeding for resistance to biotic and abiotic stresses in groundnut

(A. Bandyopadhyay, M.Y. Samdur P. Manivel, M.P. Ghewande, V. Nandagopal, P.C. Nautiyal and A.L. Singh)

A. Multiplication and Selection

In rabi/summer 1995, 191 advanced cultures were multiplied. Generations od segregating material from F_2 to F_8 (152) were advanced and a few promising selections were made. A few advanced and promising cultures were also multiplied in polyhouse after ELISA testing. In kharif 1995, 190 advanced cultures were multiplied. Besides, generations of segregating cultures from F_2 to F_8 were advanced and simultaneously selections were made.

B. Screening of advanced breeding cultures for resistance to biotic and abiotic stresses

In rabi/summer 1995, following three experiments were conducted.

i. Screening of advanced cultures for iron chlorosis

The Visual Chlorosis Rating (VCR) and chlorophyll content were estimated at various stages. Out of 20 genotypes , PBS's 33, 70, 136, 185 and 190 and Girnar 1 were found tolerant of iron chlorosis.

ii. Screening of cross derivatives against diseases

Twenty cross derivatives were evaluated in Uniform Disease Nursery Trial against collar rot, BND, PStV and *Alternaria* blight. The incidence of BND ranged from 2.45 per cent (Co 1 X PI 259747 C) to 19.35 per cent (Kisan X NCAc 17133C). The incidence of collar rot, stem rot and *Alternaria* blight was negligible.

iii. Yield evaluation trial

In kharif 1995, in a trial with 30 spanish cultures bred for disease and insect resistance, PBDR 94-1 recorded 11 per cent improvement in pod and seed yield/plant over the best check Girnar 1. Its SP was however on a par with Girnar 1, and showed moderate resistance (a 4 score on 0-9 scale) to rust.

In another trial with 13 virginia cultures selected for resistance to biotic stresses PBS 48 significantly out yielded both the checks (Kadiri 3 and M 13) for PYP and SYP. Its SP was on par with Kadiri 3 but significantly higher than M 13. Score for rust incidence on 0-9 scale for PBS 48 was 2.5.

iv. Screening of advanced cultures against leafminer

The entries of all the six yield evaluation trials conducted during kharif, 1995 (two with spanish, three with virginia and one with HPS cultures) were screened for resistance to leafminer *(Aproaerema modicella)* infestation. Visual scoring on 0-5 scale along with proportion of infested leaves of 20 randomly collected samples were used for screening. Across the trials, CSMG 9101, PBS's 173, 178, 183, 45, 170, PBDR's 13, 31+32, 33A and 34, code's 7, 11, Sel 28a and IR 34 were apparently resistant (score 0-3 and infested leaves < 30 %).

GENETICS AND CYTOGENETICS

Project: Genetics and breeding of high peg-strength in groundnut (*P. Paria*)

Generation advancement of the high peg strength selections from crosses involving M 13 x NRGS 1 (1), GAUG 10 x PBDR 25 (12), GAUG 10 x PI 393523 (8), Karad 4-11 x PBDR 25 (15), Karad 4-11 x CGC 4018 (21), J 11 x PBDR 25 (21), M 13 x PBDR 25 (22), C 364 x 17090 (13), M13 x PI 393523 (2) PBDR 25 x S. Am Col. 25 (7), PI 393523 x S.Am. Col. 25 (4) Karad 4-11 x NRGS 1 (3), C 364 x 4018 (5), GAUG 10 x 4018 (3), Karad 4-11 x PI 393523 (3) were done during rabi/summer 1996.

During kharif 1995, selections from the cross C 364 x PBDR 25 (101), from Karad 4-11 x PBDR 25 (6), GAUG 10 x PBDR 25 (198),(20) Karad 4-11 x CGC 4018 (7), GG11 x NRGS 1 (8), PBDR 25 x S. Am col.(11), PBDR 25 x 4018 (8), M 13 x PBDR 25 (32), M 13 x NRGS 1 (15), C 364 x 4018 (4), PI 393523 x S. Am. Col.(1) M 13x PI 393523 (2), GAUG 10 x NRGS 1 (1) and Karad 4-11 x 4753 (3) were field multiplied.

Project : Characterization and utilization of wild *Arachis* species for groundnut improvement (*P. Paria, Radhakrishnan T, M.P. Ghewande, V. Nandagopal*)

A. Maintenance of interspecific hybrids

Ninety F_1 hybrids of eight different interspecific crosses and 60 spontaneous cultivated forms derived from spontaneous allo-hexaploid hybrids were maintained in the field.

B. Interspecific hybridization

All together 5960 pollinations were made involving CT 7-1, a rust resistant interspecific derivative, in the following combinations:

Cross	Pollinations	Pods collected
1. J11 x CT 7-1	3471	1394
2. CT 7-1 x SB 11	876	331
3. J11 x Corduroy	390	105
4. J11 x (J11x CT 7-1)	811	340
5. J11 x *A. paraguariensis*	412	152

Probable hybrid pods were collected and stored for isolating hybrids in the kharif 1996.

C. Isolation of hybrids

Seven hybrids from the cross CT 7-1 x J11 and one from the cross M13 x CT 7-1 were isolated.

D. Generation advancement

i. Advanced generations

Forty-two advanced interspecific derivatives as well as 73 selections having high yield and other desirable attributes, from the crosses, J 11 x *A. villosa*, GG 2 x *A. chacoense*, M 13 x *A. villosa*, J 11 x *A. chacoense*, J 11 x *A. cardenasii*, Girnar 1 x *A. chacoense* and GG 2 x *A. duranensis* were multiplied in kharif 1995.

ii. Early generations

Seventy selections from the early derivatives of the back-crosses with J11 or Girnar 1 as female parent and the following hybrids (BC1) as male parents were field multiplied:

With J11:
J11 x *A villosa*
J11 x (J11 x *A. cardenasii*)
J11 x *A. chacoense*
J11 x *A.* sp. Manfredi 5
J11 x (TMV 2 x *A. chacoense*)
With Girnar 1:
J11 x *A. chacoense*

E. Generation advancement of PStV free material

In order to generate PStV-free breeding materials and cultures, 45 advanced interspecific derivatives and 2000 single line selections were ELISA tested and planted at the GAU campus, Dantiwada.

One hundred and twenty-four field grown interspecific hybrids were ELISA tested and the 78 PStV free plants were *in vitro* multiplied by using nodal culture.

In order to recover the interspecific hybrids in the field in the shortest possible time, vegetative propagation by micro cutting was attempted. Cuttings with one node at the lower end were planted in thermocol cups containing sterile mixture of three parts of *super-soil* and one part of quartz sand. The cuttings were incubated at 25°C. After incubating for two days in dark, the cuttings were incubated under normal day and night conditions were simulated artificially. The cuttings are being established.

F. Characterization of wild species and Interspecific hybrids

i. Seed proteins

A preliminary study of seed proteins of seven wild spp. of *Arachis* in 1992-93 showed distinct differences in banding pattern on SDS PAGE. A detailed study including 23 wild spp. were done using the SDS PAGE. The preliminary observations showed differences in the buffer soluble protein profile.

ii. Leaf proteins

Leaf protein profiles of 16 wild species were also studied using the SDS PAGE. Leaf tissue was extracted in 0.05 M Tris HCl (Ph 8.5) and the protein content in the supernatant was estimated. In each well 250 micrograms of protein was loaded after preparing it in the Laemmli sample buffer. Preliminary observations showed differences in the bands and the detailed analysis of the gel is in progress.

Leaf protein pattern of the ten interspecific hybrids viz., J11 x *A.* sp. 8192, J11 x *A. cardenasii* (1158), J11 x *A. cardenasii* (11588),

J11 x *A. cardenasii* (8216), J11 x *A. cardenasii* (11561), J11 x *A. ipaense*, J11 x *A. correntina* , J11 x *A.* sp. 8164, J11 x *A. villosa* J11 x *A. khulmanii* and their parents was done by SDS PAGE. The banding pattern is being analyzed.

Project : Embryo rescue, micropropagation and haploid production in Groundnut (*Radhakrishnan T, P. Paria, K. Chandran*)

A. Anther culture

Stable callus cultures were induced on semisolid medium and cell lines could be established in suspension. However, when anthers were collected from flowers of field grown plants, the bacterial contamination was high even after extremely careful sterilization. When anthers collected from the flowers produced *in vitro* were used as source of explants, they callused well without any contamination. *In vitro* flowering is a deviant response of multiple shoot formation. An experiment has been initiated to enhance regular *in vitro* flowering by manipulating the media and growth regulator combinations.

B. Nodal culture

Six interspecific hybrids J11 x ICG 11558, J11 x *A. otavioi*, J11 x ICG 8192, J11 x ICG 8132, J11 x ICG 8164 and J11 x ICG 8216 were multiplied *in vitro* by the nodal culture method previously standardized and were planted in the field in kharif 1995.

C. Micropropagation

In experiments on multiple shoots, it was observed that higher concentrations of BA could induce shoots and break the dormancy of the buds irrespective of their position. An experiment was conducted with *in vitro* germinated shoot cuttings of the variety Florunner. The terminal explants i.e. with apical bud and two or more axillary buds when cultured on MS medium supplemented with 25 mg l^{-1} BA, the dormancy of all the buds was broken irrespective of its position and growth of plantlets was promoted. Hence, the use of higher concentrations of BA was found to be better in the culture of terminal explants.

D. Rescue of PStV free interspecific hybrids and their derivatives

This technique was further applied in rescuing the PSt virus-free interspecific hybrids from the field. Terminal explants from all the 78 virus-free plants were surface-sterilized and cultured *in vitro*. These cultures remained sterile for about a week and then developed bacterial contamination from their cut ends. To overcome this difficulty, the antibiotic Gentamicin (commercially available veterinary injection, liquid) in 80 mg l^{-1} and 120 mg l^{-1} was filter-sterilized and incorporated in to the MS medium containing 25 mg.l^{-1} BA. Explants were surface-sterilized using standard sterilization procedures. It was observed that the incorporation of antibiotic in the culture medium could prevent the contamination from the systemically harboured bacteria. The field grown interspecific hybrids were tested for the presence of PStV. From the plants those ELISA -ve, nodes were collected and cultured following this protocol.

E. Genotypic variability in regeneration potential of the released cultivars *in vitro*

To determine the differences in regeneration potential of different genotypes, de-embryonated cotyledons of 50 released varieties were cultured on MS medium supplemented with three concentrations of BA (10, 15 & 20 mg l^{-1}). The experiment was done in three replications of ten explants each. The regenerative response of the genotypes varied significantly from 6-70 per cent. The maximum response was given by the cv. RS1 and MH 2. The media used also contributed significantly to the variation in response. The media containing 10 and 15 mg l^{-1} of BA were found to be the best. The variation in number of shoots per explant appeared to be determined by genotypic differences amongst the varieties. RS1 and GUAG 10 produced maximum number of shoots per explant. However, the interaction between genotype and medium was significant for response. The results indicated that for augmentation of response, modification to certain extent would be required depending on the genotype.

Project : NARP Project on "Bio-technological approaches for increasing and sustaining yield in major field crops"

Sub project: Crop improvement

Objective 6: Groundnut disease resistance

(A. Bandyopadhyay, T.G.K. Murthy, Radhakrishnan T, S. Desai)

The major objective of this sub-project is to develop reliable and repeatable protocols for the high frequency regeneration of groundnut plantlets by direct and indirect methods of organogenesis.

A. Somatic embryogenesis

i. Germination of somatic embryos

To enhance direct conversion of somatic embryos, the embryos were induced embryo from axes of immature pods of cv. Kadiri3 by culturing on MS medium with 2 hormonal combinations. The embryos (2/14 and 1/7 mg l^{-1}) of NAA and 2,4-D were transferred to following medium for germination.

a. MS medium
b. MS + charcoal 3g l^{-1}.
c. MS + 10mg l^{-1} NAA
d. MS + 15mg l^{-1} NAA
e. MS + charcoal 3g.l^{-1} + 10g l^{-1} Agar
f. MS + charcoal 3g.l^{-1} + 15g l^{-1} Agar
g. 1/2 MS salt medium
h. MS + Gelrite 1.5g.l^{-1} + 0.25 mg l^{-1} BA
i. MS + Gelrite 1.5g.l^{-1} + 0.25 mg l^{-1} BA + charcoal 3g l^{-1}
j. MS + Gelrite 1.5g.l^{-1} + 0.25 mg l^{-1} GA3
k. MS + Gelrite 1.5G/lit. + 0.25mg l^{-1} GA3 + charcoal 3g l^{-1}

Among the combinations tried only the combination j gave best results (62.33 germination percentage).

ii. Direct regeneration of somatic embryos

The immature embryo axes of cultivar Girnar 1 were cultured on MS medium with 2 mg l^{-1} NAA and 14 mg l^{-1} 2,4-D for inducing somatic

embryos. After 25 days of culture, somatic embryos induced were dissected and cultured for direct regeneration through multiple shoots. The culture was done in three different media viz.

* B5 + 0.1mg l^{-1} BA + 0.1mg l^{-1} NAA + 25 µm $AgNO_3$ + 2 % sucrose
* MS + 3mg l^{-1} BA + 1mg l^{-1} GA3 + 2 % sucrose
* MS + 1mg l^{-1} BA + 3mg l^{-1} GA3 + 2 % sucrose

All the combinations of hormones tried could induce multiple shoots from the somatic embryos. However, the 3rd combination was found to induce shoots at the highest frequency (15 shoots/embryo). This method was found to be easier and could also produced more plantlets as compared to direct conversion.

iii. Secondary somatic embryogenesis

The primary somatic embryos induced were again sub-cultured on MS media containing 14 mg l^{-1} 2-4,D + 0,1 and 2 mg l^{-1} NAA and incubated in dark for secondary embryogenesis. Testing of secondary somatic embryos for antibiotic resistance i.e. Hygromycin, Basta and Kanamycin is being done for using as a selectable marker in transformation studies.

iv. Maintenance of embryonic calli

The embryonic calli isolated were maintained on MS medium containing 3 mg l^{-1} Picloram and 1 mg l^{-1} glutamine in dark.

v. Shoot induction from leaves

The petioles and immature leaves of the cv. SB 11 were cultured on MS medium containing three combinations of NAA BA viz. 1 15, 1 20 and 1 25 mg l^{-1} to induce shoot buds which could be used in transformation. However, no shoot buds were induced and all the explants callused. The experiment was repeated using the cv. Florunner, but ending in similar results.

vi. Study tour

A study tour was approved by the Research Advisory Committee (RAC) of the project and was intended to familiarize the co-principal.

co-investigator and project associate with the bio-technological tools with special reference to transformation work on groundnut at the laboratory of Dr. Peggy Ozias-Akins, Coastal Plain Experimental Station, University of Georgia, Tifton, USA. At this laboratory, work on the transformation of groundnut tissues using genes for resistance to *Bacillus thurengensis*, is on. They use *Agrobacterium* mediated as well as biolistic method (using gene gun) for incorporating the genes in groundnut.

The scientist had hands on experience on and preparation of explants *in vitro* for transformation, working operation and handling of gene gun and using gene gun transformation.

They also learnt the use of dry bombardment using gene gun to facilitate *Agrobacterium* infection during co-culture and techniques of locating the genes in the transformants using molecular probes prepared through PCR method.

AGRONOMY

Project : Development of suitable agronomic practices in groundnut

(P.K.Ghosh)

A. Effects of N application and mulching on nutrient availability and pod yield.

Previous experiments at NRCG indicated that the summer groundnut crop with wheat straw mulch showed N deficiency in the early stage (up to 60 days after sowing). An experiment was therefore conducted with two levels of N (25 and 37.5 kg/ha) and two methods of application (basal and top dressing) under two types of mulches (wheat straw and black polythene) during rabi/summer 1995. The highest pod yield (14 q/ha) was recorded in the plots mulched with wheat straw and black polythene followed by wheat straw mulch (13.3 q/ha) and no mulch (12.0 q/ha). There was not much differences in yield to either doses of N or due to method of application.

Soil N content at 30 and 60 days after sowing (DAS) was higher in plots with wheat straw mulch than the control (no mulch). In general, nitrogen content was higher in plots where N was applied as basal dose than top dressing (Table 5). The plots which received higher doses of N, showed higher soil N content at 30 and 60 DAS. However, this could not influence the pod yields.

B. Correction of yellowing in groundnut through management practices

An effort was, made during rabi/summer 1995 to control or reduce the intensity of yellowing by applying to the soil different amendments like FYM, wheat straw, or sulphuric acid (H_2SO_4) alone or a mixture of H_2SO_4 + hydrochloric acid (HCl) at 0.5 per cent concentration. through irrigation water. None of the treatments could correct yellowing excepting a slight improvement due to the application of H_2SO_4. However, application of FYM and wheat straw either singly or in combination improved the yield of groundnut over control.

Table 5. Effect of N application and mulching on N content in soil

Mulches	Total N applied (kg/ha)	Soil N (Kg/ha)					
		30 DAS			60DAS		
		B	T	Mean	B	T	Mean
No mulch	25	87.3	77.0	82.2	131.5	123.7	127.6
			90.6			**108.0**	
	37.5	94.6	103.4	99.0	97.8	79.8	88.4
wheat straw (WS)	25	96.6	89.8	93.4	102.7	105.1	103.9
			96.6			**121.6**	
	37.5	111.4	88.8	100.1	156.6	121.9	139.3
WS+ black polythene	25	83.7	100.2	91.9	82.2	120.8	101.5
			97.0			**107.2**	
	37.5	98.6	105.6	97.0	116.6	109.3	113.0
mean		95.4	94.1		114.4	110.1	

B= basal, T= top dressing; total N was split into two equal parts one for basal and another for top dressing

C. Yield quality characters of groundnut varieties for export purpose

Eleven bunch and ten spreading cultivars of groundnut were tested during rabi/summer and kharif 1995 to study the different quality aspects. In rabi/summer 1995 among the bunch cultivars, highest pod yield was recorded in GG 2 (11.6 q/ha) followed by ICGS 11 (11.4 q/ha) and ICGS 44 (11.4 q/ha). Among spreading cultivars,the yield was maximum in Somnath (12.1 q/ha) followed by R 141 (11.2 q/ha). Maximum hundred seed mass (HSM) was recorded in Somnath (54 g). The HSM of TG 19A , ICGS 21 ,BG 2 and M 335 was in the range of 40-50 g.

In Kharif 1995, among bunch cultivars, the highest pod yield was recorded in ICGS 76 (11.1q/ha) followed by GG 2 (10.6 q/ha), ICGS

11(10.6 q/ha), and CO 2(10.2 q/ha). Among spreading cultivars, highest pod yield was recorded on M 335 (8.5 q/ha) followed by M 37/(8.3 q/ha). In general, pod yield and SP were higher in bunch cultivars than spreading type. The HSM was between 40-50 g in TG 19A, M 335, Somnath and ICGS 76. No significant differences due to season were observed among cultivars for pod yield excepting somnath and R 141. Somnath and R 141 which performed better in rabi/summer had shown lower yield and HSM during kharif season and the reverse was true in case of TG 19A. Samples of produce have been supplied to Plant Pathology and Biochemistry section for studying seed health and biochemical quality aspects, respectively.

D. Variation in growth and yield of wheat grown after kharif groundnut

Ten spanish and nine virginia groundnut genotypes were sown in kharif 1995 with recommended agronomic practices. After harvest of kharif groundnut, wheat was sown in the same plots. Wide differences in grain yield of wheat were recorded when grown after cultivation of spanish genotypes.

On the other hand, differences in grain yield of wheat after growing virginia genotypes was narrow with the highest (34.9 q/ha) being, after the cultivation of M 335 and the lowest (29.4 q/ha) after the cultivation of Somnath. Wheat responded up to 60 kg N/ha when grown after ICGS 11, CO 2, Dh 3-30 and ICGS 21 and up to 120 kg/ha when grown after CO 1, ICGS 76, ICGS 44, TG 19A and JL 24. In general, wheat responded up to 60 kg N/ha after growing virginia genotypes (R 141, M 335, BG 2, M 37, BG 3, Somnath and PG No 1) excepting after growing BG1 and ICGS 1 probably due to the poor nodulation recorded in BG 1 and ICGS 1.

E. Fertilizer requirement of groundnut-based cropping systems

Wheat, mustard, gram and sunflower were grown during rabi 1995 either after kharif groundnut or after a kharif fallow. kharif groundnut was grown with recommended doses of fertilizer whereas each rabi crop was evaluated at four levels viz. (0, 0.5, full and 1.5 times of its recommended doses of N and P. Potassium was not applied

as the plots were already rich in K. The results indicated that grain yield of rabi crops differed due to both cropping system and fertilizer levels. About ten per cent higher yield of wheat and gram was recorded after kharif fallow than after kharif groundnut. However, no such differences in yield of sunflower and mustard were observed.

When a response curve was fitted between doses of fertilizer and yield of rabi crops, wheat responded up to 1.5 times the recommended dose (180 kg/ha N and 54 kg/ha P) when grown after a kharif fallow and to the recommended doses (120 kg/ha N and 35 kg/ha P) after kharif groundnut. The reverse was the case for sunflower i.e. response up to 1.5 times the recommended dose (40 kg N and 18 kg P) after kharif groundnut and to recommended dose (N60:P27) after a kharif fallow (Fig 1). Mustard responded up to 1.5 times the doses (45 kg N and 27 kg P) after fallow but up to half the recommended dose (15 kg N and 9kg P) when grown after groundnut. Gram showed similar responses under both the sequences and responded to only half the recommended dose (10kg N and 9 kg P).

F. Fertilizer management in groundnut intercropping

A field study was conducted in kharif'1995 with groundnut as base crop (under recommended fertilizer doses) and sunflower, pearl millet and pigeonpea as intercrops. For intercrops three levels of N (0, 50, and 100 per cent of the recommended dose) were applied along with recommended doses of P. The recommended dose of N for groundnut, sunflower, pearl millet and pigeon pea were 12.5, 40, 80 and 25 kg/ha, respectively. Sole groundnut produced highest pod yield (13.4 q/ha) as compared to intercropping system (Table 6). In groundnut + sunflower system (2:1), response of sunflower was observed up to half of the recommended N (20 kg/ha) with the highest Groundnut Equivalent Yield (GEY), Land Equivalent Ratio (LER), Income Equivalent ratio (IER) and Benefit:Cost (B:C) ratio of 13.0 q/ha, 1.89 ,0.99 and 3.31, respectively. So was the case when both the crops were grown in a paired manner (2:2).

Table 6. Nitrogen economy in groundnut intercropping

Intercrops	Pod Yield (q/ha)	Seed Yield (q/ha)	GEY (q/ha)	LER	IER	B:C
Sole G'nut	13.4	-	13.4	1.00	-	3.40
Sole sunflower	-	0.3	4.4	1.00	-	2.02
sole pearl millet	-	0.6	6.8	1.00	-	3.32
Sole pigeon pea	-	3.2	15.9	1.00	-	6.45
G'nut + sunflower(2:1)						
0 N	12.0	5.9	15.1	1.59	0.85	2.91
50% N	13.1	7.7	17.8	1.89	0.99	3.31
100 % N	12.6	7.8	16.7	1.87	0.95	3.10
G'nut + sunflower(2:2)						
0 N	8.3	6.6	11.8	1.41	0.60	2.09
50% N	12.3	7.5	16.2	1.82	0.93	3.16
100 % N	11.1	7.4	15.0	1.71	0.83	2.74
G'nut + pearl millet(1:1)						
0 N	11.9	12.2	16.0	1.48	0.80	3.53
50% N	9.7	15.6	14.9	1.48	0.72	2.99
100 % N	9.0	19.0	15.3	1.59	0.73	2.89
G'nut + pigeonpea(3:1)						
0 N	12.7	13.2	28.6	1.95	1.02	6.02
50% N	9.6	14.7	27.3	1.83	0.94	5.46
100 % N	12.1	14.0	26.1	1.95	1.00	5.74

GEY=Groundnut Equivalent Yield, LER= Land Equivalent Ratio, IER= Income Equivalent Ratio

$$GEY = \frac{\text{Yield of inter crop x price rate ofintercrop produce}}{\text{price of groundnut}}$$

$$LER = \frac{\text{Yield of crop A as intercrop}}{\text{Yield of sole crop A}} + \frac{\text{Yield of crop B as intercrop}}{\text{Yield of sole crop B}}$$

$$IER = \frac{\text{Income from both the crops in intercropping}}{\text{Income from both the crops as sole}}$$

a. Maturity classes of groundnut

b. Plant stand of immature seed (20 DAS)

c. Plant stand of mature seed (20 DAS)

d. Plant stand of over-mature seed (20 DAS)

Plate 2. Plant stand of groundnut as affected by different maturity stages.

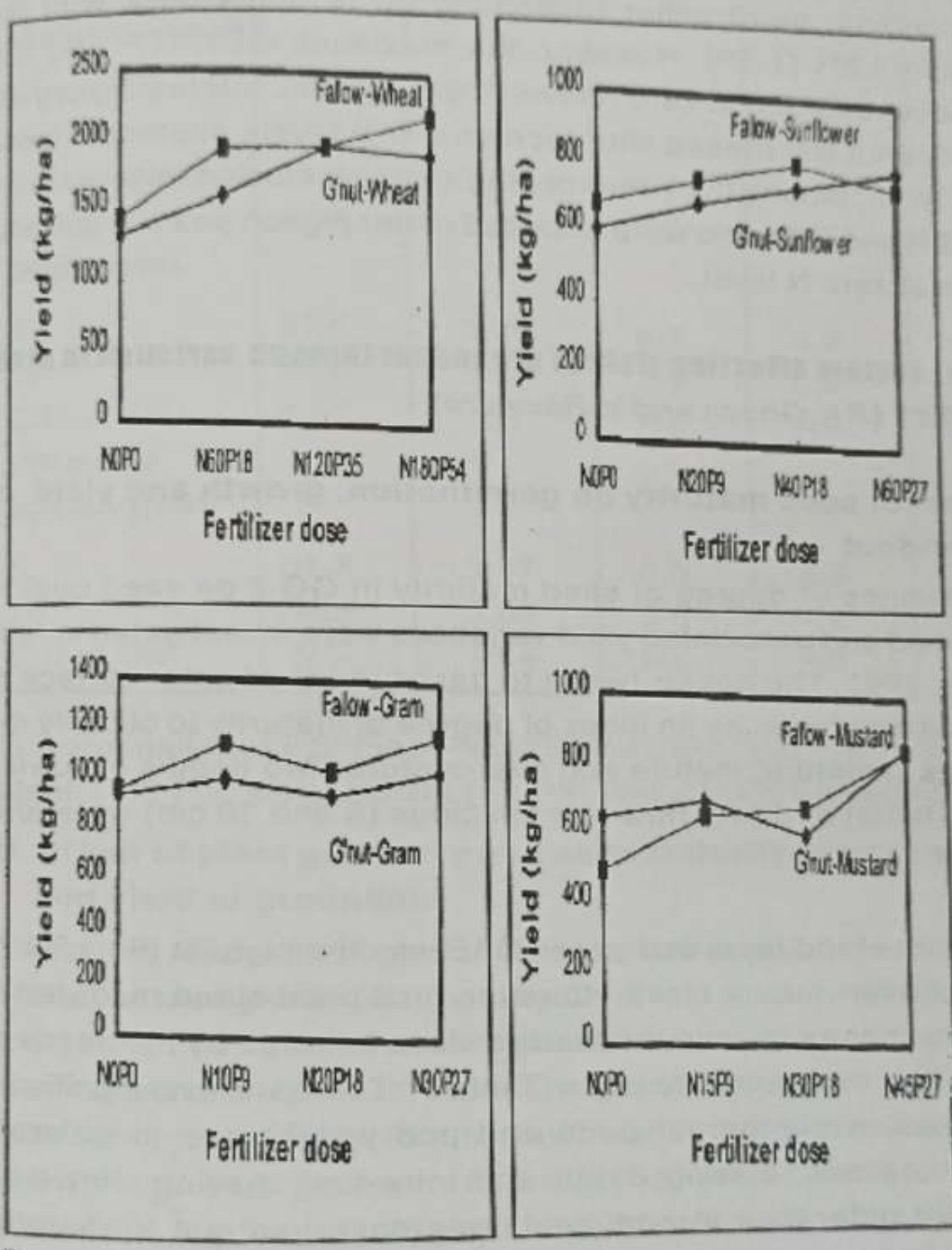


Figure 1. Relationship between fertilizer dose and seed yield under different cropping systems

Although, pigeon pea responded up to half of recommended N but maximum GEY (28.7 q/ha), LER (1.95), IER(1.02) and B:C ratio (6.02) were recorded at zero N level. In Pearl millet + groundnut intercropping, pearl millet responded up to full N dose with the maximum LER (1.59). However, the maximum GEY, IER and B:C ratio were recorded at zero N level in this system. Interestingly, yield of groundnut decreased with increase in N levels applied to pearl millet. Thus, among the intercropping systems studied, highest GEY, LER, IER and B:C ratio were obtained under pigeon pea + groundnut system at zero N level.

Project: Factors affecting yield of groundnut through variation in plant population (*P.K. Ghosh and V. Ravindra*)

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

The influence of degree of seed maturity in GG 2 on seed quality, plant stand and associated yield variations were investigated in rabi/summer 1995. The colour (white to dark brown) of inner surface of pod shell was taken as an index of degree of maturity to classify the seeds as immature, mature and over-mature. Two depths of sowing (5 and 10 cm) and two intra-row spacings (5 and 10 cm) were also included.

Initial plant stand recorded at ten DAS was the highest (90.4 %) in seeds of over-mature class. However, final plant stand recorded at harvest was maximum in the mature class followed by the seeds of over-mature and immature class (Table 7). There were no significant differences in number of pods and pod weight due to different maturity classes, sowing depth and intra-row spacing. However, significant difference in pod yield was observed due to maturity classes and sowing depth. Seeds of mature class produced significantly higher pod yield (16 q/ha) over immature class (13.3 q/ha). However, it was at par with the yield obtained from seeds of over mature (15.8 q/ha). Thus the variation in pod yield among different maturity classes could be attributed to variation in final plant stand.

Table 7. Effect of seed maturity on plant stand and some yield traits in groundnut

	G %	FPS	PN	PW	PY
Maturity class					
Immature	75.6	2.90	4.7	3.9	1326
mature	83.2	3.41	6.4	4.9	1602
over mature	90.4	3.38	5.7	4.4	1585
C.D at 5%	3.76	2.24	NS	NS	221.6
Depth(cm)					
5	81.5	3.25	6.1	4.9	1645
10	84.6	3.21	5.1	3.9	1365
C.D. at 5%	3.07	NS	NS	NS	180.9
Intra-row spacing(cm)					
5	81.7	3.37	5.5	4.3	1551
10	84.5	3.08	5.8	4.5	1458
C.D at 5%	NS	18.4	NS	NS	NS

G:Germination; FPS: Final Plant Stand (lakh/ha); PN: Pod no./plant; PW: Pod weight/plant (g); PY: Pod yield/plant (Kg./ha.)

B. Effect of plant geometry and seed maturity group on growth and yield of groundnut

The effect of four plant geometries (2 plant populations, 1.1 and 2.2 lakhs/ha, along with two rectangularities 1:2 and 1:4) and 3 seed maturity groups of cv. Somnath (immature, mature and over-mature) was tested during kharif'1995. The plant population of 2.2 lakhs x 1:2 rectangularity (30x15 cm) gave higher pod yield/plant and final plant stand and minimum mortality than with other combinations (Table 8). The lowest pod yield was recorded with 1.1 lakh/ha plant population x 1:4 rectangularity (60x15 cm). Although plant geometry of 1.1 lakh/ha x 1:4 rectangularity maintained higher plant stand than 1.1 lakh/ha x 1:2 combination, higher pod yield was recorded in the latter simply because of high yield/plant which is the result of

plant rectangularity. Thus, both plant population and plant rectangularity determined yield/plant and ultimately improved yield/unit area. Higher pod yield of groundnut in mature class was due to high yield/plant although final plant stand was the same in mature and immature class.

Table 8. Effect of plant geometry and seed maturity on plant stand, growth and yield of groundnut

Treatments	Intitial plant stand	Mortaility % (after days) 15-45	45-75	75	Final plant stand	Yield plant (g)	Pod yield (kg/ha)
Geometry							
(1.1lakh/ha x 1:2)	0.63	4.0	10.1	12.3	0.44	6.7	701.2
(1.1 lakh/ha x1:4)	0.73	3.7	14.2	8.2	0.53	4.7	651.8
(2.2 lakh/ha x1:2)	1.15	5.1	11.8	3.1	0.94	9.4	982.3
(2.2 lakh/ha x1:4)	1.32	7.3	19.3	7.4	0.87	7.7	829.1
Maturity groups							
Immature	0.95	5.6	16.5	2.0	0.73	6.3	670.0
Mature	0.92	4.0	11.9	4.3	0.73	8.7	888.8
Over-mature	0.99	5.5	13.2	-	0.86	7.5	814.5

1:2,and 1:4 represent rectangularity

Project : Studies on integrated weed management in groundnut
(P.K.Ghosh)

A. Influence of herbicides on groundnut economics

Combination of fluzi-fop-p butyl, a post-emergence herbicide alone or in combination with the pre emergence herbicide pendimethalin and interculture operation (IC) at 35 DAS was tested during kharif 1995. Dry matter of weed was comparatively lower in weed free

plots at 30 DAS. At 60 DAS and at harvest weed dry matter were minimum where fluzi-fop-p-butyl was applied in combination with IC and pendimethalin. Post-emergence herbicide alone did not have much effect on weed control (Table 9). Highest pod yield, net return and B:C ratio were recorded when fluzi-fop-p butyl was applied @ 0.25 kg a.i./ha in combination with pendimethalin @ 1.0 kg a.i./ha and IC at 35 DAS.

Table 9. Effect of herbicide on weed dry matter and economics in kharif groundnut

Treatments	Weed dry matter (g/m2) at 30DAS	60 DAS	harvest	Pod yield (kg/ha)	Net Return (Rs/ha)	B:C
T1.fluzi fop-p -butyl(@0.25 kg ai/ha)	59.0	143.7	171.7	696	7208	2.19
T2. -do - (@ o.5 kg ai/ha)	37.8	151.8	138.3	722.2	7255	2.02
T3. T1 + pendi-methalin(@ 1.0 kg/ha)	43.4	140.8	129.1	777.8	7147	1.58
T4. T2 + pendi-methalin(@ 1.0 kg/ha)	74.5	97.7	105.7	688.9	5519	1.14
T5. T1+ IC	72.9	11.6	49.6	945.0	10653	3.02
T6. T2 + IC	56.0	14.3	57.7	861.0	9100	2.38
T7. T3 + IC	54.0	14.8	76.5	1338.8	16072	3.38
T8. unweeded check	61.6	202.7	219.7	494.5	4462	1.50
T9.Weed free (3 HW)	25.5	15.7	112.7	944.4	10447	2.81

IC: Interculture; HW: Hand weeding

PATHOLOGY

Project : Studies on Economically Important Fungal and Viral Diseases of Groundnut *(M.P. Ghewande, S. Desai)*

A. Uniform disease nursery

Fifty promising genotypes were screened against diseases in a uniform disease nursery during kharif 1995. Out of them, 22 were resistant against ELS, eight against LLS and 19 against rust. Seven cultures viz. ICGV's 78991, 86023, 86564, 87254, 87280, ICG 7881, and NCAc 343 were resistant to ELS, LLS and rust.

A disease nursery was laid out with 72 genotypes during rabi/ summer 1995 also. A row of GG 2 was sown after every four test rows as a susceptible check. Observations were recorded on initial and final plant stand, incidence of PBND, PStV, collar rot, stem rot, *Alternaria* blight (*Alternaria tenuissima*) and pod yield. NCAc 2656, ICG 10054, PPS 4, a cross derivative of TMV2 x (TMV2 x PI259747), 29-5-2, PPS 3 and ICG 1703 yielded more than other genotypes. But for PBND, the incidence of all other diseases was very negligible. The incidence of PBND ranged from zero (ICG 239) to 24.3 per cent (NCAc 927). The incidence of PStV ranged from zero (ICGV's 86564, 87280, NCAc 2656, a cross derivative each of JL24 x PI 259747, TMV2 x (TMV2 x PI 259747B), CO1 x PI259747B and NCAc 2737, ICG 239, and PPS 8) to 8.33 per cent (a cross derivative of J11 x CGC 4018 BF and JL24 x PI 259747 G-1). The highest stem rot incidence was recorded on PPS 5-3 (7.57 %) whereas no disease was recorded on PPS's 4, 5-1, 6, 8, ICGV's 86564, 86594, 86707, 87280, 87237, 87254 and some of the germplasm accessions. A very negligible incidence of collar rot was recorded.

B. Identification of sources of resistance to *Sclerotium rolfsii*

In the screening blocks got constructed, soil was artificially infested with the inoculum multiplied in the laboratory. Crop of the

susceptible variety, GG 2, was raised to check and improve the inoculum load for screening against *Sclerotium rolfsii*.

C. Survey and detection of PstV

During kharif 1995, the breeder seed production plots of GAU at various research stations viz. Kapat, Manavadar, Jamkhambalia, Nanakandasar, and Targhadia, were surveyed for the incidence of PStV. No incidence of PStV was found. The survey team comprised scientists from NRCG, GAU (Junagadh), and GAU (Anand).

During summer 1995 and *Kharif* 1995, experimental fields of different sections were monitored for the incidence, spread, and development of symptoms of PstV. The disease incidence during summer 1995 was negligible.

Seven hundred germplasm accessions belonging to valencia and spanish accessions from the National Gene Bank NBPGR, New Delhi were tested for PStV and released for rejuvenation in summer 1996 at GAU, SK Nagar as a part of cleaning up operation of genetic resources from PstV contamination.

Breeder seed of five cultures of Plant Breeding section were indexed for PStV for multiplication at Dantiwada during summer 1995 and directly enter into All India level testing. (these cultures were at IVT I, AVT I and AVT II stages and withheld due to PStV problem since 1991).

ELISA testing of the seed material of various sections was done for sowing in summer 1996. In all, 76900 individual seeds made into 3076 (25 seeds/sample) samples were cut and tested through ELISA in a process to clean up seed from various scientific sections and GAU for PstV. Out of these 2404 lots were ELISA negative.

D. Management of major diseases through cultural practices

i. Manipulation through sowing dates

Seven sowing dates from June to September, at fortnightly intervals were evaluated in RBD at a spacing of 45 cm x 10 cm with a plot

size of 5m x 3.6m in three replications during kharif 1995. The genotype used was GG 2. Results indicated that early planting (15 June) had low intensity of leafspot and rust.

Different dates of sowing starting from 19th Dec. 1995 to 6th Mar. 1996 were also evaluated for the management of diseases during rabi/summer 1995-96. Maximum pod yield was realized (2958 kg/ha) when the sowing was done during the first fortnight of February. Second fortnight of Dec. or first fortnight of Jan. were not suitable for sowing as the pod yields were very low (1244 and 1033 kg/ha, respectively). PBND incidence did not vary significantly with the date of sowing. However, PStV incidence was less during early sowings and increased in the crop sown until second fortnight of February. Again, there was less disease incidence in the crop sown during first fortnight of march. This highlighted the role of the climatic conditions, crop growth stage and probably, the role of vector too on the disease incidence. Correlations were made between incidence of PBND and pod yield and PStV incidence and pod yield. However, no significant relationships could be observed.

ii. Manipulation of plant population

Four spacings viz. 45 cm x 10 cm; 30 cm x 10 cm; 22.5 cm x10 cm; and 22.5 cm x 7.5 cm were evaluated in RBD with four replications using GG 2 as test cultivar. The spacing of 45 cm x 10 cm was found to be useful in reducing the intensity of leafspot and rust during kharif 1995. During summer 1995, the yields of pod and haulm differed significantly among the treatments. A reduced spacing resulted in lesser PBND incidence, as already known. However, the optimum spacing was 22.5 cm x 10 cm where minimum PBND (6.81 %) coupled with maximum pod (3214 kg/ha) and haulm yield (4778 kg/ha) were recorded. Pod and haulm yields were negatively correlated with PBND (r=-0.918 & -0.853, respectively). The results need further confirmation.

iii. Intercropping of groundnut with other crops

Four crops viz., sunflower (cv. Morden); pigeon pea (cv. T 21); bajra (cv. GHB 32) and jowar (local) were evaluated as intercrops each in

a ratio of 3 groundnut : 1 intercrop in RBD with four replications and a plot size of 5 m x 3.9 m. GG 2 was used as test cultivar. No intercrop could influence intensities of early leafspot and rust during kharif 1995 possibly because of continuous rains and water logging. However, groundnut + jowar combination could reduce the intensity of *Alternaria* leafspot by 16 per cent. These results need confirmation.

Project : Studies on Seed Pathological Aspects with Special Reference to Seed Health and Aflatoxin in Groundnut (*M.P. Ghewande, S. Desai, J.B. Misra*).

A. Seed treatment of groundnut with species and isolates of *Trichoderma* for the management of diseases of groundnut

In a field trial in kharif 1995, ten isolates of *Trichoderma* belonging to different spp. were evaluated as seed dressers for the management of seed, seedling and soil-borne pathogens in RBD with four replications and a spacing of 45 cm x10 cm. GG 2 was used as test cultivar. *Trichoderma* spp., in addition to their biocontrol ability, are also reported to promote plant growth. Among the different physiological observations recorded, fresh and dry weights of shoot and root were significantly different among various treatments. However, pod yield and fodder yield did not differ.

B. Management of seed and soil-borne pathogens

Trichoderma harzianum, *T. viride*, (biocontrol agents) *Bradyrhizobium*, (nitrogen fixing bacteria) *Aspergillus awamorii*, (Phosphorus solubilizing fungus) carbendazim 25SD (seed dressing fungicide) that go with the seed or as soil application and their combinations including a control were evaluated for their compatibility in 31 treatment combinations in a RBD with three replications using GG 2 as test genotype. The plot size was 4 m x 3 m.

Observations were recorded on various physiological, harvest and post harvest parameters. Fresh and dry weights of shoot and root were significantly different among the treatments. However, pod yield and haulm yield did not vary significantly for any of the treatment.

C. Screening of some fungicides and plant products for the management of seed and seedling diseases of groundnut

Ten treatments viz. carbendazim 25SD, carbendazim 50WP, thiram, hexaconazole, mancozeb , neem seed powder and leaf powders of *Eucalyptus*, *Terminalia catapa*, *Pongamia pinnata* were tested in RBD with a spacing of 3 cm x10 cm Cv. GG 2 was used for the study.

The incidence of seed and seedling diseases was very low. However, among the five fungicides and four plant products evaluated for their efficacy to reduce seed and seedling diseases, 2 per cent leaf powder of *Terminalia* and 2 per cent neem seed powder improved the initial plant stand considerably. However, no significant differences in intensities of ELS, LLS, *Alternaria* leaf spot, and PBND and pod and haulm yields were observed. This indicated that the crop need protection at the later stages also for good harvests.

D. Evaluation of bold-seeded genotypes for resistance to pre-harvest aflatoxin contamination

A field trial was conducted during kharif 1995 for evaluating resistance to pre-harvest aflatoxin contamination. Out of the 15 genotypes, five bold-seeded confectionery type accessions were found to be tolerant to pod infection, seed infection and colonization by *A. flavus*. Three bold seeded genotypes (NRCG's 5506, 8938, and 8939) showed a low level of *A. flavus* colonization under field condition. ICG 239 was found to be free from pod and seed infection and colonization.

E. Evaluation of bold-seeded genotypes for resistance to infection and colonization *in vitro* and aflatoxin contamination

Twelve bold-seeded accessions, seven bold-seeded advanced breeding lines and five bold-seeded released varieties along with susceptible and resistant checks were tested *in vitro* for resistance to infection and colonization by *A. flavus*. Out of these, ICHNG 48809, RG 244, GG 20, GG 11 and NRCG 698 were tolerant to seed colonization by *A. flavus*.

ENTOMOLOGY

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

A. Compatibility of neem with synthetic pesticides and their effects on insects

The following combinations of the synthetic pesticides and the neem products (viz. crude neem oil (CNO) and neem seed extract (NSE) were tested against the insect pests. The spray of these mixtures was taken up at vegetative, flowering and pod filling stages and compared with the control. Since the disease incidence was not up to the damage level, only the population of insect and the damage caused by them were recorded.

i. Treatments:

T1. 2% CNO + 0.04% endosulfan + 0.02% phosphamidon
T2. 2% NSE + 0.04% endosulfan + 0.02% phosphamidon
T3. 2% NSE + 0.02% phosphamidon + 0.05% carbendazim +0.025% Mancozeb
T4. 2% NSE + 0.04% endosulfan + 0.02% phosphamidon + 0.05% carbendazim + 0.025% mancozeb

ii. Periods:

P1. Vegetative
P2. Flowering
P3. Pod filling
P4. P1+P2
P5. P1+P3
P6. P2+P3
P7. P1+P2+P3
Control

Oviposition by jassids was less than that by thrips. In the treatments containing neem products and insecticides a poor oviposition by

Table 10a. Effect of neem mixed with synthetic pesticides on the oviposition of thrips

Period	Treatment				Mean
	T1	T2	T3	T4	
P1	2.7	4.3	2.7	4.3	3.5
P2	5.0	7.3	2.7	4.0	4.8
P3	5.0	11.3	3.3	3.3	5.8
P4	6.7	3.7	3.7	6.3	5.1
P5	5.7	6.3	3.0	4.3	4.8
P6	3.3	3.7	4.0	3.2	3.6
P7	8.0	5.0	5.3	3.3	5.3
Control	8.7	5.7	8.0	5.3	6.9
mean	5.6	5.9	4.1	4.3	

CD=(0.05%) Treatment = 1.3*
Period = 1.8*
Period X Treatment = 3.7*

Table 10b. Effect of neem mixed with synthetic pesticides on the oviposition of leafminer

Period	Treatment				Mean
	T1	T2	T3	T4	
P1	46.7	79.2	58.3	72.5	64.2
P2	45.0	62.5	65.8	63.3	59.2
P3	65.0	66.7	55.0	80.8	66.9
P4	51.7	59.2	66.7	75.8	63.3
P5	71.7	70.8	51.7	56.7	62.7
P6	57.5	59.2	63.3	50.0	57.5
P7	29.2	52.5	64.2	56.7	50.6
Control	77.5	76.7	74.2	74.2	75.7
mean	55.5	65.8	62.4	66.2	

CD=(0.05%) Treatment = 7.6**
Period = 10.8**
Period X Treatment = NS

thrips was observed (Table 10a). Their effects on leafminer was also similar (Table 10b). The pod yield per plant was some what better as compared to control though not statistically (Table 10c).

Table 10c Effects of neem with synthetic pesticides on yields of groundnut (g/plant)

Period	Treatment				Mean
	T1	T2	T3	T4	
P1	4.3	5.1	5.3	5.6	5.1
P2	4.3	5.3	5.9	5.0	5.2
P3	4.1	5.1	4.7	4.0	4.5
P4	4.9	4.7	5.2	6.1	5.3
P5	4.2	5.1	6.6	5.4	5.3
P6	4.8	4.5	4.4	4.4	4.5
P7	3.9	4.5	5.9	5.9	5.1
Control	4.5	5.5	4.9	4.8	4.9
mean	4.4	4.9	5.4	5.2	

CD=(0.05%) Treatment = 0.5"
Period = NS
Period X Treatment = NS

B. Monitoring for major insects in groundnut

Monitoring of insect pests using pheromone and sticky traps was undertaken. The aphid population started building up by the last week of December and attained the maximum by January (1768/ trap/month). There after, a declining trend was noted. Similarly, male moths of leafminer trapped in the pheromone traps ranged from zero to 44.6 between January and December. (Table 11).

C. Integrated Pest Management in Groundnut

The various components for disease, insects and weed management were combined and 12 treatments were formulated for field experimentation.

Table 4 Monitoring of insect pest by traps

Period std. week	Aphids/trap/week		Leafminer David's trap
	Cylinder drum	Sticky flat	
14-17	5.0	2.6	0.3
18-21	1.3	0.3	0.0
22-25	0.0	0.0	0.0
26-30	3.0	1.5	0.0
31-34	0.5	0.3	0.8
35-38	1.5	1.0	12.6
39-43	2.3	1.0	20.0
44-47	7.8	5.0	18.0
48-52	140.6	45.8	44.6
1-4	1768.3	1004.1	17.3
5-8	340.2	164.3	4.5
9-12	40.0	19.8	1.0

i. Major components

- Seed treatment with carbendazim @ 2 g/kg of seeds
- Weedicide application of Basalin @ 1.5 Kg a.i./ha)
- Soil application of carbofuran @ 25 kg/ha.
- Trap/barrier crops (red gram cv. BDN 1, soybean cv. Gujarat 1, castor cv. GAUCH 1 and bajra cv. MH 169)
- Pesticides mixtures (Dithane M 45 at 0.025% + Bavistin at 0.05%; 2% crude neem oil in teepol + endosulfan at 0.04% + phosphamidon at 0.02%)
- Pheromone traps (leafminer + *Spodoptera* + *Helicoverpa*)
- Interculture operations

In each plot, the culture Girnar 1 was sown in 9 rows of 5m length at a plant to plant spacing a 45 cm.

ii. Treatments

T1. Seed treatment with carbendazim @ 2 g/kg seed + trap crops (one row of soybean after every 4 rows of groundnut bajra and

castor in 3:1 rows surrounding the groundnut) + pheromones (leaf miner + *Spodoptera* + *Helicoverpa*) + insecticides mixture (2% crude neem oil + 0.04% endosulfan + 0.02% phosphamidon)

T2. Seed treatment with carbendazim @ 2 g/kg seed + trap crops (pigeonpea in one middle and 2 border rows after each 3 rows of groundnut) + 2 % neem leaf extract (NLE) + 0.025 % mancozeb + 0.05% Carbendazim + culture filtrate of *Penicillium islandicum*

T3. Pre-emergence application of fluchloralin @ 1.5 kg a.i./ha + a hand weeding + an interculturing

T4. T1 (excluding 2% CNO) + T2 +T3

T5. T1 (excluding insecticides mixture) + T2 (excluding NLE 2%) + T3

T6. T1 + T2 (excluding fungicides & 2 % NLE) + T3

T7. T1 (excluding insecticides mixture) + T2 (excluding fungicides) + T3

T8. T1 + T2 (excluding 2% NLE) + T3

T9. T1 (excluding border rows- bajra and castor) + T2 (excluding 2% NLE) + T3

T10. Only crops (soybean in one middle row + pigeon pea border rows + 6 rows of groundnut + 3 rows of bajra and one castor row surrounding the plot)

T11. Farmer's practice: application of insecticides, fungicides, a hand weeding and an interculturing operation.

T12. Control (only groundnut, no weeding and no spray)

a. Evaluation of insect component in IPM

The population of insects was less by 25 per cent as compared to the control. The reduction in leafminer was due to insecticide mixture and pheromone trap (Table 12). The gross income was the highest where all the feasible components were used except bajra and castor (Rs 26,573/ha) as compared to Rs 10,625/ha in control (Table 13).

b. Influence of various components of IPM on the incidence of diseases

During kharif 1995, an integrated management regime comprising i) groundnut seed treatment with carbendazim 50 WP @ 2g/kg, ii)

intercropping with pigeonpea (in the ration 3 groundnut:1 pigeonpea), iii) spray of aqueous neem leaf extract (2 %) at 40 DAS, iv) spray of fungicidal mixture (mancozeb 0.20 % + carbendazim 0.05 %) at 55 DAS and v) spray of culture filtrate of *Penicillium islandicum* at 70 DAS, was found to be effective in controlling LLS and rust.

During rabi/summer 1995, the practice comprising i) trap crops/ border crops of bajra (3 rows) & castor (1row), ii) pheromone traps (for *Spodoptera*, *Heliothis* and leafminer), iii) insecticidal spray, iv) pre-emergence application of fluchoralin @ 1.5 kg a.i./ha, v) seed treatment with carbendazim 50 WP @ 2g/kg seed and vi) fungicidal spray (carbendazim 0.05 % + mancozeb 0.25 %) at 40, 55 and 70 DAS, reduced the incidence of PBND and collar rot considerably when compared with the control.

Table 12 Insect incidence in the IPM experiment (kharif)

Tr.	No.of jassids/ 5 sweeps		No.of thrips/ 5 sweeps		% Leaflet damage by leafminer		
	pre-spray	post-spray	pre-spray	post-spray	pre-spray	post-spray	harvest
T1	45.7	20.7	15.7	9.7	13.8	12.1	23.8
T2	55.0	46.3	13.3	15.0	14.2	32.5	39.6
T3	48.3	54.3	19.0	16.3	19.6	46.7	32.5
T4	43.7	30.7	16.7	10.3	15.0	17.9	29.6
T5	48.0	42.3	15.0	15.3	15.4	22.1	30.0
T6	48.7	24.0	20.0	12.3	14.6	11.7	24.2
T7	38.7	42.3	15.3	13.0	15.0	19.6	27.1
T8	47.0	32.3	14.7	12.0	13.3	12.9	27.5
T9	47.0	33.3	16.0	14.0	12.5	15.0	29.6
T10	50.7	42.3	13.3	14.7	13.8	24.5	30.0
T11	44.3	38.0	13.7	14.3	12.1	20.0	36.7
T12	36.3	45.7	8.7	18.7	6.7	5.4	9.6

CD=(0.05%) NS 9.35** NS 4.6* NS9.35** 12.58*

Table 13 Yields(kg/ha) of main crop and the trap/barrier crops in IPM

Treatment	G'nut	S'bean	Bajra	Pigeonpea	Castor	Return (Rs)
T1	1171.9	80.5	12.13	—	8.37	—
	(14062.3)	(402.3)	(60.7)	—	(125.6)	14650.9
T2	864.2	—	—	847.2	—	—
	(10370.4)	—	—	(8472.1)	—	18842.5
T3	1363.0	—	—	—	—	—
	(16355.6)	—	—	—	—	16355.6
T4	914.0	82.0	12.5	771.4	13.84	—
	(10963.1)	(409.9)	(62.6)	(7713.6)	(207.9)	19356.9
T5	788.7	113.6	13.3	787.9	13.43	—
	(9463.8)	(567.9)	(66.4)	(7879.3)	(201.5)	18178.9
T6	1038.5	104.2	10.5	662.0	7.62	—
	(12462.2)	(521.0)	(52.3)	(6619.6)	(114.4)	19769.5
T7	1209.9	99.46	7.7	638.1	13.6	—
	(14518.6)	(496.3)	(38.5)	(6380.8)	(204.4)	21638.6
T8	1017.3	111.6	17.2	905.7	12.9	—
	(12207.5)	(558.1)	(86.0)	(9056.7)	(1931.5)	22101.7
T9	1188.2	111.61	—	1175.7	—	—
	(14257.8)	(558.1)	—	(11757.2)	—	26573.1
T10	826.2	125.0	17.9	1002.0	22.2	—
	(9914.2)	(624.7)	(89.2)	(10020.0)	(332.4)	20980.5
T11	1359.5	—	—	—	—	—
	(16314.1)	—	—	—	—	16314.1
T12	885.4	—	—	—	—	10625.2
	(10625.2)	—	—	—	—	—

c. Evaluation of weed component in IPM

Twelve treatment combinations involving fungicide mixtures, neem product, insecticide mixtures, herbicide (fluchlorolin @ 1.5 kg a.i./ ha + 1 hand weeding + 1 IC)and trap crops (Bajra,soybean, pigeonpea castor) were tested during rabi/summer1995 and kharif'1995. Inclusion of herbicide reduced dry matter of weed in both the seasons. During rabi/summer1995, maximum dry matter of weed was found at 75 DAS (173 g/m2) and at harvest (92.2 g/

m2) when herbicide was excluded from the combination(T8) :(seed treatment with bavistin + soil application of carbofuran + trap crop + insecticide mixture) but the dry matter was lowest as recorded from the combination(T9) :(seed treatment with neem seed extract + insecticide mixture + pheromone + herbicide component. During the kharif season, the maximum weed dry matter was recorded at 30, 60 DAS and at harvest in the control plots (T2) followed by the plots where there was no herbicides component (T1,T2,T9 and T10) The lowest dry matter of weed at harvest was recorded where herbicide component was included (T8) in T1 and T2 (excluding neem leaf extract) treatments (Table 14).

Table 14 Effects of herbicides in different treatment combinations in IPM on weed.

Treatments	Dry matter (kg/ha)		
	30 DAS	60DAS	Harvest
T1	964	127.7	205.2
T2	786	131.2	195.4
T3	298	44.6	85.6
T4	517	39.4	91.2
T5	464	35.5	114.8
T6	594	55.9	78.7
T7	383	48.9	108.0
T8	621	61.9	52.3
T9	950	178.9	129.6
T10	562	126.3	146.2
T11	683	83.9	90.0
T12	790.2	1150.3	1042.8

BIOCHEMISTRY

Project : Biochemical basis of resistance to biotic and abiotic stresses in groundnut (*J.B. Misra and S.K. Yadav*)

Leaves of genotypes, resistant (Girnar 1 and GG 2) and susceptible (JL 24 and VRI 3) to moisture deficiency stress, were sampled after subjecting them to stress at vegetative, flowering or pod-filling phase. Activities of nitrate reductase (NR), glutamate oxaloacetate transaminase (GOT) and glutamate pyruvate transaminase (GPT) enzymes and contents of sucrose, reducing sugars, proline, free amino acids and phenols were determined in the samples. There was a reduction of activities of NR and GPT under moisture stress. At pod-filling phase imposition of moisture stress caused a drastic reduction in NR activity in both resistant and susceptible genotypes. All genotypes accumulated proline, amino acids and sucrose under stress conditions while there was a reduction in reducing sugars.

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

A. Determination of ratio of activities of sucrose synthase (SS) and sucrose phosphate synthase (SPS)

The activity of SS remained several folds higher than SPS throughout vegetative, flowering and pod-filling phases of the crop. The results indicated that in groundnut leaves besides SPS, SS also plays a positive role in the biosynthesis of sucrose.

B. Evaluation of HPS genotypes for quality traits

Seeds of 18 HPS genotypes supplied by Agronomy section were analysed for oil, protein, sucrose, free amino acids and phenolic contents. Fatty acid composition of oil extracted from these genotypes was also analysed (tables 15 and 16). ICGS 21 was

found to be a moderate oil (47.3%) and a high O/L ratio (2.1) genotype. Other genotypes having O/L ratio >2 were ICGS 76 (2.47), BG 3 (2.20) and PG 1 (2.05) and those having >1.5 were BG 14 (1.79) and TG 19 A (1.69).

Table 15 Oil content and fatty acid composition of HPS genotypes

Genotype	Oil (%)	Fatty acid composition					O/L
		16:0	18:0	18:1	18:2	Others	
Dh 3-30	50.05	13.6	2.12	45.4	36.1	2.75	1.25
GG 2	49.53	15.6	2.28	44.4	34.8	4.77	1.27
JL 24	49.00	16.0	1.88	41.0	39.0	2.08	1.05
ICGS 21	49.97	13.2	1.48	55.5	26.9	2.83	2.06
Co 1	50.68	14.3	1.83	47.2	33.4	3.13	1.41
Co 2	50.04	16.1	2.48	45.9	32.5	2.90	1.41
TG 19 A	46.46	13.4	1.71	51.5	30.3	3.12	1.69
ICGS 11	48.93	13.9	1.65	47.3	34.4	2.59	1.37
ICGS 44	49.51	14.4	1.49	46.4	33.4	3.17	1.38
ICGS 76	50.51	14.6	3.21	56.1	22.7	3.24	2.47
BG 14	49.40	14.4	1.49	52.1	29.1	3.89	1.79
PG 1	51.45	12.2	1.51	56.2	27.4	2.70	2.05
M 37	52.40	14.4	1.51	48.4	33.1	2.61	1.49
ICGS 1	50.00	14.4	1.58	44.9	36.6	2.51	1.22
BG 3	52.16	13.0	1.33	57.2	25.9	2.64	2.20
Somnath	49.45	13.4	1.42	48.6	33.8	2.72	1.43
R 141	49.52	14.5	2.05	41.3	38.9	3.31	1.06
M 337	48.91	14.0	1.97	48.4	33.2	2.37	1.45

16:0 = palmitic; 18:0 = stearic; 18:1 = oleic; 18:2 = linoleic; and O/L = oleic to linoleic ratio.

Table 16 Protein, amino acids sugars and phenols in HPS genotypes

Genotype	Contents (%)						
	Protein	FAA	TS	Sucrose	RS	TP	ODP
Dh 3-30	22.18	0.21	3.62	1.53	0.77	0.70	0.12
GG 2	20.18	0.20	3.20	2.12	0.71	0.74	0.12
JL 24	25.48	0.20	3.21	1.63	0.71	0.62	0.14
ICGS 21	23.11	0.22	3.30	1.94	0.63	0.81	0.12
Co 1	24.96	0.19	3.36	2.34	0.65	0.65	0.18
Co 2	25.96	0.24	3.65	2.74	0.91	0.55	0.18
TG 19 A	25.23	0.21	5.19	2.34	1.14	1.00	0.17
ICGS 11	23.95	0.26	4.60	3.23	0.96	0.73	0.15
ICGS 44	23.90	0.23	4.59	2.60	1.09	0.72	0.20
ICGS 76	20.86	0.24	5.16	3.08	1.07	0.84	0.09
BG 14	23.59	0.30	4.57	2.23	1.45	1.03	0.19
PG 1	20.46	0.22	3.37	2.06	1.26	1.13	0.23
M 37	20.38	0.26	3.95	2.38	1.15	0.70	0.30
BG 3	21.38	0.28	5.03	2.97	1.32	0.73	0.34
ICGS	21.60	0.29	4.00	1.92	1.33	0.96	0.24
Somnath	23.14	0.35	4.81	2.55	1.19	0.80	0.14
R 141	24.11	0.32	5.13	1.94	1.24	0.77	0.20
M 337	23.07	0.30	5.18	1.97	1.41	0.80	0.23

FAA = Free amino acids; TS = Total sugar; RS = reducing sugars; TP = total phenols; ODP = o-dihyroxy phenols.

C. Analysis seed samples received from other sections

Service was provided to other sections of this centre and also to Project Coordinator (Groundnut) by analysing the seed samples sent by them from time to time (table 17).

Table 17 Service rendered to other sections

Section	No. of samples	Content analyzed
Plant Physiology	58	Oil, protein, sucrose and sugars
	30	Oil
	27	Oil
Genetic Resources	52	Oil
	28	Oil, protein and sugars
Plant Breeding	497	Oil
PC Unit	1167	Oil
Farmer's	8	Oil

D. Development of a rapid procedure for estimation of protein content in groundnut seed samples

Preliminary experiments were conducted to develop a method based on the principle of colourimetric determination of removal of dye from soluble phase of a standard dye solution due to quantitative binding with protein and simultaneous precipitation of dye-protein complex by a heavy metal. Mercuric chloride was a better mordant (precipitation agent) compared to barium chloride and stannous chloride. The experiments conducted with bromophenol blue-mercuric chloride (dye-mordant) indicated that the quantity of dye bound to precipitated proteins was proportional to the quantity of whole meal up to 200 mg and defatted powder up to 80 mg . Determination of left over dye in the soluble phase thus indicated the quantity of dye that was bound to protein.

PLANT PHYSIOLOGY

Project: Physiology and biochemistry of seed viability and dormancy in groundnut (*P.C. Nautiyal, V. Ravindra and J.B. Misra*)

A. Studies on seed viability

i. Standardization of drying and storage techniques to prolong seed viability of rabi/summer groundnut

Efforts were made to standardize drying and storage techniques by adopting for drying methods and three storage methods.

a. Drying Methods

1. NRCG method : The NRCG method of drying is being developed for the areas where the rains are frequent during the drying period (May-June). In this method a tri-pod type structure (pyramid shape) was raised in the field with the help of three bamboo sticks, about 6-7 ft. long. Coir ropes were wound around the structure starting from the bottom to the top, maintaining a space between two loops. Immediately after harvest groundnut plants were hung on the rope of the structure in **pods up-haulm down** position that haulm of the upper row covering the pods of the lower row.

2. Farmers' method (FM): After uprooting the plants were arranged in dough nut shaped heap with pods facing the inside of the ring and the haulm outer side.

3. Windrow-shade method (WS): The pods were dried in such a way that those in one windrow were covered by haulm of the plants from the adjacent windrow, in a fish-scale arrangement fashion.

4.DOR Method: The plant bundles of 0.5 m in diameter were placed one over the other, the lower being the haulms down and the upper being the haulm up position so that the haulm of the upper bundle shaded the exposed pods of the inverted lower bundle from direct

sunlight (DOR, 1983). After drying for five days in plants, the pods were picked and sun dried in gunny bags to a moisture content of 5-6.5 per cent and packed in ten kg capacity polyethylene-lined gunny bags.

The produce of GG 2 for the rabi/summer (January-May) was dried following above four methods for five days and on the sixth day, pods were picked and dried in thin spread layer. Subsequently the pods were exposed to bright sun shine for 5-6 hours.

b. Storage Methods

The pods dried by the above methods were stored using either calcium chloride or silica gel as desiccants. Polyethylene-lined gunny bags were half-filled with the groundnut pods and stored with desiccants viz. calcium chloride (100 g/10 kg pods in a muslin cloth hung in a perforated plastic container) or silica gel (300 g/10 kg pods) packed in a muslin cloth bag and placed in the centre of the gunny bags. The bags were then filled completely with groundnut pods, sealed and placed vertically at ambient conditions. The pods stored in polyethylene-lined gunny bags without desiccant served as control (C).

The viability and seedling vigour of the seeds were monitored after zero, eight and 12 months after storage (Table 18). Pods dried by the NRCG and DOR methods and stored with desiccant retained more than 70 per cent germinability with high seedling vigour even after 12 months of storage. Interestingly, the effect of NRCG & DOR drying methods was more prominently different when desiccants were used for storage.

ii. Viability of the seed produced in rabi season produce

Eighteen genotypes were sown in October 1994 and the seed quality of the produce was assessed. The pods after harvest (February 1995) were dried thoroughly,filled in cotton bags and stored in galvanized tin bins. The seed viability and seedling vigour were monitored during

the storage (Table 19). The seed viability and seedling vigour did not decrease significantly up to six months but significant decrease was noticed only after nine months of storage. The genotypic differences were also distinct. After 12 months of storage the germination ranged between 8-82 per cent and cultivars, Jyoti, KRG 1, SB 11, ICGS 11, ICGS 44, VRI 3, Girnar 1 and TMV 7 showed higher germinability. These cultivars were identified as high viability lines in our earlier studies also. Thus, though the rabi season (October-February) produce lost its seed viability only after six months of storage, its ability to retain seed viability during storage was inferior to that produced in the kharif season.

Table 18 Seed germination and seedling vigour of the seeds obtained from the pods dried and stored by different methods.

Drying and storage methods	STORAGE PERIOD (months)								
	0			8			12		
	G	SVI	EC	G	SVI	EC	G	SVI	EC
Control									
NRCG	92	772	0.085	46	239	0.132	48	153	0.188
DOR	88	642	0.071	44	172	0.175	42	172	0.159
WS	86	670	0.065	35	164	0.140	32	137	0.224
FM	82	688	0.071	45	195	0.140	42	172	0.117
$CaCl_2$									
NRCG	92	772	0.085	82	467	0.093	74	495	0.129
DOR	86	627	0.071	80	440	0.061	78	530	0.087
WS	86	498	0.065	62	310	0.073	50	335	0.138
FM	86	722	0.071	55	286	0.093	55	214	0.135
Silica Gel									
NRCG	92	772	0.085	79	442	0.108	78	468	0.106
DOR	86	627	0.085	76	425	0.113	76	468	0.106
WS	86	670	0.065	67	375	0.067	53	333	0.127
FM	83	697	0.071	55	236	0.112	45	225	0.115

G= Germination (%) SVI=Seedling Vigour Index EC=Electrical conductivity of seed leachate.

Table 19 Seed germination and seedling vigour of seeds of 18 genotypes produced in the rabi season.

Genotype	STORAGE PERIOD (months)					
	0		9		12	
	G	SVI	G	SVI	G	SVI
TMV 2	97	620	63	327	39	113
VRI 3	97	552	74	481	70	252
SG 84	95	731	66	580	60	360
Jawan	95	541	66	310	56	140
JL 24	96	499	67	314	56	140
Jyoti	98	519	88	492	80	256
ICGS 44	95	703	70	553	65	370
TMV 7	97	620	80	504	65	221
TG 3	96	576	68	306	62	240
KRG 1	98	774	86	412	82	360
Kadiri 3	92	828	71	454	46	188
CO 2	96	729	71	454	50	130
ICGS 11	99	940	72	489	72	475
MH 1	92	625	90	432	50	160
TG 22	95	798	90	738	62	223
SB 11	98	617	86	387	80	208
Kaushal	94	667	58	400	20	64
Girnar 1	98	754	80	464	68	142

G= Germination percentage, SVI= Seedling vigour index

iii. Viability of farmers seed lot:

Samples of rabi/summer produce of the cultivar GG 2 were collected from farmers' seed lots in the Bhuj region of Gujarat to asses the viability potential. The samples were filled in cotton bags and stored in galvanized tin bins. The viability and seedling vigour was monitored during storage (Table 20). Initial germination of these seed lots ranged between 87-97 per cent and reduced drastically (>50 %) in most of the seed lots after five months of storage (Table 20).

Table 20 Storability of produce from the rabi/summer season, collected from the farmers in the Bhuj region of Gujarat

Location	Pod moisture%	HSM	Storage period in months			
			0	5	0	5
			Germination %		EC	
Bhujpur	5.34	31.42	88	29	0.109	0.173
Bidra	5.92	41.33	91	23	0.165	0.136
Mandvi	6.74	32.18	93	07	0.143	0.259
Garshida	5.46	26.14	90	16	0.094	0.112
Nakhtrana I	5.63	42.44	96	44	0.048	0.142
Nakhtrana II	5.73	40.38	88	29	0.088	0.163
Mokhi	6.20	33.09	93	73	0.043	0.094
Daselpur	5.55	28.04	97	67	0.045	0.070

EC= Electrical conductivity of seed leachate μ mol.g-1 seed.

B. Studies on seed dormancy

i. Fresh seed dormancy in spanish type groundnut

About 200 spanish germplasm lines screened earlier for fresh seed dormancy and 20 additional promising lines were studied further during rabi/summer and kharif 1995. After harvest, plants were left in the field and the next day pods were picked and shelled. The seeds were incubated at 30°C in the incubator for six days. Genotypes showed variation in germination percentage. During rabi/summer 1995, the crop was harvested at 110 DAS and most of the genotypes showed more than 60 per cent fresh seed dormancy. During the kharif season the crop was harvested at three maturity stages viz. stage I (90), stage II (100) and stage III (115 DAS). The dormancy was the highest at stage I and thereafter a decreasing trend was observed (Table 21). After 10 days of curing and storage, all the genotypes showed very high seed germinability (91-100 %). Seeds of different genotypes of the harvest I and II showed variation in their germination (38-97 %) even after ethrel treatment, whereas the seeds of all the genotypes of harvest III showed almost cent per

cent germination after ethrel treatment. At harvest III, the NRCG's 2410, 7323, 4080, 2443, 7506, and 201 showed a high degree of fresh seed dormancy.

Table 21 Fresh seed dormancy (%) in spanish groundnut genotypes during rabi/summer and kharif seasons at three pod development periods.

NRCG No.	Rabi/summer	Kharif Harvested at		
		90DAS	100 DAS	115 DAS
4049	77	79	52	40
2547	79	88	84	28
2410	77	90	66	80
7557	73	80	72	56
201	65	58	63	60
7216	73	92	86	40
2443	69	66	73	68
7247	68	72	61	48
7495	40	54	47	40
2526	86	84	72	56
7432	62	77	73	36
7329	41	84	57	52
7127	20	76	56	24
7509	64	80	81	36
7339	64	86	90	56
7112	67	74	65	52
4080	73	75	53	68
7323	80	89	83	76
7506	76	67	59	64
6808	81	73	67	65

D=Dormancy (%)

ii. Role of seed parts and maturity on dormancy

Sixty genotypes belonging to virginia bunch and runner types were studied for the role of seed parts and seed maturity on dormancy. Pods of the genotypes after one week of harvest were shelled and based on the colour of inner surface of shell the seeds were divided into three maturity groups viz. **i.** immature **ii.** mature and **iii.** over-mature. The seeds of different maturity groups were divided into equal halves. Seed coats of one half were removed, and the seeds with and without seed coat were incubated at 30°C for four days. The non-germinated seeds after treating with 0.05 per cent ethrel were again incubated and germination was recorded after three days. Genotypic variability in the nature of seed dormancy was found among the virginia types. The germination of various maturity groups of seeds of different genotypes ranged from zero to hundred per cent without ethrel treatment and ten to hundred per cent with ethrel treatment. On the basis of the seed dormancy nature the lines studied were categorized into three groups, mature seeds showing more than 80 per cent germination (Group I), seeds showing spurt in germination due to removal of testa (Group II) and no germination of any mature group of seed even after removal of testa (Group III). Genetic variability for the degree of dormancy was also quite distinct. The dormancy period of most of the genotypes was laid between 30-40 days, but some genotypes did not show any germination even after 45 days of storage. Some of the genotypes classified into the three groups aregiven below.

Group I : NRCG 2683, 701, 5987, 1903, 1703, 731, 6170, 5987 and 3039.

Group II : NRCG 6611, 770, 4163, 3271, 416, 3147, 2999, 4982,and 1963.

Group III: NRCG 6183, 65, 416, 958, 5420, 3315 and 7386

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

A. Studies on mechanism of drought tolerance and yield assessment under rainfed and irrigated conditions

An experiment was conducted in rabi/summer 1994 with nine spanish genotypes where soil moisture stress was imposed at different

phenophases i.e. vegetative-flowering phase (20-45 DAS) and pod-filling phase (55-80 DAS). Observations on leaf water potential, leaf relative water content (RWC), photosynthesis (Pn) and growth were taken at peak stress period when the soil moisture was around 7-8 per cent at 0-15 cm soil depth. The total biomass, vegetative mass and pod yield decreased significantly due to the soil moisture stress imposed during the vegetative-flowering phase in all genotypes. The varietal differences were distinct where Girnar1 and ICGS 11 showed least reduction in yields. Pod yield of Girnar 1 was the highest in all the treatments. Varietal differences for Pn, leaf RWC and leaf water potential under normal conditions and stress were significant. The lines with high biomass and pod yield lines were able to maintain high leaf RWC and Pn rate under soil moisture stress also.

The same genotypes were sown in kharif 1995 for their yield assessment under rainfed and irrigated conditions. Since the rainfall during kharif season was high (1250 mm) and evenly distributed the crop did not experience soil moisture stress and therefore significant differences in pod yield and SP between rainfed and irrigated conditions were not found.

B. Studies on heat tolerance in groundnut

Twelve spanish groundnut genotypes were studied for the heat tolerance (membrane thermostability) during the rabi/summer season. Third or the fourth leaf from the top of main axis of each genotype were collected randomly from the field at different phenophases i.e. 40, 75 and 100 DAS and the leaf discs from the sampled leaves were washed thoroughly in running water and put in vials. Vials used for heat treatment were covered with aluminum foil and incubated in a water bath at 50°C for 1 h, while control vials were maintained in a water bath at 25°C during the same period. The per cent relative injury index (RI) was calculated by the following formula.

$$RI\ (\%) = 1 - \{[1-(T1/T2)] / [1-C1/C2)]\} \times 100$$

Based on the mean values of the relative injury index of four sampling stages the genotypes SG 84 and ICGS 44 showed higher thermostability as compared to others (Table 22).

Table 22 Per cent relative injury index of the field grown spanish groundnut at different phenophases during rabi/summer season.

Genotype	R I (%)			
	45 DAS	70 DAS	100 DAS	Mean
TG 22	40.6	15.6	32.6	30
JL 24	32.4	26.5	29.5	30
TAG 24	51.4	31.7	42.3	42
Girnar 1	56.4	26.7	23.1	35
SG 84	35.1	14.3	34.1	28
ICGS 44	43.1	17.7	16.6	26
PBS 8	49.5	16.6	39.4	35
TG 26	43.9	28.5	33.5	35
GG 2	38.6	19.1	35.3	31
Jyoti	52.0	14.1	45.2	37
5-S	29.5	19.0	36.4	28
SB XI	40.7	15.9	20.5	26
Range	29-56	14-31	16-45	26-42

C. Leaf photosynthesis and metabilities in relation to source sink manipulations

During the rabi/summer season the cultivar GG 2 was studied for the source sink manipulations by removing the flowers in one of two sets daily up to 45 DAS. The single leaf Pn and the mutabilities like sucrose, fructose and phenolic contents in the leaf were analyzed in both the sets i.e. the set with flowers (FP) and the set in which flowers were removed (FR). In T1 the measurements were made on leaf position from 0 to 6, however in T2, the leaf position from 0-4 only were available for analysis. This treatment brought about reduction in plant height. Pn was higher in the 2nd and 3rd

leaves from top and lesser in the lower leaves. The sugars concentration were low in the young leaves, whereas the phenols and OD phenol concentration were almost same in all the leaves. At 45, DAS after the treatment a slight increase in the concentrations of sucrose and total sugars was noticed in the leaves of FR plants, (Table 23).

Table 23 Concentrations of sugars and phenols in the leaves of the plants with flowers and with flowers removed till 45 DAS

Leaf position	Sucrose		Total sugars		Total phenols		OD phenols	
	T1	T2	T1	T2	T1	T2	T1	T2
0	0.87	2.73	7.67	10.29	8.16	6.30	5.81	4.78
1	1.14	5.13	13.16	15.46	5.57	6.28	3.73	4.47
2	3.44	9.11	13.30	18.00	6.30	7.38	4.11	5.32
3	4.69	6.45	13.26	14.60	6.81	7.07	4.89	5.43
4	4.13	2.93	12.26	11.00	8.35	7.21	5.99	5.11
5	2.26	-	6.45	-	6.01	-	3.74	-
6	3.30	-	8.94	-	8.13	-	5.73	-

All values are expressed as mg/g fresh weight of leaf.
T1= plants with flower, T2= Plants with flowers removed till 45 DAS.

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

A. Effect of macro and micronutrients on yield and pod filling

A field experiment was conducted to know the effects of Ca, K, and B and their interactions on yield and pod filling in two genotypes, TG 19A (HPS type) and NRCG 7085-1 were studied. It was observed that application of Ca, K, and B alone or in combinations improved the pod filling (increased the SP) and pod and seed yields. On an average application of either Ca @ 100 Kg/ha or K @ 100 Kg/ha increased 37.9 and 10.5 per cent pod yield and 5.9 and 7.3 per cent hundred seed mass over control, respectively. Though, application

c. Sulphur deficiency symptoms

d. Iron efficient and iron inefficient genotypes

a. Fertirrigation through drip

b. Iron deficiency symptoms

Plate 3. Mirco nutrient research

of B @ 2 kg/ha resulted in increase of pod yield by 4.3 per cent, no improvement in hundred seed mass was recorded over control. The combined application of these nutrients could produce higher yield.

B. Application of micronutrients through drip irrigation (fertiirrigation)

A field experiment was conducted to assess the efficiency of application of Fe, Zn and B through drip irrigation in comparison with their soil and foliar applications. Fe, Zn and B were applied thrice at 30, 50 and 70 DAS as soil, foliar and through drip irrigation methods. Application of these micronutrients through drip irrigation, did not increase plant height, chlorophyll content and pod yield as compared to the other two methods, but increased haulm yield, SP and seed mass and hence, seed yield significantly. The SP and seed mass of groundnut due to various treatments are given in table 24.

Table 24 Influence of application of Fe, Zn and B through various methods on shelling percentage and hundred seed mass of groundnut.

Sr.No.	Treatment	SP	HSW
1.	Control	68.1	35.0
2.	Fe Soil	66.1	40.1
3.	Zn soil	65.8	35.9
4.	B Soil	67.7	39.5
5.	Fe Foliar	68.5	39.8
6.	Zn Foliar	66.6	38.7
7.	B Foliar	69.5	43.1
8.	Control Drip	71.3	44.2
9.	Fe Drip	71.3	44.1
10.	Zn Drip	74.3	47.1
11.	B Drip	72.8	46.6

Drip application of Fe, Zn and B increased 26, 34.3 and 33.1 per cent seed weight over control, respectively. Drip irrigation alone increased SP and HSW over flood irrigation.

This experiment was also repeated by growing the crop just after rainy season, during October to February. Same amounts of micronutrients provided through drip showed higher yields than their soil and foliar applications. The drip system of irrigation kept the soil loose for peg penetration and pod development and hence probably increased the number of SMS.

C. Comparison of effects of soil application and seed dressing of macro and micro-nutrients

A field experiment was conducted to compare the effects of salts of various macro- and micro-nutrient applied as seed dressing and that applied in furrows. It was observed that application of $CuSO_4$, $CaCl_2$ and $FeSO_4$ as seed dressing was more beneficial and increased the pod yield, SP and HSW. However, H_3BO_3, $CuCl_2$ and CuOAC were promising as soil applications in furrows.

D. Effectiveness of soil application of iron containing compounds in alleviating iron-chlorosis of groundnut

Four iron containing compounds namely FeEDTA, FeEDDHA, $FeSO_4$ and iron citrate each at two concentrations, were tested for alleviating lime-induced iron-chlorosis of groundnut using both Fe -inefficient and -efficient genotypes. Four Fe-efficient genotypes, GG 2, CSMG 84-1, TAG 24 and TG 26 and four Fe-inefficient genotypes, PBS 13, PBDR 36, VRI 3 and I2 genotypes were used in this study. It was noticed that all the sources of iron when applied in soil could reduce the occurrence of iron-deficiency chlorosis and excessive vegetative growth and increase in chlorophyll and Fe^{2+} contents of leaves, and pod yield. Though the higher dose (20 kg Fe/ha) of $FeSO_4$ and Fe-citrate did increase pod yield over their lower doses (5 kg Fe/ha), at 5 kg Fe/ha, the beneficial effects of iron sources on groundnut were more pronounced with FeEDDHA and Fe-citrate than other iron sources. The Fe-inefficient genotypes showed better performance with iron sources than the Fe-efficient ones.

E. Macro and micro-nutrient deficiencies in groundnut grown in calcareous soil and effects of external application of these nutrients on growth and yield

A field experiment, during dry seasons, was conducted to find out the effect of macro- and micro- nutrients on the growth and yields of groundnut and the yield losses caused by the deficiencies of these micronutrients in groundnut in calcareous soil deficient in most of the micronutrients. It was observed that the application of N, P, K, Ca, Mg, and S increased 27.4 per cent pod yield. However, application of micronutrients along with macronutrients produced 39.3 per cent more pod yield than control, which was 12.2 per cent more over macronutrient. The yield losses caused by the deficiencies of Fe, Mn, Zn, Cu, B, and Mo were to the tune of 9.6, 8.4, 15.5, 13.3, 16.7 and 18.9 per cent, respectively. The SP and the hundred seed mass also increased with the application of micro- as well as macro- nutrients, (Table 25).

Table 25 Assessment of yield losses due to micro-nutrient deficiencies in groundnut during dry season of 1995

Treatments (kg/ha)	Pod yield over T3	Yield loss (%)
T1,Control	2005	-
T2,N,P,K,Ca, S, Mg	2557	-
T3,T2+ Fe, Mn, Zn, Cu, B	2795	-
T4, T3-Fe	2528	9.6
T5, T3-Mn	2560	8.4
T6, T3-Zn	2360	15.5
T7, T3-Cu	2424	13.3
T8, T3-B	2328	16.7
T9, T3-Mo	2267	18.9

Also a pot experiment was conducted to assess the deficiencies of N, P, K, Ca, S, and Mg occurring in groundnut in calcareous soil of

Saurashtra. The effects of external application of these macronutrients were observed on four groundnut genotypes. Application of micronutrients alone increased chlorophyll, but decreased carotene and pod yield over control (without micronutrients) in all the genotypes. However, these micronutrients when accompanied with macronutrients increased the photosynthetic rate and pod yields from 16 to 30.7 per cent across genotypes. Non-supply of nitrogen at the time of sowing showed severe yellowing up to 50 DAS, but soon after the nodules were developed this yellowing was reduced. Though genotypic variations were noticed, the non application of the macronutrients produced less pod and fodder yields. NRCG 6919 did not show no yield loss due to non-application of N, and 7085-1 due to non-application of Ca, P and S. The treatment without P showed maximum yield reductions in all the genotypes except NRCG 7085-1 which was identified as a P-efficient genotype. The treatments without P and S caused maximum reduction of photosynthetic rates in leaves. On an average, the yield losses due to the deficiencies of N, P, K, Ca, S and Mg in groundnut grown in calcareous soils were to the tune of 17.6, 30.7, 29, 27.1, 24.7 and 29.6 per cent, respectively, indicating that all these macronutrients are essential for harvesting high yield.

F. Maintenance and multiplication of iron -efficient and-inefficient lines

Thirty Fe-efficient and seven Fe-inefficient groundnut genotypes were maintained through field multiplications. Nitrate reductase and peroxidase activities of leaves and root of selected genotypes were studied. The activities of both of these enzymes were two to three times lower in the Fe-deficient plants than the Fe-efficient one.

Experimentation for five consecutive years have revealed that the genotypes, NRCG's 7085-1, 7085-3, 2588 and 6919 of spanish group and 7599 of valencia group have got good potential and hence could be released directly for their cultivation after AICRP(G) trials in future. The ELISA tested cut seeds of two genotypes namely FeESG-8 and FeESG-10-1 are under multiplication at Bhubaneswar and also at Dantiwada for their further testing in AICRP(G) system.

G. Influence of various levels of B and Mo in nutrient solution on the growth and yield of groundnut

Sand culture experiments were conducted under various levels of B and Mo to find the optimum levels of these micronutrients for best growth and yield of groundnut. It was noticed that the toxicities of the micronutrients caused stunted growth and interveinal to complete chlorosis leading to iron deficiency in case of B and complete chlorosis in case of Mo toxicity. The rate of photosynthesis, growth and pod yield were maximum at 0.5ppm of B and 0.25 ppm of Mo, and hence these were the best combinations for nutrient culture studies of groundnut. The respiration rate in groundnut roots was more at the toxic levels (5 and 1 ppm of B and Mo, respectively) of these micronutrients.

H. Basic studies on the nutrient efficient groundnut genotypes

Sand culture experiments were conducted to study the photosynthesis, respiration, growth rates and pod yield of genotypes efficient for utilization of one or more of the nutrients, Ca, S and Fe. Though genotypic differences were noted, it was observed that Fe-efficient genotypes showed higher protochlorophyllides, chlorophyll (both Chl *a* and *b*), and carotene contents in leaves than the Fe-inefficient genotypes. However, the rate of photosynthesis did not increase accordingly in the Fe-efficient genotypes. TG 17, an Fe-efficient genotype, showed maximum photosynthesis (18 mmol/s) with an average rate of respiration, NRCG 1308 both Fe- and S efficient but Ca-inefficient showed fairly high photosynthetic rate (14.1-16.4 mmol/s). But the genotype NRCG 2588 which is efficient for all of Fe, S and Ca and I, and NRCG 4659 which are efficient for Fe and S showed comparatively lower rates of photosynthesis. Generally it was observed that the genotypes with high rate of leaf photosynthesis showed comparatively lower root respiration, but the same was not true with all the genotypes. Except for few anomalies, in general the genotypes having high photosynthesis in leaves and low respiration in roots showed higher pod yields.

MICROBIOLOGY

The section has a project entitled "Studies on Biological nitrogen fixation and phosphorus solubilization in groundnut". The post of microbiologist has been lying vacant since long. Therefore in the Staff Research Council meeting it was felt that until a regular microbiologist joins the centre only maintenance, multiplication and supply of efficient rhizobium cultures, phosphorus solubilizing microbes and salt tolerant rhizobium isolated and identified so far by the centre can be undertaken. Accordingly, 40 *Bradyrhizobium*, three Phosphorous solubilizing microbes and six salinity tolerant Bradyrhizobium spp. were maintained . PSM-H5, *Bacillus polymyxa*, Rhizo. 27, *Pseudomonas striata*, IRG 40 and IRG 6 were supplied to various state agricultural universities and biofertilizer agents.

The strains IRG 60,IRG40 and Rhizo. 27 of *Bradyrhizobium* and PSM-1+5 strain and all the strains of the spp. *B. polymyxa* and *P. striata* were supplied to various state agricultural universities & Biofertilizer agents.

IV. TECHNOLOGY TRANSFER

The ICAR has launched a new pilot project on **Technology Assessment and Refinement Through Institution-Village Linkage (TAR-IVLP)** in July, 1995. The goal was to develop effective operational linkages between scientific institutions and villages for technology integration and optimization to meet the growing demands of different production systems to increase productivity, augment income and improve the quality of life of rural people. This is a part of the project being implemented at 42 centres at national level. This Centre has been identified as one of the centres for this project. Accordingly, a multi-disciplinary team of scientists was constituted to execute the project.

1. Director, NRCG	- Nodal officer
2. Dr. M. P. Ghewande	- Core-Team Leader
3. Dr. V. Nandagopal	- Member
4. Dr. R.K. Mathur	- Member
5. Dr. P.K. Ghosh	- Member

Participating scientists were also nominated by the Gujarat Agricultural University, Junagadh Campus, from Horticulture, Agricultural Economics, Agricultural Extension, Soil Science, Animal Science, Agriclutural Engineering, and Home Science as members.

The activities of TAR-IVLP were initiated in the month of September, 1995. A survey for the preparation of the project document was conducted in 26 villages of the Junagadh district. Out of the 26 villages, four villages viz. Zanjarda, Umatwada, Nandarkhi and Vadhavi were selected based on the criteria laid down by the ICAR for the project. After the training of the core-team scientists and participating scientists, a detailed programme for execution of the project was formulated.

The bench-mark survey was carried out in the four selected villages during October, 1995. The data on the status of different production systems with latest technology adoption, resource availability, farming situations, socio-economic status, farmers needs, market facilities etc. were collected by adopting Participatory Rural Appraisal (PRA) techniques for agro-ecosystem analysis, and the project document was prepared.

The project document was suitably modified in the light of discussions held during the 1st Zonal Steering Committee meeting.
In consultation with the Principal Scientist (S), and DDG (AE), ICAR, the project document was revised in the month of March, 1996.

V. PUBLICATIONS

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VI. OTHER INFORMATION

ADMINISTRATIVE AND FINANCIAL

A. TOTAL STAFF IN NRCG AND THE NUMBER OF SC AND ST EMPLOYEES AS ON 31.3.96.

	SANCTIONED POSTS	FILLED UP	SC	ST
Scientific Staff	32	23	5	-
Technical Staff	43	40	6	5
Administrative staff	18	16	4	-
Supporting staff	21	21	5	5 +1(OBC)
TOTAL	114	100	20	10 +1(OBC)

B. EXPENDITURE STATEMENT FOR 1995-96 (Rupees in lakhs)

	RE		Expenditure	
	Non Plan	Plan	Non Plan	Plan
1. Estt. Charges including LSP &PF	57.00	7.00	61.08	0.00
2. T.A	2.00	4.00	2.00	2.75
3. Other charges including equipment	3.00	60.80	3.00	58.48
4. Works	0.00	19.00	0.00	18.72
5. Other contingencies	0.00	1.00	0.00	0.04
Total	62.00	91.00	66.08	79.99

TECHNICAL PROGRAMME

The list of the projects as on 31.3.1995 along with the details on project leader, date of start and likely date of completion is as below:

Project P1-81/97-01/ IGN-F-30/0332	:	Collection, maintenance, evaluation, documentation and distribution of genetic resources of cultivated groundnuts and related *Arachis* species. Project leader: Dr. N.R. Bhagat Date of Start : January, 1981 Likely date of completion: March, 1997
Project P1-88/0030-IGN -F30/0332	:	Breeding and genetic studies for improving yield and quality in groundnut. Project leader: Dr. A. Bandyopadhyay Date of Start : June, 1988 Likely date of completion: March, 1997
Project P1-88/0030-IGN -F30/0332	:	Breeding for resistance to biotic and abiotic stresses in groundnut. Project leader: Dr. A. Bandyopadhyay Date of Start : June, 1992 Likely date of completion: March, 1997
Project P1-85/95-08- IGN-F30/0332	:	Genetics of and breeding for high peg strength in groundnut. Project leader: Dr. P. Paria Date of Start : January, 1985 Likely date of completion: March, 1997
Project P1-85-05-IGN - F30/0332	:	Characterization and utilization of wild *Arachis* species for groundnut improvement. Project leader: Dr. T.G.K. Murthy(12.6.95); P. Paria Date of Start : January, 1985 Likely date of completion: Continuous

Project P1-93/97-06-IGN-F30/0332 : Embryo rescue, micropropagation and haploid production in groundnut.
Project leader: Dr. Radhakrishnan T
Date of Start : April. 1993
Likely date of completion: March, 1997

Project P1-92/97-36-IGN-F27/0332 : Development of suitable agronomic practices in Groundnut.
Project leader: Dr. P.K. Ghosh
Date of Start : June, 1991
Likely date of completion: March, 1997

Project P1-92/97-36-IGN F27/0332 : Factors affecting yield in groundnut through variation in plant population.
Project leader: Dr. P.K. Ghosh
Date of Start : May, 1991
Likely date of completion: March, 1997

Project P1-89/97-09-IGN-H20/0332 : Studies on economically important fungal and viral diseases of groundnut.
Project leader: Dr. M.P. Ghewande
Date of Start : January, 1989
Likely date of completion: March, 1997

Project P1-89/97-33-IGN-H10/0332 : Studies on major insect pests of economic importance in groundnut.
Project leader: Dr. V. Nandagopal
Date of Start : June, 1989
Likely date of completion: March, 1997

Project : Investigations on weed management in groundnut
Project leader: Dr. P.K. Ghosh
Date of Start : April, 1993
Likely date of completion: March, 1997

Project P1-93/97-12-IGN-F60/0332 : Physiology and biochemistry of seed viability and dormancy in groundnut.
Project leader: Dr. P.C. Nautiyal
Date of Start : April, 1993
Likely date of completion: March, 1997

Project P1-89/97-13-IGN-H20/0332 : Studies on seed pathological aspects with special reference to seed health and aflatoxin in groundnut.
Project leader: Dr. M.P. Ghewande
Date of Start : April, 1993
Likely date of completion: March, 1997

Project P1-83/97-15-IGN-F60/0332 : Studies on abiotic stresses in groundnut.
Project leader: Dr. Y.C. Joshi
Date of Start : June, 1993
Likely date of completion: March, 1997

Project P1-83/97-16-IGN-F60/0332 : Studies on inorganic nutrient disorders in groundnut.
Project leader: Dr. A.L. Singh
Date of Start : August, 1993
Likely date of completion: March, 1997

Project P1-93/97-17-IGN-F26/0332 : Studies on nitrogen fixation and phosphorus solubilization in groundnut.
Project leader: Vacant
Date of Start : April, 1993
Likely date of completion: March, 1997

Project P1-88/95-35-IGN-F60/0332 : Biochemical basis of resistance to biotic and abiotic stresses in groundnut.
Project leader: Dr. J.B. Misra
Date of Start : January, 1991
Likely date of completion: March, 1997

Project P1-88/95-35-IGN-F60/0332 : Biochemical analysis of groundnut quality and composition.
Project leader: Dr. J.B. Misra
Date of Start : July, 1988
Likely date of completion: March, 1997

B. Externally funded projects

1. NARP : Biotechnological approaches for increasing and sustaining yield in major field crops
Sub project 1: Crop Improvement
Objective 6: Groundnut disease resistance
Project leader: Dr. A. Bandyopadhyay
Date of Start : September, 1993
Likely date of completion: September, 1996

2. ACIAR : Studies on water use efficiency in groundnut.
Project leader: Dr. M.S. Basu
Date of Start : July, 1993
Likely date of completion: July, 1996

3. ICAR : Breeder seed production for annual oilseed crops: National Seed Project.
Project leader: Dr. A. Bandyopadhyay

INSTITUTIONAL ACTIVITIES

A. Out come of the SRC Meeting held on June 6-7,1995.

For re-shaping the operational approach of the research projects, the Chairman, SRC emphasized the need for adopting project based budgeting on mandays (field labour, Technicians, Scientists), chemicals/glassware, contingencies (recurring/non-recurring), manintenance, and overhead costs etc.

He also mentioned in brief about the strategy for regeneration of entire genetic wealth free from PStV at Off-season Nursery, Bhubaneswar and replace the infected lot of NRCG and GAU (Junagadh) at the quickest possible time. He requested the SRC members to orient their action plan towards this goal. Due to PStV problem at NRCG, the germplasm out-flow to the NARS has been restricted. Hence until NRCG genetic stocks are made virus-free, fresh germplasm from ICRISAT may be multipled at Bhubaneswar.

It was suggested that characterization of a set of released groudnut varieties be done jointly by scientists from GRS and PBS sections by sowing one set at Junagadh and another at OSN, Bhubaneswar. This helps the seed certification agencies in pure seed production. Further the house suggested that the work may be taken up at two or three locations for two seasons to bring out a valid document.

A pilot experiment was proposed in collaboration with ICRISAT to screen groundnut accessions for high temperature tolerance at Junagadh and Hanumangarh.

The chairman aslo desired that thrusts may be given in the following areas of research by the Scientists of NRCG.

- Refinement of the technology to maintain seed viability in collaboration with ICAR complex, Barapani.
- Screening for tolerance to Aluminium toxicity in collaboration

with ICAR Complex, Barapani, since it is assuming serious dimensions in recent years particularly in the Eastern and Nort-Eastern regions of the country.

- Screeing for high temperature tolerance especially for western and North-western regions of the country.
- Identification of phosphorus solubilizing microorganisms for acid soils.
- Development of crop production technologies for rice based cropping systems.

The chairman proposed that the area left after sowing of the experiments may be covered with agro-forestry including oil bearing tress in non-cultivable areas; maintenance of varietal museum; multiplication of seed of component crops required for cropping systems research; demonstration of NRCG technologies on paird-row, inter cropping systems and nutrient uptake patterns.

B. Strategy meeting on Peanut Stripe Virus

A strategy meeting on Peanut Stripe Virus was organized at NRCG, Junagadh on 9.8.1995. The invitees included leading Virologists, Plant Breeders and Plant Protection Scientists in the country including scientists from ICRISAT for deciding the course of action to eradicate PStV.

The note-worthy recommendations were:

- Multiplication of virus free seeds of the promising materials including inter-specific derivatives by using ELISA at GAU, Dantiwada Campus, a virus free area.
- Current research on PStV at NRCG and GAU including host range, seed transmission, vector transmission and crop loss experiments be discontinued.
- Govt. agencies were informed for not procuring seed from the vicinity of GAU & NRCG to check the spread of the virus.

- A new collaborative project be proposed involving ICAR-ICRISAT-SAU(GAU) for man power development.
- The entire germplasm collection including wild species maintained at NRCG & GAU should be destroyed
- Fresh collection should be created by accessing the germplasm from long term condition at NBPGR, New Delhi prior to 1985 and from ICRISAT by multiplying at Bhubaneswar.
- Survey and surveillance will continue by a multidisciplinary team of scientists including Plant Quarantine and ICRISAT Scientists.

C. Out come of In-House Group Meeting

In the In-House review meeting held on 27.12.1995, the secretary SRC informed the house that in accordance with the meeting held on PStV, the sowing of PStV infected material should be avoided by NRCG and desired that the crop may be raised in a limited area. The seed has to be sent to Plant Pathology section for ELISA testing and only PStV free seeds may be sown in the field.

a. Proceedings of kharif groundnut research worker's group meeting.

b. Field visit during kharif groundnut research worker's group meeting.

Plate 4. Kharif groundnut research worker's group meeting.

TRAINING AND VISITS

A. Within India

Dr. M.S. Basu	Project Coordinators meeting, New Delhi, April 26, 1995.
	Strategy development for increasing May 16-20,groundnut production in northern 1995 states.
Dr. A. Bandyopadhyay	Review meeting of the NARP Basic Research Sub-Project **Field Crop Biotechnology** IARI, New Delhi, August 7-8, 1995.
	Perspective plan preparation discussions, DOR, Hyderabad, February 20-25, March 21-24, 1996 .
Dr. A. Bandyopadhyay Dr. M.S. Basu Dr. M.P. Ghewande Dr. N.R. Bhagat Dr. K. Rajgopal Dr. T. Radhakrishnan Dr. P.K. Ghosh	Second annual kharif groundnut research workers' group meeting, NRCG, Junagadh, April 30, 1995.
Dr. A. Bandyopadhyay Dr. N.R. Bhagat Dr. M.S. Basu Dr. M.P. Ghewande	Meeting for HPS groundnut, BARC,Trombay, Mumbai. April 15-17, 1995. Annual rabi/summer groundnut research workers' special group meeting, NRCG, Junagadh, October 7- 8, 1995.
Dr. M. S. Basu Dr. S. Desai Dr. N.R. Bhagat Dr V. Nandagopal	One-day strategy meeting on PStV, held at NRCG, Junagadh August 9, 1995.
Dr. N.R. Bhagat	State Level Agricultural Fair, Organized by the GAU at Junagadh, January 16-18 1995.
Dr. M.P. Ghewande	First zonal steering committee meeting of the pilot project on technology assessment and refinement through institution and village linkage, Jaipur, November 6, 1995.

Dr. M.P. Ghewande Dr. P.K. Ghosh Dr. R.K. Mathur	National seminar on integrated crop disease management for sustainable agriculture, Dr. Babasaheb Ambedkar Marathwada University, Aurangabad, February 26-27, 1996.
	Meeting of the zonal research & extension advisory committee, GAU, Junagadh, March 13-14, 1996.
Dr. J.B. Misra	Participated in the 64th Annual Meeting of Society of Biological Chemists (India) held at Lucknow, October 6-8,1995.
Dr. Chunilal	Course on information management for Agricultural scientists, Feb.23- Mar.1, 1996.
Mr. Prem Narayan	Training Workshop on Computer networking and information processing in agriculture, IASRI, New Delhi, April 18- May 2, 1995.
Dr. Manivel Dr. M.Y. Samdur Dr. A.L. Singh	50th FCARS programme, NAARM, Hyderabad, February-July, 1995
	National symposium on modern trends in plant physiology at GBPUAT, Pantnagar, March 18-20, 1996.
Dr. P.K. Ghosh	National seminar on biodiversity, plant growth regulators and February biotechnology, Ahmedabad, 22-24, 1996.
Dr. V. Nandagopal	Workshop on current approahes to pheromones to pheromone technology, SPIC Science Foundation, Madras,Nov. 29-Dec. 1, 1995
	National Seminar on Integrated Pest management in Agriculture, Dr. Panjabrao Deshmukh krishi Vidhyapeeth, Akola, Agricultural college, Nagpur, December 29-30,1995.
Mr. K. Chandran	Course on scientific and technical paper writing, NAARM, Hyderabad, November 17-23,1995.

B. Abroad

Dr. M.S. Basu	International working group meeting on groundnut in the Asia-Pacific region,

	Thailand, March 12-14 1995 .
	International workshop on achieving high gorundnut yield, Shadong, China, August 25-29, 1995.
Dr. A. Bandyopadhyay	Study visit to Coastal Plain Expermental Station, Tifton, Georgia, U.S.A., December, 2-13,1995.

C. Visitors

Dr. K.S. Amin (Retd. Principal Scientist, NRCG)	Second annual kharif groundnut research workers' group meeting, NRCG, Junagadh, April 30, 1995.
Dr. Radhakrishnan T Dr. N.B. Singh (ADG, Oilseeds & Pulses) Dr. D.V.R. Reddy (Principal Virologist, ICRISAT) Dr. S.N. Nigam (Principal Groundnut Breeder, ICRISAT) Dr. P.S. Bharodia (Sr. Research Scientist (Oilseeds) GAU, Junagadh Dr. A. Mishra (Associate Professor, GAU, Anand)	One-day strategy meeting on PStV,held at NRCG, Junagadh August 9, 1995.

D. Abroad tour reports

Dr. M.S. Basu, Project Coordinator, Groundnut was deputed to attend **International Working Group Meeting on Groundnut Virus Diseases in Asia-Pacific Region** held at Khon Kaen University, Thailand during March 12-14, 1995.
He presented the country report on the status of Peanut Stripe Virus and highlighted the efforts made for eradicating the virus from the AICRP(G) centres in India within a record time. In the international forum this achievement has highly been appreciated and the member countries in the South-Asia Pacific Region are trying to adopt similar measures to eradicate/contain the spread of the virus at their respective places.

Dr. M.S. Basu was deputed to China to attend **International Workshop on Achieving High Groundnut Yields** at Shandong

Peanut Research Institute, China during August 25-29, 1995. In this Workshop, groundnut scientists from Asia and Asia-Pacific Region participated. The Workshop started with the field visit to gain knowledge about the technologies practised for achieving high groundnut yield in China. The implications for each and every production factors contributing towards high yield in groundnut were examined critically and noted. The noteworthy features were : i) very fast spread of improved groundnut varieties; ii) use of polythene mulch; iii) sowing in raised bed and rotation of groundnut with wheat and maize. The plant types of most of the high yielding released groundnut varieties were of intermediate nature and having better plasticity and genetic make-up to withstand various stresses limiting productivity as compared to spanish bunch. The hand operated multi-purpose machine for spraying weedicides, placement of fertilizer, sowing of seed and spreading of polythene on the raised-bed were shown to the delegates and photographs of the machine component-wise were taken with a view to develop similar prototype in India. A sample of the quality polythene mulch used extensively in China in millions of hectares have also been brought to improve the quality of the Plastic film presently being manufactured by Indian Petro Chemicals Ltd., Baroda.

PERSONNEL

A. NRCG

Dr. M.S.Basu	Director (actg.)

GENETIC RESOURCES

Dr. N.R.Bhagat	Senior Scientist
Dr. R.Rajgopal	Scientist(SS)
Sh. S.Chandran	Scientist

PLANT BREEDING

Dr. A.Bandyopadhyay	Principal Scientist
Dr. A.Shome	Senior Scientist
Dr. R.K.Mathur	Scientist
Dr. S.Manivel	Scientist
Sh. Samdur	Scientist

CYTOGENETICS

Dr. P.Paria	Senior Scientist
Dr. T.G.K.Murthy	Scientist(SS)
Sh. T.Radhakrishnan	Scientist(SS)
Sh. S.K.Bera	Scientist

PLANT PHYSIOLOGY

Dr. Y.C.Joshi	Senior Scientist
Dr. P.C.Nautiyal	Scientist(SS)
Dr. A.L.Singh	Scientist(SS)
Dr. V.Ravindra	Scientist(SS)
Dr. Ajay	Scientist
Sh. V.G.Koradia	Technical Officer

BIOCHEMISTRY

Dr. J.B.Mishra	Senior Scientist
Dr. S.K.Yadav	Scientist
Sh. D.M.Bhatt	Technical Officer

AGRONOMY

Sh. Devi Dayal	Scientist (SS) (on study leave)
2. Dr.P.K.Ghosh	Scientist

MICROBIOLOGY

Dr. K.K.Pal	Scientist
Ku. S.M.Chauhan	Technical Officer

PATHOLOGY	
Dr. M.P.Ghewande	Senior Scientist
Dr. S.Desai	Scientist (SS)
ENTOMOLOGY	
Dr. V.Nandagopal	Scientist
FARM SECTION	
Dr. R.S.Tomar	Farm Superintendent
Sh. H.P.Lalwani	Technicl Officer
Sh. V.K.Sojitra	- do-
Sh. H.M.Hingrajia	- do-
LIBRARY	
Sh. N.Karthikeyan	Information & Documentation Officer
ADMINISTRATION	
Sh. G.C.Prasad	Finance & Accounts Officer
B. AICRPG	
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Sh. A.L.Rathna Kumar	Scientist
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