annual report 1996-97

NATIONAL RESEARCH CENTRE FOR GROUNDNUT

(INDIAN COUNCIL OF AGRICULTURAL RESEARCH)

IVNAGAR ROAD, P.O. BOX 5, JUNAGADH 362 001

GUJARAT, INDIA

ANNUAL REPORT
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PREFACE

The stiff competition from other cheaper sources of edible oils has made it imperative to diversify groundnut use for purposes other than oil, if groundnut agriculture has to remain commercially viable. While preparing a holistic Perspetive Plan for groundnut research, a good amount of thought has been given on this aspect. We have spent a substantial amount of time on drafting the Perspective Plan until 2020 under the dynamic leadership of Dr. R.S. Paroda, our Director General.

During the year 1996-97, basic, strategic and applied research continued on crop improvement, understanding drought mechanisms, refining integrated pest management package, newer,, simpler and better techniques for quality assessment and cropping systems research.

Human resource development was given a special thrust at all the strata for optimum utilization of the manpower.

Technology trasfer activities including training of farmers under the TAR-IVLP programme were organized at the Centre

We are putting all possible efforts to fulfil our mandate. Any valuable suggestions is always welcome for continuous improvement of our Centre.

The kind assistance from various corners in the preparation of this report is sincerely acknowledged.

A. Bandyopadhyay

Director

TABLE OF CONTENTS

Summary

-: सारांश :-

वर्ष 1996-97 ने रा.मूँ.अ.के. पर वर्ष 2020 तक होनें वाली अनुसंधान गतिविधियों कि परिकल्पना पर चिन्तन की प्रक्रिया को अनुप्रेरित किया। मानव संसाधन विकास तथा बेहतर आर्थिक लाभों के लिये प्रक्षेत्र-भूमि के उपयोग को नवीन प्रोत्साहन दिया गया।

राष्ट्रीय मूँगफली सुधार कार्यक्रम को लगातार समर्थन जारी रहा और 550 जननद्रव्यों, जो कि भुवनेश्वर केन्द्र पर उगाये गए थे, तीन AICRP(G) केन्द्रों तथा अन्य उपयोग करने वालों को भेजा गया। उपज तथा अन्य गुणों के लिए मूल्यांकित किए गए, 1400 जननद्रव्यों और 50 विमोचित प्रजातियों में, 18 राईजोक्टोनिया लिम्ब सड़न के प्रति रोगग्राही, 107 टिक्का के लिए प्रतिरोधक तथा 8 टिक्का व रस्ट दोनों के लिए प्रतिरोधक पाए गए। सत्तर व्यापारिक प्रजातियों के 45 सस्यीय व आकारकीय गुणों के लक्षण निश्चयन व मूल्यांकन के एक प्रयोगानुसार, 4 प्रवृत्ति वर्गों में अधिकतर में उपज संबंधी गुणों में अर्थपूर्ण अन्तर परिलक्षित हुआ। परीक्षित किए गए 56 एक्सेशनों में, 11 की पहचान जैविक तथा अजैविक विक्रियाओं के लिए होनहार प्रतिरोधक के रुप मे की गई। बड़े बीज वाले 11 वर्जिनिया एक्सेशनों का उनकी उपज तथा कन्फेक्शनरी गुणों के लिए मूल्यांकन किया गया। सत्तर प्रजातियों और 14 बड़े बीज वाले एक्सेशनों के बीजों मे तेल अवयव 45.1 से 55.0 % तक पाया गया ।

पर्णीय टिक्का तथा रस्ट की प्रतिरोधकता के लिए परीक्षित की गयीं 70 प्रजातियों में ALR-1, CSMG 84-1 तथा ICGV-86590 नें बहु प्रतिरोधकता दर्शायी, जबकि TG-28 ने केवल अगेती टिक्का तथा गिरनार-1 ने केवल रस्ट के लिए प्रतिरोधकता दर्शायी। ICRISAT-NBPGR-NRCG के संयुक्त जननद्रव्य मूल्यांकन कार्यक्रम के अन्तर्गत, ICRISAT द्वारा आपूर्ति किए गए 200 एक्सेशनों का भुवनेश्वर प्रक्षेत्र पर मूल्यांकन किया गया। विभिन्न मूल्यांकनों तथा लक्षण निश्चयन परीक्षणों से प्राप्त सूचनाओं का, केन्द्र के जननद्रव्य सूचना आधार को अद्यतन करने में उपयोग किया गया। फसल-सुधार कार्यक्रम की महत्वपूर्ण गतिविधियों में, वियोजनशील सामग्री तथा अग्रिम पीढ़ी वाली सामग्री का उत्पादन, रखरखाव व मूल्यांकन, मुख्य रहीं। अग्रिम-पीढ़ी परीक्षणों में, 181 होनहार कल्चरों का चयन किया गया तथा उपज मूल्यांकन के प्रयोगों में स्पैनिश, वर्जिनिया तथा HPS प्रकारों में, प्रत्येक के 5 कल्चरों का उच्च उत्पादकता के लिए चयन किया गया। उत्परिवर्तन प्रजनन प्रयोगों में गिरनार-1 प्रजाति के M3 पीढ़ी में 33 होनहार उत्परिवर्ती प्राप्त हुए। रासायनिक युग्मकनाशक तथा विकिरण के उपयोग से परिवर्ती मात्रा में नर बन्ध्यता प्राप्त जा सकी । यद्यपि वैलेन्शिया प्रकार, कम उपज वाले होते हैं फिर भी उनमें उच्च प्रजनन क्षमता पायी गयी। तीन जीन प्ररुपों, PBS 11008, 11015 तथा 11050 की पहचान सूखे की दशा में भी उच्च पुनर्जनन क्षमता के लिए की गयी। चार जीनप्ररुपों, PBS 11014, 11040, 20023 तथा 21018 की पहचान लौह हरिमहीनता के प्रति सहिष्णुता के लिए की गयी, 19 जीन प्ररुपों में, टिक्का के लिए, 5 में पछेती टिक्का के लिए, 11 में रस्ट के लिए, 14 में आल्टरनेरिया झुलसा के लिए तथा 6 में पर्ण सुरंगी के लिए उच्च से मध्यम मात्रा में प्रतिरोधकता निरुपित की गई।

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पर्णीय टिक्का तथा रस्ट की प्रतिरोधकता के लिए परीक्षित की गयीं 70 प्रजातियों में ALR–1, CSMG 84–1 तथा ICGV–86590 नें बहु प्रतिरोधकता दर्शायी, जबकि TG–28 ने केवल अगेती टिक्का तथा गिरनार–1 ने केवल रस्ट के लिए प्रतिरोधकता दर्शायी। ICRISAT–NBPGR–NRCG के संयुक्त जननद्रव्य मूल्यांकन कार्यक्रम के अन्तर्गत, ICRISAT द्वारा आपूर्ति किए गए 200 एक्सेशनों का भुवनेश्वर प्रक्षेत्र पर मूल्यांकन किया गया। विभिन्न मूल्यांकनों तथा लक्षण निश्चयन परीक्षणों से प्राप्त सूचनाओं का, केन्द्र के जननद्रव्य सूचना आधार को अद्यतन करने में उपयोग किया गया। फसल–सुधार कार्यक्रम की महत्वपूर्ण गतिविधियों में, वियोजनशील सामग्री तथा अग्रिम पीढ़ी वाली सामग्री का उत्पादन, रखरखाव व मूल्यांकन, मुख्य रहीं। अग्रिम–पीढ़ी परीक्षणों में, 181 होनहार कल्चरों का चयन किया गया तथा उपज मूल्यांकन के प्रयोगों में स्पैनिश, वर्जिनिया तथा HPS प्रकारों में, प्रत्येक के 5 कल्चरों का उच्च उत्पादकता के लिए चयन किया गया। उत्परिवर्तन प्रजनन प्रयोगों में गिरनार–1 प्रजाति के M3 पीढ़ी में 33 होनहार उत्परिवर्ती प्राप्त हुए। रासायनिक युग्मकनाशक तथा विकिरण के उपयोग से परिवर्ती मात्रा में नर बन्ध्यता प्राप्त जा सकी । यद्यपि वैलेन्शिया प्रकार, कम उपज वाले होते हैं फिर भी उनमें उच्च प्रजनन क्षमता पायी गयी। तीन जीन प्ररुपों, PBS 11008, 11015 तथा 11050 की पहचान सूखे की दशा में भी उच्च पुनर्जनन क्षमता के लिए की गयी। चार जीनप्ररुपों, PBS 11014, 11040, 20023 तथा 21018 की पहचान लौह हरिमहीनता के प्रति सहिष्णुता के लिए की गयी, 19 जीन प्ररुपों में, टिक्का के लिए, 5 में पछेती टिक्का के लिए, 11 में रस्ट के लिए, 14 में आल्टरनेरिया झुलसा के लिए तथा 6 में पर्ण सुरंगी के लिए उच्च से मध्यम मात्रा में प्रतिरोधकता निरुपित की गई।

लिये चयन उच्च उत्सर्जन क्षमता, उत्सर्जन तथा हार्वेस्ट इन्डेक्स (HI) के आधार पर किया जा सकता है । फसलोत्तर भण्डारण की अवधि में बीज की जीवनी शक्ति को बनाए रखने के लिए उत्पाद को सुखाने हेतु 35–40 सेन्टीग्रेड तापमान बहुत उपयुक्त पाया गया। अपरिपक्व फलियों से प्राप्त बीजों में परिपक्व फलियों से प्राप्त बीजों की अपेक्षा कम जीवनी शक्ति पायी गई। स्पैनिश प्रकारों में भी ताजी सुषुप्तावस्था में विभिन्नता निरुपित की गयी और दो प्रजातियों जैसे SB–XI तथा "ज्योति" ने कोई स्वस्थाने अंकुरण नहीं दर्शाया। पादप कार्यकीविदों के लिए मूँगफली के खनिज पोषण पर अध्ययन, अनुसंधान का अन्य महत्वपूर्ण क्षेत्र रहा। कैल्शियम, पोटैशियम तथा बोरोन का अकेले या संयुक्त रुप से प्रयोग करने पर फली भराव में सुधार हुआ, जो कि 100 बीजों के भार में बढ़त तथा उच्च फली उत्पादन के रुप में भी प्रतिबिम्बित हुआ। लौह, जिंक तथा बोरोन को संयुक्त रुप से, ड्रिप सिंचाई द्वारा देने पर फलियों की उपज बढ़ाई जा सकी। मृदा में लौह–EDDHA तथा लौह–साइट्रेट का उपयोग चूना प्रेरित लौह–अल्पता जनित हरिमहीनता को रोकने में प्रभावी पाया गया। कूडों में देने पर अधिकतर पोषक तत्वों ने सकारात्मक प्रतिक्रिया दी लेकिन बीजों पर लगाकर देने से केवल सीमित तत्वों ने ही प्रत्युत्तर दिया जैसे FeSO4, MnSO4, ZnSO4 तथा CaCl2। हालांकि बोरिक अम्ल तथा कापर क्लोराइड को बीजों पर लगाकर देने से बीज जमाव पर हानिकारक प्रभाव पड़ा। मूँगफली उत्पादकता की वृध्दि में मृदा सूक्ष्म जीवों के योगदान की क्षमता का अधिकतम दोहन, अनुसंधान का एक महत्वपूर्ण क्षेत्र रहा। मूँगफली के राईजोस्फीयर से प्राप्त एक फफूँद PSF1 की पहचान ट्राइकैल्शियम फास्फेट को सक्षम रुप से धुलनशील बनाने के लिए की गई। पेन्डिमेथालीन को परिभ्रंश करने वाले 10 तथा क्लोरपाइरीफोस को परिभ्रंश करने वाले 5 जीवाणुओं को समृध्दि–तकनीकी द्वारा प्राप्त किया गया। Bradyrhizobium तथा PSMS की सक्षम प्रजातियाँ (Strains) AICRPC(G) केन्द्रों तथा SAUs को भेजी गईं। जीव रसायनज्ञ का, दूसरे वैज्ञानिकों को उनके प्रयोगिक उत्पाद की गुणवत्ता मूल्यांकन हेतु सेवा देने के अलावा गुणवत्ता मूल्यांकन की नयी तकनीकियाँ विकसित करने का प्रयास जारी रहा। Near–infra red tramsmittance spectrophotometry द्वारा मूँगफली के बीज नमूनों को बिना नष्ट किए हुए उनमें तेल अवयव का निर्धारण करने की सम्भावनाओं को प्रदर्शित किया गया। मूँगफली के बीज में अमीनो एसिड विश्लेषण पर प्रकाशित आंकड़ों पर सैध्दान्तिक अभ्यास से इंगित हुआ कि नत्रजन से प्रोटीन परिवर्तन गुणक का मूल्य 5.3 से 5.7 के बीच हो सकता है।

रोगों के कारण उपज की हानि को कम से कम करने की रणनीति के विकास हेतु पादप रोगविदों के प्रयास जारी रहे। कृत्रिम संदूषित मृदा अवस्था में, अरण्डी की खली (10 कि.ग्रा./है.) के प्रयोग से तना सड़न (Sclerotium rolfsii) कम हुआ। थाइरम (3 ग्रा./कि.ग्रा. बीज) तथा नीम–बीज पाउडर (2%) से बीजोपचार करने पर प्राथमिक पौध संख्या मे क्रमशः 16 तथा 10% का सुधार हुआ। इसी प्रकार कारबेन्डाजिम (2 ग्रा. प्रति कि.ग्रा. बीज) से बीजोपचार करने पर ELS, LLS तथा रस्ट की सघनता में क्रमशः 57, 23 तथा 34% की कमी आई। NRCG प्रक्षेत्र पर PStV के उद्‌भव पर वर्ष भर नजर रखी गई तथा इस विषाणु की खरीफ 1996 में कोई घटना नही पाई गई, हालांकि 1996 की ग्रीष्म ऋतु में छुट–पुट घटनाऐं देखी गईं।

PStV के नियन्त्रण हेतु बुआई से पूर्व 8279 बीज के नमूने ELISA तकनीकी द्वारा परीक्षित किए गए। GG 20 तथा BAU13 जीनप्ररुपों की फलियाँ खेत की परिस्थितियों में एसपर्जिलस फ्लैवस से संक्रमित नहीं हुईं जबकि, परीक्षित किए गये 20 जीनप्ररुपों में NRCG 5850 की फलियों में निम्नतम संक्रमण पाया गया। TAR-IVLP कार्यक्रम के अन्तर्गत चार गाँवों से एकत्रित, 48 नमूनों में मात्र एक ही एफ्लाटोक्सिन से संक्रमित पाया गया। कीट-पेस्ट, जो कि मूँगफली की फसल को सीधा या वाहक के रुप में नुक़सान पहुचाते हैं, की कीटसंख्या गतिविधियों पर पूरे वर्ष नजर रखी गई। खरीफ तथा रबी दोनो मौसमों की अवधि में एफिड, जैसिड, पर्ण सुरंगियों तथा थ्रिप्स की संख्या आर्थिक प्रभाव सीमा के नीचे ही रही। पर्ण सुरंगी (4.4/ट्रेप/सप्ताह) तथा एफिड (1768/ट्रेप/सप्ताह) की उच्चतम कीटसंख्या जनवरी' 96, में दर्ज की गई। आस-पास के तापक्रम तथा हवा की गति का पर्णसुरंगी संख्या के साथ ऋणात्मक संबंध पाया गया।

एकीकृत पेस्ट प्रबन्धन प्रणाली हेतु रीति-समूह विकसित करने के लिए सस्य, पादपरोग व कीट वैज्ञानिकों ने संयुक्त प्रयास किए। खरीफ हेतु रीति-समूह से आर्थिक लाभ 40% बढ़ा, हालांकि रबी हेतु रीति-समूह से केवल सीमांत लाभ ही मिला।

वैज्ञानिक वर्ग के साथ ही साथ अवैज्ञानिक वर्ग को भी दूसरे संस्थानों द्वारा संचालित प्रशिक्षण में प्रतिनियुक्त करने के अतिरिक्त अन्दरुनी उपलब्ध दक्षता का सदुपयोग करते हुए प्रशिक्षण संचालन द्वारा मानव संसाधन विकास पर विशेष बल दिया गया। प्रशिक्षण-प्रकरण व केन्द्र इस प्रकार थे: फसल में परिमाण सम्बनधी गुणों का विकास, TNAU (तमिलनाडु); सूखा प्रतिरोधकता के लिए माँडेलिंग, ICRISAT (पातनचेरु); Bt तकनीकी, NRCPB (नई दिल्ली); उन्नत आणुविक जीव विज्ञान तकनीकी, IARI (नई दिल्ली); सूचना तकनीकी, NIC (New Delhi); कृषि अनुसंधान वित्तीय सूचना प्रणाली, NAARM (हैदराबाद)। कम्प्यूटर का दिन-प्रतिदिन के कार्यों में उपयोग हेतु, स्टाफ के लिए एक अन्दरुनी प्रशिक्षण आयोजित किया गया। IPM के अर्न्तगत एफ्लाटोक्सिन के प्रबन्धन पर एक प्रशिक्षक प्रशिक्षण कार्यक्रम, हैदराबाद मे यू.एन.डी.पी. द्वारा वित्तीय सहायता प्रदत्त परियोजना के अंतर्गत आयोजित किया गया। विश्व खाद्य दिवस, अक्टूबर 16, 1996, के अवसर पर केन्द्र पर एक कृषक दिवस का आयोजन किया गया।

The year 1996-97 marked the actuation of thinking to get a perspective of research activities of NRCG up to the year 2020. Development of human resource and utilization of farm land for fetching better monetary returns were given a fresh impetus.

Support to the national groundnut improvement programme continued and 550 germplasm accessions, raised at Bhubaneshwar farm, were supplied to three AICRP(G) centres and other users. Among 1400 germplasm accessions and 50 released cultivars evaluated for yield and other traits, 18 were found to be highly susceptible to *Rhizoctonia* limb rot, 107 resistant to and 8 tolerant of both leaf spots and rust. In an exercise to characterize and evaluate 70 commercial cultivars for 45 agronomic and morphological traits, significant differences attributable to four habit groups, were observed for most of the yield traits. From among the 56 accessions screened, 11 were identified as promising for resistance to biotic and abiotic stresses. Eleven large-seeded virginia accessions were evaluated for their yield and confectionery traits. The seed oil content of 70 cultivars and 14 large-seeded accessions ranged from 45.1 to 55.0%. Among the 70 cultivars screened for resistance to foliar leaf spots and rust, ALR-1, CSMG 84-1, and ICGV 86590 showed multiple resistance, whereas TG 28 showed resistance only to ELS and Girnar 1 only to rust. Under joint ICRISAT-NBPGR-NRCG germplasm evaluation programme, 200 accessions supplied by the ICRISAT were evaluated at Bhubaneshwar farm. The information emanating from various evaluation and characterization trials was used for updating the germplasm information data base of the centre.

Generation, maintenance, and evaluation of segregating material and advanced generation material were among the important activities of crop improvement programme. From advanced generation trials, 181 promising cultures were selected and from yield evaluation trials, 5 each of spanish, virginia and HPS types were selected as high yielders. In mutation breeding experiments, 33 promising mutants were selected from M3 generation of the cultivar Girnar 1. Varying degrees of male sterility could be achieved by using chemical gametocides and irradiation. Valencia types, though low yielders, were found to have higher reproductive efficiency. Three genotypes, PBS 11008, 11015, and 11050 were identified for their high reproductive efficiency in drought conditions. Four genotypes, PBS 11014, 11040, 20023, and 21018 were identified to be tolerant of iron chlorosis. High to moderate degree of resistance was observed in 19 genotypes for leaf spot, in five for late leaf spot, in 11 for rust, in 14 for *Alternaria* blight, and in 6 for leaf miner.

Interspecific hybridization and development of *in vitro* multiplication techniques had been the important activities of the Geneticists. Besides maintaining 14 interspecific hybrids and their 40 spontaneous hexaploid progenies, 44 promising advanced generation lines of interspecific derivatives and 533 PStV free advanced breeding lines were multiplied. In experiments with tissue culture, Blayeds medium was found to promote more in vitro flowering than that by MS or B5 medium. Differences in the patterns of changes in the activities of cytoplasmic and ionically bound polyphenol oxidase and also of free and bound peroxidase, were observed in regenerating tissues over the period of growth. Genotypic differences were observed in response of wild species in respect of multiple shoot formation from

explants. A combination of 2,4-D (22 mg.ml^{-1}) and NA (2 mg.ml^{-1}) induced as high as 90% secondary somatic embryogenesis by inducing about 10 embryos on per explant of primary somatic embryo. A combination of GA3 (3 mg.ml^{-1}) and BA (1mg.ml^{-1}) was found useful for inducing multiple shoots from somatic embryos.

For developing strategies to minimize yield losses due to diseases, plant pathologists continued their pursuit. Application of castor cake (10 q/ha) reduced stem rot (*Sclerotium rolfsii*) under artificially infested soil conditions. Application of thiram (3g/kg seed) and neem seed powder (2%) as seed dressing improved the initial plant stand by 16 and 10 %, respectively. Interestingly, seed-treatment with carbendazim (2g/kg seed) reduced the intensities of ELS, LLS and rust by 57, 23 and 34%, respectively. Occurrence of PStV in NRCG fields was monitored round the year and no incidence of this virus was observed in kharif 1996, however, sporadic occurrence was seen in summer 1996. For containing spread of PStV, 8279 seed samples were tested by ELISA technique before sowing.

Under field conditions, pods of genotypes GG 20 and BAU 13 did not contract *Aspergillus flavus* whereas those of NRCG 5850 had the lowest infection among 20 genotypes studied. Only one out of 48 samples collected from four villages under TAR-IVLP programme, was found to be contaminated with aflatoxin.

The population dynamics of insect pests which damage groundnut crop directly or act as vectors was monitored round the year. Populations of aphid, jassid, leaf miner, and thrip remained well below the economic threshold level during both rabi and kharif seasons. The highest aphid (1768/trap/week) and leaf miner (4.4/trap/week) populations were recorded in January '96. Population of leaf miner had a significant negative correlations with ambient temperature and wind velocity.

Concerted efforts were made by agronomists, plant pathologists and entomologists to develop a package of practices for Integrated Pest Management (IPM). The package for kharif enhanced the gross monetary return by 40% however the package for rabi did so only marginally.

Studies on cultural practices that would give groundnut farmers maximum returns from the land, water and other resources available to them continued. Relay cropping by sowing of groundnut at 30 cm spacing between the rows of standing crop of wheat (grain filling stage) returned the highest groundnut equivalent yield. Kharif groundnut had contrasting effects on N and P fertilizer requirements of the subsequent crops. The requirements of N and P fertilizers were reduced by 50% for gram but increased by 50% for wheat or sunflower. However, there was no effect on the requirements of mustard. Effects of habit groups and genotypes of groundnut could be seen even on the crop that followed it. Variations in the yield of wheat could be attributed to the habit groups and genotypes of preceding groundnut crop. Intercropping experiments with groundnut showed that pigeonpea did not require any external application of N, whereas sunflower required only half the normal dose. Application of N beyond 50% of the requirement of pearl millet, proved detrimental to the intercropped groundnut. Pearl millet as a fodder crop, with two cuts, fetched better returns than maize and sorghum in intercropping experiments on groundnut. Wheat straw mulching

for groundnut had its best effect when N was applied in split dose- one half as basal and another half as spray of 2% urea on mulch at 20 DAS.

Plant physiologists continued their quest to better understand contribution of various physiological factors to pod yield of groundnut. It was shown that the association between carbon isotope discrimination ($^{13}C/^{12}C$) and specific leaf area could be used for screening groundnut genotypes for water use efficiency. Selection for tolerance of moisture deficit stress could be done on the basis of high transpiration efficiency, transpiration and harvest index. Drying of produce at temperatures 35-40°C was found to be most optimum for retaining seed viability during post harvest storage. Seeds obtained from immature pods had a lower seed viability than those obtained from the mature pods. Variation was observed among the spanish types too for fresh seed dormancy and two cultivars, viz. SB XI and Jyoti did not show any *in situ* sprouting.

Studies on the mineral nutrition of groundnut had been the another important area of research for plant physioloists. Application of Ca, K, and B either individually or in combination, improved the pod filling, which was also reflected as high 100-seed mass and high pod yield. Pod yield could be enahanced by combined application of Fe, Zn, and B through drip irrigation. Soil application of FeEDDHA and Fe-citrate was found effective in preventing lime-induced Fe-deficiency chlorosis. Furrow placement gave a positive response for most of the nutrients but response to seed dressing was seen only for limited nutrients, viz. $FeSO_4$, $MnSO_4$, $ZnSO_4$, and $CaCl_2$. However, seed dressing by boric acid and copper chloride had deleterious effects on seed germination.

Enhanced realization of potential of soil microflora in promoting productivity of groundnut had been an important area of research. PSF1, a fungus isolated from groundnut rhizosphere was identified to be efficient in solubilising tri-calcium phosphate. Through enrichment techniques, 10 pendimethalin degrading and 5 chlorpyriphos degrading bacteria were isolated. Efficient strains of *Bradyrhizobium* and PSMs were supplied to AICRP(G) centres and SAUs.

Besides providing service to the other scientists by evaluating quality of their experimental produce, the biochemist continued efforts to develop new techniques for evaluation of quality. Potential of near-infra red transmittance spectrophotometry for determination of oil content of groundnut seed samples in a non-destructive manner was demonstrated. A theoretical exercise with published data on amino acid analysis of groundnut seeds indicated that the nitrogen-to-protein conversion factor for groundnut seeds may vary between 5.3 and 5.7.

Human resource development was given a special emphasis by deputing non-scientific as well as scientific staff to undergo trainings imparted by other organizations and also by organizing trainings by harnessing expertise available in-house. The topics and venues of trainings were: Improvement of Quantitiative Traits in Crops, TNAU (Coimbatore); virology, SV University (Tirupati); Modelling for Drought Resistance ICRISAT (Patancheru), Bt technology; NRCPB (New Delhi); Advanced Molecular Biology Techniques, IARI (New Delhi); Agricultural Research Financial Information Systems, NAARM (Hyderabad). An in-house training Use of Computers in Day-to-day Work was organized for the members of staff. A trainers training programme on management of aflatoxin under IPM was arranged in Hyderabad under UNDP funded project. On the occasion of World Food Day, the 16th October, 1996, a Farmers' day was organized at the centre.

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: Genetic 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 metergauge 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 land scape of the area is generally falt. 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 1996-97

Months	Temp °C		RH %	Rain fall mm/rainy days	Soil temp °C		Wind Velocity km/hour	Sun shine hrs/ day
	Max	Min			5cm	10cm		
Apirl'96	39.1	22.2	74		38.2	36.5	8.72	10.40
May	39.3	25.4	81		40.0	39.2	11.57	10.60
June	35.9	26.3	84	305.5/4	35.6	35.4	13.70	6.10
July	31.3	25.4	92	333.4/16	30.7	30.5	8.68	2.64
August	29.5	24.1	94	65.0/9	28.7	28.8	7.51	1.83
September	32.9	23.4	87	0.9/2	32.4	31.9	5.30	5.85
October	35.0	21.1	71	26.2/3	32.5	31.5	6.98	7.78
November	32.4	13.6	69		27.7	27.1	5.33	8.93
December	31.2	11.9	67		25.8	25.1	5.73	8.30
January'97	28.7	11.3	70	12.0/2	24.5	23.2	6.18	8.62
February	32.8	12.4	66		27.8	26.6	6.03	9.73
March	36.6	19.1	61		32.7	31.4	8.40	6.83

Research accomplishments

GENETIC RESOURCES

Project: Collection, maintenance, evaluation, documentation and distribution of cultivated groundnuts and related *Arachis* species.

(N.R. Bhagat, K. Rajgopal, K. Chandran (till July 31, 1996), P. Paria, M.P. Ghewande, V. Nandagopal, A.L. Singh and J.B. Misra)

A. Collection

Seeds of sixteen released groundnut cultivars were assembled for characterization and evaluation.

B. Distribution

Seventy five accessions were supplied within the Centre to Entomology (2) and Plant Breeding (73) sections and 550 germplasm accessions were supplied directly from Off-season Centre, Bhubaneshwar to three AICRP(G) centres. The distribution of germplasm directly from Junagadh remained suspended due to peanut stripe virus (PStV).

C. Maintenance of *Arachis* species

To avoid perpetuation of PStV infection, wild species maintained in plots were destroyed after harvesting the pods and 13 PStV-free *Arachis* species were maintained in the concrete pots.

D. Maintenance and preliminary evaluation of cultivated germplasm

The entire working collection maintained at the Centre was destroyed, due to a direction given by the Chairman SRC to control PStV. Systematic approach to eradicate PStV from this location having continued, rejuvenation and replenishing PStV free collection was being undertaken at Gujarat Agricultural University (GAU), Sardar Krushi Nagar and NRCG Off-season Centre, Bhubaneshwar, Orissa.

(a) GAU - Sardar Krushi Nagar Campus

A set of 750 accessions picked out at random from the base collection at NBPGR, New Delhi were brought to the Centre and subjected to ELISA test. Seven hundred and thirty PStV free accessions were sown at GAU, Sardar Krushi Nagar Campus. Eighteen accessions failed to set pods and pod yield in 71 accessions was less than 10 grams. The pod recovery in 640 accessions was satisfactory.

(b) Off-season Centre, Bhubaneshwar

About 1400 germplasm and 50 released cultivars sown in kharif 1996 for seed multiplication and yield evaluation were also scored for their reaction to major foliar diseases (early leaf spot, late leaf spot and rust) and *Rhizoctonia* limb rot, at pod filling stage under natural epiphytotic conditions. Eighteen

accessions were found highly susceptible to *Rhizoctonia* limb rot, 107 accessions were resistant and 8 were tolerant of the three major foliar diseases. The accessions resistant to and tolerant three foliar diseases in kharif 1995 showed similar reaction in kharif 1996 also.

(c) Characterization and evaluation of released cultivars

The characterization and yield evaluation of 70 released cultivars (virginia bunch (HYB) : 16, virgin runner (HYR) : 17, valencia (FST) : 2 and spanish (VUL) : 35) was undertaken in RBD with thre replications. The collection was scored for 45 agro-morphological traits, pertaining to plant (9), flowe (3), leaf (7), stem (3), peg (2), pod mass (10), pod (7) and seed (4) in association with the plan breeders. Correlation analysis of last year data did not reveal any trend between major yield traits The cultivars showed overlapping of many qualitative traits and it was difficult to identify cultivar based on a common set of characters.The identifying set of characters will vary from cultivar t cultivar or group of cultivars. For example, colour or variegation on testa could be used as a key to th entity of some cultivars viz., TMV 10, Chitra, CSMG 84-1, M 145 and ALR 1. The smooth po surface as in JL 24 (but pod constriction is moderate) and TAG 26, or large seed size as in BAU 1 (with red testa), B 95 and TKG 19 A etc. The pods in ICGV 86590 were mostly three seeded wit moderate pod beak, constriction and reticulation.

The collection showed significant variation for all the yield related traits (Table 1). The highest po yield.m^{-2} was recorded in GG 3 (108 g) followed by GG 13 (101 g). The 100-seed mass (HSM) was th highest in cv. BAU 13 (85.0 g) whereas it was the lowest in MH 4 (23.6 g).

Table 1. Mean (M), Range (R) and Mean Sum of Squares (MSS) of 10 agronomic traits i 70 released cultivars

Traits	M	R	MSS
Pod bearing plants (%)	98	84-100	22.5**
Days to maturity	112	100-143	236.6**
Pod yield.m^{-2}(g)	57	16-108	944.7**
Pod length (mm)	24	20-31	23.0**
Pod width (mm)	12	9-15	3.3**
Seed length (mm)	12	10-17	6.1**
Seed width (mm)	8	7-8	0.3*
Shelling (%)	68	60-76	57.3**
Sound mature seed (%)	87	79-92	19.9**

Variations in pod yield.m^{-2}, HSM and days to maturity were high whereas pod and seed features, in general, showed a narrow range. The cultivars screened for major foliar diseases in field conditions viz., ELS, LLS and Rust indicated multiple resistance in ALR 1, CSMG 84-1 and ICGV 86590 with disease score 3 to 6, whereas Girnar 1 was found resistant to rust (score 3). The oil content in seeds of these cultivars was estimated using specific gravity method. The oil content ranged from 45.1 to 55.0 %. In 44 accessions, oil content ranged from 50.0 to 55.0 %, the highest (55.0%) being in cv.GG 20.

(d) Evaluation of special-feature groundnut accessions

The trial with 56 accessions belonging to four habit forms (HYB 13, HYR 15, VUL 14, FST 14) was repeated in kharif '96, to identify accessions with high yield potential coupled with resistance to or tolerance of major biotic and abiotic stresses. The collection was field-planted with two checks for each habit type, and scored for yield and yield related traits. Pod yield.m^{-2},ranged from 42 to 231 g, shelling outturn from 58 to 74, sound mature seed from 59 to 97 % and HSM from 25 to 58 g in the collection with corresponding general means for these traits were 118 (g), 67 (%), 84 (%) and 39 (g) respectively. (Table 2).

Table 2. Mean (M) and range (R) for 9 agronomic traits in 56 special-feature accessions

	PYM	SP	SMS	HSM	HPM	PL	PW	SL	SW
HYB(13)									
M	93	67	74	44	81	26	12	13	7.7
R	42-167	58-74	59-81	25-58	47-117	20-34	10-15	10-17	7.2-8.2
HYR(15)									
M	117	68	76	40	82	26	12	13	7.7
R	67-189	61-74	66-84	31-49	67-100	23-28	11-13	12-14	7.3-8.0
FST(14)									
M	134	64	92	37	95	27	12	12	7.7
R	104-231	58-73	86-95	28-42	70-112	21-31	11-13	11-13	7.2-8.0
VUL(14)									
M	126	69	94	34	73	22	11	11	7.7
R	98-162	63-73	90-97	28-50	51-118	19-27	10-12	10-13	7.3-8.5
GROUP									
M	118	67	84	39	83	25	11	12	7.7
MSS	3634.32**	51.11**	278.49**	25.63**	750.05**	31.38**	2.63**	4.59**	0.23
CD%	4.63	1.53	2.36	1.77	37.98	4.02	1.45	1.97	1.13

PYM =pod yield.m^{-2}(g), SP = shelling %, SMS = sound mature seeds(%), HSM=100 seed mass(g), HPM = 100-pod mass (g), PL = pod length (mm), PW = pod width (mm), SL = seed length (mm), SW = seed width (mm), ** = Significant at 1 %.

The yield performance of long duration cultivars of the ssp. *hypogaea* was however, not encouraging due to end-season soil moisture deficit stress. The yield related traits of promising accessions identified for further evaluation on the basis of pod yield is presented in Table 3.

Table 3. Promising accessions identified in the collection on the basis of five economic traits

NRCG	Variety	PYM (g)	SP (%)	SMS (%)	HSM (g)
HYB					
5190	NCAc2242	167	71	75	40
7720	NS 74	145	74	79	41
	Control	115	71	85	46
HYR					
1463	NCAc 2309	186	65	76	45
6987	G 201	189	73	84	40
	Control	120	69	73	42
VUL					
5316	EC 22451	149	69	93	38
6797	AH 7434	144	73	95	50
9553	CES 103	158	70	95	50
9573	ACC 724	162	72	94	33
	Control	107	68	95	31
FST					
1339	U 2-12-3	231	66	95	35
4659	PI 275949	168	61	93	41
5108	EC 24422	158	60	93	42
	Control	96	68	79	36

PYM = Pod yield.m^{-2}(g), SP = Shelling %, SMS = Sound mature seed %, HSM = 100 seed mass (g)

(e) Evaluation of large-seeded virginia accessions

According to the Bureau of Indian Standards, the bold grade of groundnut has the seed mass of 45 to 57g/100 seeds. Eleven virginia accessions (HYB-9, HYR-2) with seed mass within this range identified against cv. M 13, BAU 13 and GG 11. The collection was scored for six plant, five yield and yield related traits and oil content (%). The collection showed significant variation for five yield and related traits and oil content (Table 4). The Pod yield.m^{-2} ranged from 48-98 g and HSM from 45-58 g. The lowest oil content of 49 % was recorded in NRCG 671 and the highest (54 %) in NRCG 2750.

Table 4. Mean values of five economic traits and oil content in 14 large-seeded accessions

Variety	NRCG	PYM(g)	SP(%)	SMS(%)	HSM(g)	OC(%)
Ah 7329	3014	65	71	76	48	53
BP 1	4829	62	60	76	49	51
Basse	3026	48	64	72	52	50
Bold 2	671	98	71	90	48	49
IS-10-NC-4 X	5363	62	66	81	55	51
JL 56	7277	56	70	78	49	51
NCAc 1092	481	64	64	67	47	51
NCAc 17286	1039	62	68	78	47	51
NCAc 1861	879	60	66	78	56	51
NCAc 2309	1463	77	68	73	49	53
Spantex	2750	71	68	83	58	54
BAU 13	(C)	78	64	73	65	52
GG11	(C)	60	65	74	45	47
M 13	(C)	72	69	64	51	50
	GM	67	67	76	51	51
	MSS	441.9**	30.6**	123.2*	86.9**	9.5**
	SEm	2.2	0.8	1.9	1.0	0.8

GM = general mean, MSS= mean sum of squares, SEm = standard error of mean, C= control

Screening of fourteen large-seeded accessions for *Aspergillus flavus* under laboratory conditions indicated moderate level of seed colonization in NRCGs 481, 2750 and 3014.

E. Inter-institutional collaboration

Under the joint ICRISAT-NBPGR-NRCG groundnut germplasm evaluation programme, a set of two hundred accessions (HYB:62, HYR:22, FST:57 and VUL:59) was sown at Bhubaneshwar with four local checks, M 13, ICGS 44, ICGS 76 and Gangapuri, in an augmented design. The collection was scored for 13 morpho-agronomic descriptor states as specified by the ICRISAT.

F. Documentation of evaluation data

The data on evaluation and characterization of groundnut resources was documented. The inventory of accessions maintained at the NRCG Off-season Centre, Bhubaneshwar was prepared. A

compendium providing passport information on germplasm accessions identified for some importa
traits, since the inception of the Centre was prepared. The compendium documents promisi
accessions for 36 traits, identified by various sections within the Centre for biotic and abiotic stress
and other favorable agronomic and biochemical constituents.

PLANT BREEDING

Project: Breeding and genetic studies for improving yield and quality in groundnut.

(A.Bandyopadhyay, R.K.Mathur, P. Manivel and M.Y. Samdur)

The primary objective of this project is to develop breeding lines possessing high yield, desirable duration and quality attributes. The major thrust has been given on earliness, especially in virginia types, fresh seed dormancy in spanish types, high oil content, high kernel weight and resistance to aflatoxigenic fungi and aflatoxin load. Basic genetic studies of applied breeding value have also been carried out. Work has been initiated for breeding for quality traits in groundnut but lack of practical methods to select these traits in segregating generations is a major obstacle.

A. Hybridization, multiplication, generation advancement and selection

Artificial hybridization between parental lines to bring together a desirable combination of genes is an integral component of any crop improvement programme. A total of 44 crosses were effected for earliness in virginia (18 crosses), for development of confectionery type of groundnut possessing resistance to aflatoxigenic fungi (12 crosses), for seed viability in spanish (7 crosses), for fresh seed dormancy in spanish (6 crosses) and for high shelling per cent (one cross).

In kharif 1996, 28 F_1 hybrids were studied and advanced to F_2 generation. Thirty eight crosses from F_2 to F_6 generations were advanced. A total of 181 promising cultures (66 in virginia and 115 in spanish) were selected from advanced generations. The 457 advanced cultures and 269 selections were further multiplied. In rabi-summer 1996, six important breeding lines *viz*., 5 S, RB 46, NFP 101, NFP 140, PBS 8 and Girnar 1 were multiplied at S.K. Nagar (GAU). Regular monitoring for PStV was done and the produce was further multiplied during kharif 1996.

B. Evaluation of promising advanced breeding cultures

Three in-station yield evaluation trials, one each with spanish, virginia and HPS types were conducted for identifying promising cultures in kharif 1996. The salient results are presented in Table 5.

C. Basic and strategic research

One of the greatest handicaps in studies on groundnut improvement is the small size of populations in segregating generations which in turn, limits the scope of genetic reshufling during the course of segregation. The probable ways to overcome this problem would be i) to increase the crossing success, ii) to induce functional male sterility by chemical/physical means which in turn may induce higher rate of cross pollination, iii) to increase the base population of the F_1s through mass *in vitro* cultures, and

iv) to provide suitable environment for success in hybridization considering these constraints. following experiments have been conducted for last two years.

Table 5. Salient results of in-station yield evaluation trials

	Seed yield (kg/ha)	Shelling out turn	HSM (g)
SPANISH			
Promising cultures over the best check (out of 29)			
Sel 28a	2274	66	35.2
PBS 11049	2242	73	39.2
Checks			
Girnar 1	2193	70	31.8
JL 24	1889	74	47.8
GG 2	1473	75	36.0
VIRGINIA			
Promising cultures over the best check (out of 30)			
PBS 21031	1993	66	37.6
PBS 29022	1993	72	41.3
PBS 24003	1904	71	38.0
PBS 22028	1891	67	49.1
PBS 21064	1802	70	28.9
Checks			
ICGS 44	1759	71	39.0
Kadiri 3	1468	72	39.6
HPS			
Promising cultures over the best check (out of 14)			
PBS 29033	1625	66	65.0
PBS 29035	1415	68	74.7
PBS 29031	1379	67	72.0
PBS 29025	1334	73	54.3
PBS 29020	1264	67	71.9
Checks			
Somnath	0825	66	86.8
B 95	0983	64	67.0
ICGV 89211	0286	69	78.0
HNG(HPS)2	1533	69	80.5

(a) Induction of clustered flowering

Initial clustered flowering would not only shorten the period over which hybridization is done but also prolong the opportunity for the hybrid pods to mature with similar levels of maturity. Field experiments were conducted during rabi-summer and kharif seasons of 1996. The results showed that the cutting off the main axis at flower initiation stage resulted in maximum flowers produced in a short duration of time (35-40 days after sowing).

(b) Rapid multiplication of F_1s through nodal culture

An attempt was made to standardize nodal culture protocols for field-grown F_1 plants. The rate of success was 5 %. The major problem faced was that of microbial contamination of explants.

(c) Pollen germinability and crossability

To study the effect of environmental factors such as temperature and relative humidity on pollen germinability and success in crossing , an experiment was conducted with four groundnut cultivars (JL 24, GG 2, Kadiri 3 and M 13) crossed in six possible cross combinations keeping GG 2 and Kadiri 3 as the female parents. The per cent success in crossing was high when a spanish type was used as the female parent (29 %). One of the probable reasons for difference in success in crossing could be the differences observed in pollen germinability. Associations between per cent pollen germination with relative humidity was positive and with temperature negative. The success in hybridization also showed a negative association with temperature but positive trend with relative humidity.

(d) Reproductive efficiency

To study the conversion rate of flowers to pods, the experiment was undertaken in rabi-summer 1996 and repeated in kharif, 1996. valencia and spanish types were earliest to flower, the virginia types were late. Flowers were produced mainly on primary branches. The various reproductive indices viz., total pods to total flower ratio, mature pods to total flower ratio, mature pods to total pods ratio, harvest index etc, indicated valencia as the reproductively efficient type though total production of flowers & pods were the lowest. It may be possible to use this efficiency in the productive background.

(e) Induction of functional male sterility

Spray of male gametocides

To induce functional male sterility, six male gametocides viz., 6-benzyl aminopurine (BA), ethidium bromide (EB), ethrel, indole acetic acid (IAA), 2,4-D and diethyl sulphonate (DES) were sprayed individually on plants at flower initiation and 10 & 20 days after flower initiation. Per cent pollen sterility varied across the treatments as well as among the plants within a treatment. Maximum pollen

sterility of 90 % was observed in one plant each from plants treated with 2,4-D and DES. Ethrel suppressed production of flowers almost totally. 2,4-D caused higher biological damage to the plants and variations in pod size than others.

Gamma irradiation

In kharif 1996, the seeds of four groundnut cultivars were irradiated with gamma rays. 30 kR appeared to be the most lethal dose. The range of pollen sterility varied between 5-100 %. A plant with cent per cent male sterility was observed in the cultivar Somnath at 25 kR.

D. Mutation experiment: M3 generation

Girnar 1 is a multiple resistant and high yielding spanish variety released from this centre but it has low shelling out turn. Hence, to increase the shelling out turn of Girnar 1 while retaining its other useful characteristics the seeds were treated with two chemical mutagens DES and EMS. Single plant progenies of M_2 generation were raised in kharif 1996 and 42 promising mutants were selected

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

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

At NRCG attempts had been made to develop promising breeding lines for drought tolerance, major foliar diseases and tolerance to iron chlorosis because these are the most important biotic and abiotic stresses for groundnut in our country.

A. Hybridization, multiplication, generation advancement and selection

A total of 23 crosses were made for the various purposes like disease resistance (11 crosses), drought tolerance (5 crosses), cold tolerance (3 crosses), insect resistance (2 crosses) and salinity tolerance (2 crosses). Twenty crosses from F_2 to F_6 generations were advanced and a total of 21 promising advanced cultures (8 virginia and 19 spanish) were selected from advanced generations. The 268 advanced cultures were further multiplied for use in breeding programme.

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

(a) Screening of advanced cultures for drought tolerance

Twenty two advanced breeding cultures were screened for drought tolerance in rabi-summer 1996. The mid season water stress was induced at 40-65 days after sowing. The reproductive efficiency of

spanish types was higher than virginia types under both irrigated and drought conditions. The cultures with PBS 11008, 11015, and 11050 were found reproductively efficient and tolerant to drought.

(b) Screening of advanced cultures for iron chlorosis

Twenty four advanced breeding cultures were screened for tolerance to iron chlorosis. The cultures with PBSs 11040, 20023, 11014 and 21018 were found to be iron efficient.

(c) Screening of advanced breeding lines for disease resistance

In kharif 1996, advanced breeding cultures were screened for resistance to diseases and insect-pests under field conditions.

The screening for late leaf spot (LLS), early leaf spot (ELS), *Alternaria* and rust was done under high disease pressure at field conditions. One culture JCA 16 was found to posses multiple resistance to rust, ELS, LLS and *Alternaria* blight. The culture PBS 21063 had high degree of resistance to LLS. Two cultures to late leaf spot and 11 to rust were identified with moderate resistance.

(d) Screening of advanced breeding lines for insect-pest resistance

The genotypes resistant to leaf miner over two kharif seasons were PBS Nos. 24039, 29030 and 29017.

C. Screening of advanced cross derivatives for resistance to diseases under uniform disease nursery trial

In rabi-summer 1996, 47 genotypes comprising 15 cross derivatives and 32 advanced breeding cultures were evaluated in uniform disease nursery trial in collaboration with the Plant Pathology section. Among them PBS 12156, 12108, 11050, 12038, 12111, 12157 and 12109 showed below 5 % incidence of stem rot whereas genotypes PBS 12085 had the highest incidence (41.65 %).

GENETICS AND CYTOGENETICS

Project: Characterization and utilization of wild *Arachis* spp. for groundnut improvement.

(P. Paria, S.K. Bera, Radhakrishnan T, M.P. Ghewande and V. Nandagopal)

This programme was initiated to introgress the economically important characters like resistance to biotic and abiotic stresses from wild relatives of groundnut to the cultivated species. For attaining this objective, interspecific hybridization and screening of the materials generated were being taken up.

A. Maintenance of wild *Arachis* species and interspecific hybrids

The following wild *Arachis* species were maintained in the field after a regular monitoring against PStV through ELISA.

Diploid (2n=20)	IGG No.	Tetraploid (2n=40)	IGG No.
Arachis cardenasii	11558	*A. glabrata*	8902
A. duranensis	8196	*A.hagenbeckii*	8188
A. chacoense	4983		
A. paraguariensis	8130		
A. stenosperma	8906		
A. prostrata	8189		
A. marginata	8903		
A. otavioii	8192		
A. villosa	8907		
A. pusilla	8131		
A. appresipila	8127		
A. correntina	8132		

Forty F_1 hybrids of different interspecific crosses and 40 spontaneous hexaploid progenies were maintained in the field.

Name of the cross	Triploid F_1	Hexaploid progeny
J11 x ICG 11558	10	9
J11 x ICG 8192	10	12
J11 x ICG 8162	10	8
J11 x ICG 8164	10	11

B. Generation advancements

Fifty selections from F_2 and F_3 generations of five interspecific crosses involving the species *villosa*, *A. cardenasii*, *A. helodes* and the interspecific derivatives viz. a derivative of J 11 x *cardenasii* and CT 7-1 were field-multiplied for selection against foliar disease pathogens and yi Forty-four promising advanced breeding lines of different derivatives from 11 interspecific cros involving the wild species, *A. cardenasii*, *A. cardenasii* (4x), *A. khulmanii* and *A. appresip* and the accession ICG 8127 as male parents and the cultivars J 11, GG 2, JL 24, TMV 2, M 13 a Kadiri 3 as the female parents having high yield with combinations of other desirable yield attribu were raised in the field for multiplication and evaluation.

A set of 280 PStV-free promising lines with high -peg strength and -yield were maintained at GA campus, Dantiwada.

C. Cytology

To study the interspecific relations, pairing behaviour of chromosome in the triploid interspecific hybr (F_1), J 11 (*A. hypogaea* L.) x *A. cardenasii* (ICG 11558) and J 11 (*A. hypogaea* L.) x *A. otavioii* (IC 8192) along with their parents were studied. Mostly bivalents were observed in PMCs of J 11, *A. cardena* and *A. otavioii* at Metaphase I, but a few univalents, probably due to premature chiasma terminalizatio were also observed in them. Cytomixis, perhaps a relics of premeiotic spindle error, was found to b prevalent in the PMCs of cv. J 11 and found to cause irregular chromosomal distribution at Anaphas resulting in formation of micronuclei. In both the hybrids, bivalents were predominant in the PMC Univalents, trivalents and quadrivalents were also observed in them at varying frequencies. The me chromosomal associations in Metaphase I as observed in the hybrids are given in Table 6.

Table 6. The chromosome association in MI of interspecific hybrids

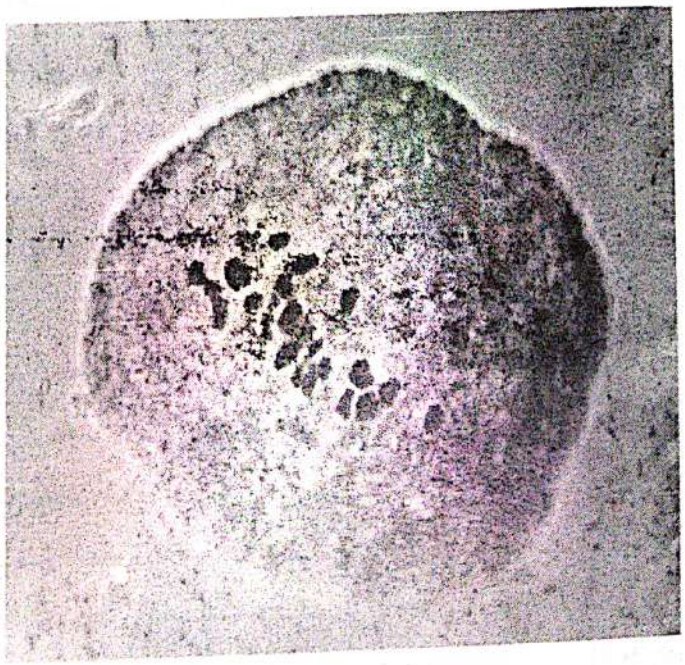
Hybrids	Number of PMCs	Mean Chromosome association				
		I	II	III	IV	V
J11 x ICG 11558 (*A. cardenasii*)	75	3.57	10.02	1.13	0.43	0.01
J11 x ICG 8192 (*A. otavioii*)	23	3.86	12.21	0.47	0.13	0.00

The trivalents observed in the hybrids were in the form of chain, ring, Y, and spoon.-○-while quadrivalen were in the form of Y chain, ring, and-○- Ring trivalents are possible only when one assumes the presen of iso-chromosome in the system. and spoon, trivalent structures are possible with three homologou homeologous chromosomes. Similarly, Y shaped quadrivalents are possible when there will be fo homologous/homeologous chromosomes in the system. The genomic constitution of the hybrids wa

supposed to be AAB where on of the A genome was of *A. cardenasii* or *A. otavioii*. Rest A and B genome was contributed by *A. hypogaea*. Hence, formation of Y quadrivalent suggests presence of some chromosome in duplicate in *A. hypogaea* genome. Therefore, these facts provoke some doubt over the basic number of the genus *Arachis*.

All the 92 suspected F_1 seeds from the cross J 11 x *A. paraguariensis* when planted in the field, were found to be maternal. Of them, one was found to be nullisomic with 2n=38. From a separate cross cv. J 11 x CT 7-1 (an interspecific derivatives received from ICRISAT), another nullisomic was detected in F1. It was not known with certainty whether the missing chromosome pair in both the nullisomics were same or different. However, both the nullisomics was fertile and it was possible to harvest a total of 28 pods from them. Meiotic analysis of the nullisomics revealed that PMCs with 19 bivalents constitute modal class and mean chromosome configurations per PMC at Metaphase I were 0.63 univalents and 18.54 bivalents. At Anaphase I, an equal separation of 19/19 was observed in about 50 % of the PMCs. Rest of the PMCs showed unequal separations of 20/18 or 21/17. Four plants were raised from the seeds of nullisomic derived from cv. J 11 x *A. paraguariensis*. Out of these four plants two plants were cytologially confirmed to be nullisomic having 2n=38. The rest two were phenotypically same as the nullisomics and hence, were assumed to be nullisomics. Morphological difference recorded for cv. J 11 and nullisomic plant are presented in Table 7.

The nullisomic plant



Metaphase plate in meiosis of the nullisomic plant

Table 7. Mean phenotypic scores of cv. J 11 and Nullisomic

Character	J11	Nullisomic
Leaf let area(cm^2)	9.22	4.30
Leaf let length(cm)	4.65	3.39
Leaf let breadth(cm)	2.52	1.68
Petiole length(cm)	3.24	2.30
Stomatal length(mm)	0.025	0.025
Stomatal breadth(mm)	0.02	0.015
Stipule length(cm)	2.4	2.03
Sepal length(mm)		
Joint	8.0	8.46
Single	10.0	10.13
Petal length(mm)		
Standard	13.60	11.26
Wings	8.00	7.73
Keels	8.8	8.00
Hypanthium length(mm)	27.33	15.54
pollen fertility (by aceto carmine staining)	98%	97%

D. Hybridization

(a) Interspecific

All together, 1201 interspecific pollinations were made using cv. J 11 as female parent and diffe wild *Arachis* species as male parents as shown below:

Cross	No. of pollinations	Pods harvested
J11 x *A.cardenasii*	432	413
J11 x *A. duranensis*	311	255
J11 x *A. stenosperma*	222	135
J11 x *A. paraguariensis*	236	94

Probable hybrid pods were collected and stored for isolating true hybrids.

(b) Intraspecific

A total of 930 pollinations were attempted among different phenotypic leaf markers to develop a multiple markers system and to study their inheritance pattern in following combinations.

Crosses	No. of pollinations	Pods arvested
Corduroy x J11	473	242
TMV NLM 2 x Puckered leaf	38	5
TMV NLM 2 x corduroy	203	1
TMV NLM 2 x Golden yellow leaf	33	1
Golden yellow leaf x Puckered leaf	52	7
Puckered leaf x Golden yellow leaf	131	23

A Diallel crosses with six parents were made to study the genetics of nitrogen uptake in groundnut. Cultivated varieties DH 3-30, ICGS 76, JL 24, TG 19A, Co 2 and Chico having different uniform nitrogen uptake values were selected as parents.

Project: Embryo rescue, micropropagation and haploid production in groundnut.

(Radhakrishnan T., P. Paria, S.K. Bera and K. Chandran (Till July 1996))

This project has been taken up with a major objective of standardizing high frequency regeneration systems for subsequent application in genentic improvement of groundnut. Protocols for high frequency multiple shoot regeneration and somatic embryogenesis have already been achieved by us. The present efforts concentrate on the utilization of somatic embryogenesis in the genetic transformation of groundnut as well as haploid production through anther culture.

A. Induction of flowers *in vitro*

Under the experiment on the *in vitro* flowering, 10, 15 and 20 mg.l^{-1} of BA were tried in MS, Blayeds and B5 media. The observations on shoot regenerations and flowering were taken after 15 days in culture. MS medium is distinctly superior in shoot regeneration through multiple shoots, irrespective of the concentration of BA tried, while Blayeds medium was distinctly superior in inducing flowering and flower production. Blayeds medium with 20 mg.l^{-1} BA was the best medium amongst all for flower production *in vitro*. Though, MS media are superior in inducing multiple shoots Blayeds medium is trivially superior in producing more number of shoots. Hence, Blayeds medium was judged as the best for producing more number of shoots and flower buds. B5 medium did not induce flowering though it could induce multiple shoots.

B. Biochemical analysis of regenerating tissues

For studying the possible markers for regenerating tissues, polyphenoloxidase and peroxidase enzyme activities were assayed in the multiple shoot regenerating de-embryonated cotyledons. Both the cytoplasmic- and the ionically bound- fractions of the enzymes were assayed. In regenerating tissues, cytoplasmic fractions of the polyphenol oxidase activity increased consistently over growth in culture while the ionically bound fraction decreased consistently and sharply for first six days of growth and afterwards maintained a stable level. For peroxidase activity in the regenerating tissue, the level of bound fraction maintains a static level up to 15 days of growth in medium (by that time the shoot induction process was complete) and afterwards it increased consistently and sharply. The free fractions of peroxidase maintained a stable level was up to 12 days followed by a slow increase in level over the growth period.

C. Testing the regeneration potential of wild *Arachis* species

To test the regeneration potential of the wild species of groundnut *in vitro*, the following wild species were cultured on MS medium containing 5, 10 and 15 $mg.l^{-1}$ of BA.

1. *A. stenosperma* (ICG 8906)
2. *A. cardenasii* (ICG 8116)
3. *A. ipaense* (ICG 8208)
4. *A. appresipila* (ICG 8217)
5. *A. sp.* (GK 30008) (ICG 8190)
6. *A. correntina* (ICG 8132)
7. *A. paraguariensis* (ICG 8130)
8. *A. duranensis* (ICG 8200)
9. *A. sp.* (ICG 8192)

The species differed in their regeneration potential even at the most successful hormonal concentrations applied to the cultivars with the best results. In general, lower concentration of BA i.e. 5 $mg.l^{-1}$ in this case was better than 10 and 15 $mg.l^{-1}$ of BA in inducing regeneration. In cultivated varieties, 10-15 $mg.l^{-1}$ of BA could induce multiple shoots in very high frequencies and with 30 to numerous shoots per explant. In case of wild species the frequency varied from 10 to 30% with a maximum of 18 shoots per explant. The maximum response was from *A. cardenasii* and *A. correntina* gave the poorest response. *A.appresipila*, instead of producing multiple shoots from the embryonal ends of the de-embryonated cotyledons, initiated callusing on the total explant and then produced numerous shoot buds which expanded and grown in to full shoots on later sub culturing. The frequency of this shoot bud induction was 82.61% which can be considered as a very high frequency of regeneration.

Shoot bud initiation from *A. appresipila*

Multiple shoot formation from *A. cardenasii*

D. Direct regeneration of somatic embryos in to multiple shoots

Previous experiments revealed that MS medium containing GA_3 and BA, in the ratio of 3:1, could produce multiple shoots from individual somatic embryos. With a view to enhance the number of shoots per embryo, the concentrations of GA_3 and BA were reversed i.e. 1:3 ratio. The increase in the concentration of BA resulted in increase in the number of shoots per embryo and the reduction in the concentration of the GA_3 did not affect the shoot induction (Table 9).

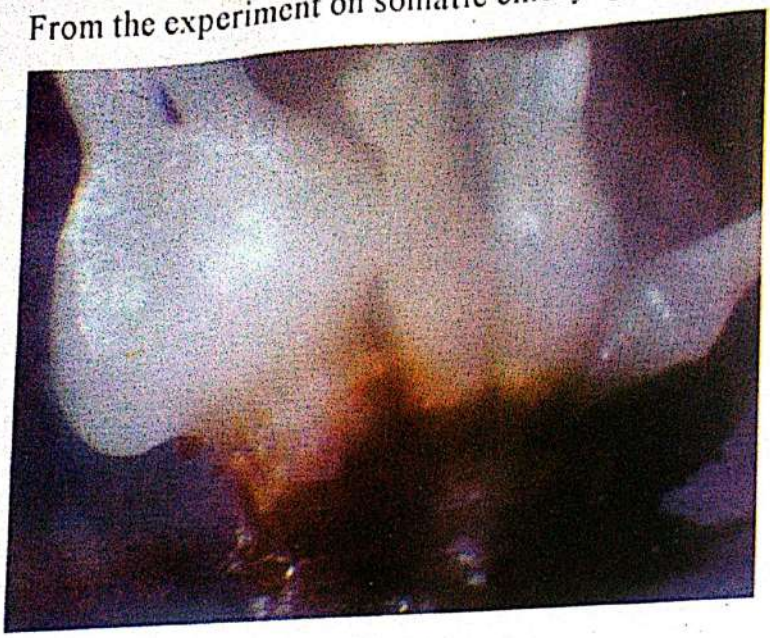
Table 9. The frequency of shoots produced per embryo in the two hormonal combinations.

Auxin combination ($mg.l^{-1}$)	Embryos cultured	Embryos responded	Shoots per embryo
3 GA_3 + 1 BA	248	78	2.44 ± 1.72
1 GA_3 + 3 BA	228	83	5.10 ± 3.43

Out of the shoots produced, 152 well developed shoots were further cultured in a rooting medium (MS + 2 $mg.l^{-1}$ NAA) for the induction of roots. Eighty-six shoots developed roots and turned out to complete plantlets. The plantlets developed are being hardened.

E. Secondary somatic embryogenesis

From the experiment on somatic embryogenesis, 13 different combinations of auxins wh



were found to give the best resul
were tried for secondary soma
embryogenesis. Fully grown prima
somatic embryos induced from
cv.Girnar 1 were cultured on M
medium containing these aux
combinations. The frequency
secondary somatic embryogenesis
well as the number of embryos p
explant varied widely with the leve
and combinations of auxins (Table

Secondary somatic embryogenesis

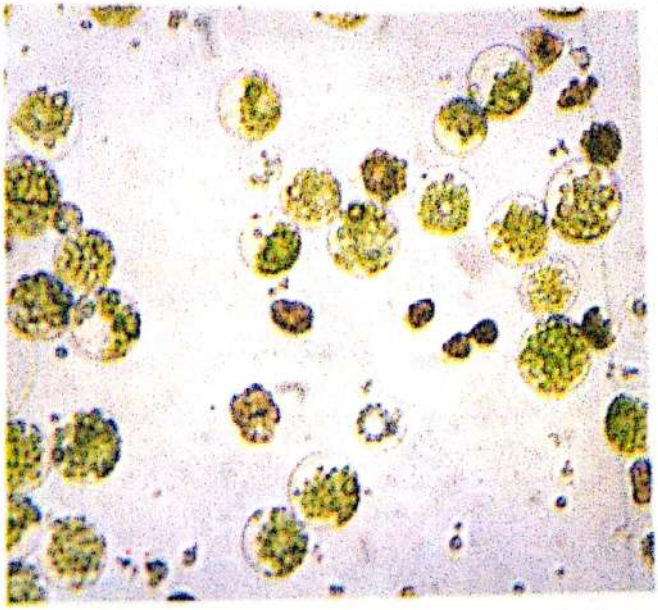
Table 8. Secondary somatic embryogenesis-frequency and number of embryos per explan

Auxin combinations 2,4-D/NAA mg.l^{-1}	%Secondary somatic embryogenesis	No. of somatic embryos per explant
18/1	50.0	5.2 ± 5.98
20/1	60.0	4.0 ± 2.24
22/1	70.0	4.5 ± 3.55
24/1	70.0	7.4 ± 8.10
26/1	40.0	4.0 ± 1.63
28/1	50.0	3.8 ± 0.43
14/2	72.3	8.1 ± 7.12
18/2	70.0	3.1 ± 1.55
20/2	40.0	3.3 ± 2.05
22/2	90.0	9.4 ± 3.64
24/2	30.0	1.5 ± 0.50
26/2	60.0	8.5 ± 1.66
28/2	80.0	5.0 ± 1.41

F. Isolation and purification of protoplasts

Different explants from *in vitro* raised seedlings of cv. SB XI were incubated overnight in 12 combination of cellulase and pectinase (0.25% to 2% cellulase and 1 and 2 % pectinase) in an osmoticum containing CPW salts and 9% mannitol. The enzyme combinations comprising 1% and 2% cellulase with 1 and 2% pectinase resulted in good release of protoplasts. However, the combination of 2% cellulase and 1% pectinase yielded more number of viable protoplasts and the hypocotyl explants responded better.

The released protoplasts were purified by layering over 20% sucrose and their viability was tested using FDA staining.



Hypocotyl protolasts of SB XI

PLANT PATHOLOGY

Project: Studies on economically important fungal and viral diseases of groundnut

(M.P. Ghewande and S. Desai)

The seed and soil borne diseases, aflaroot, collar rot, stem rot, cause serious losses to plant stand in groundnut and hence yield. Similarly, early leaf spot, late leaf spot, rust and peanut bud necrosis disease can cause 50-70% yield loss. It is thus imperative to manage these diseases through a variety of methods. The management practices like resistant varieties, seed dressing, soil amendments and other cultural practices (dates of sowing, spacing, intercropping) and use of plant products are usually low-cost inputs and hence easily acceptable by farmers. Therefore these methods were tried to manage the above mentioned diseases. Sources of multiple disease resistance have been identified. Cultural practices such as manipulation of planting dates, plant population and intercropping had shown some positive impact on disease control. Some plant products showed fungicidal activity. Considerable progress has been made in cleaning up of groundnut seed material for PStV through ELISA.

A. Disease resistance

Data from two years (1995-96) showed that the three genotypes viz., ICGV 87254, ICG 7881 and NCAc 343 possessed multiple disease resistance (ELS, LLS, Rust). The genotypes, ICGV 87254, ICGV 86694 and ICGV 86020, gave maximum yield (9-10 g /plant). ICGV 87254, a high yielding genotype, with multiple disease resistance could be used in the groundnut crop improvement programme. During Rabi/summer 1996, four genotypes ICGV 87240, NCAc 927, RG 188-Sen-48-36 and PBDR 49 (breeding line of NRCG) recorded negligible incidence of PBND. The incidence of stem rot ranged from 0.0 to 46.21 per cent. PBDR 49 and IR 16 B (breeding line of NRCG) were found to be free from stem rot infection. PBS 118 (breeding line of NRCG) recorded very less incidence of stem rot (1.04 per cent) under field condition. The minimum incidence of stem rot (16 per cent) was recorded in the ICGV 86020 followed by PI 341879 (18 per cent) when compared with other genotype NCAc 343 (45 per cent) under sick plot (concrete blocks) condition.

B. Disease Management

(a) Manipulation of sowing dates

Early planting (second fortnight of June) was found to reduce the intensity of late leaf spot by 13.5 per cent and rust by 26 per cent and resulted in higher pod yield of 1343 kg/ha. However, first week

of July planting had less intensity of early leaf spot (2.5 grade) with a reduction of 53 per cent when compared with other dates of planting. Similarly, early planting (second fortnight of June) had less incidence of stem rot (2.47 per cent) when compared with July and August planting (14.59 per cent).

(b) Manipulation of plant spacing

A plant spacing of 45x10 cm in GG 2 variety had the less intensity of ELS (5.58 grade), LLS (6.4 grade), and rust (5.91 grade) with a yield of 2091 kg/ha when compared with other plant spacings. However, yield level was more from the closer spacing 22.5x7.5 (2498 kg/ha) This could be attributed partly to higher plant population in closer spacing. Similar trend was observed during kharif 1995.

(c) Intercropping

Four crops viz., sunflower (cv. Morden); pigeonpea (cv. T21); bajra (cv. GM B32) and Jowar (local) were evaluated as intercrops each in a ratio of 3:1 (Groundnut: intercrop) in RBD with four replications and a plot size of 5m x 3.9 m. GG 2 was used as the test cultivar.

Reduction in disease intensity of ELS, LLS, rust and *Alternaria* leaf spot due to various intercrops ranged from 9.16 to 18.96 per cent, 4.83 to 11.49 per cent, 6.74 to 7.95 per cent and 5.88 to 23.53 per cent respectively. The reduction in intensity of ELS (18.96 per cent) was maximum when groundnut was intercropped with pigeonpea and that of LLS (11.49 per cent) in the groundnut + bajra intercropping system. Intercropping of groundnut + bajra and groundnut + jowar reduced rust intensity by 8 per cent. A maximum reduction of 23.53 per cent in disease intensity of *Alternaria* leaf spot was recorded in groundnut + pigeonpea intercropping. When the yield level of groundnut and intercrops were considered together, the groundnut + pigeonpea combination had the maximum yield (groundnut=1182 kg/ha, pigeonpea= 1117 kg/ha); sole crop of groundnut gave yield of 1500 kg/ha. Groundnut + pigeonpea combination was found to be suitable for disease management also as compared to other crop combinations.

C. Integrated management of stem rot (*Sclerotium rolfsii*)

Three components viz., i. seed treatment with the fungicide (carbendazim 75 wp), ii. use of commercial preparation of *Trichoderma viride* as a biocontrol agent (Monitor WP and Monitors) and iii. soil amendment with castor and neem cake were suitably used in the management of stem rot in sick plots (in concrete blocks) during kharif, 1996. Incidence of stem rot ranged from 15.7 to 34.2 per cent. The lowest incidence of stem rot (15.67 per cent) with highest pod yield was obtained when castor cake was applied to the soil @ 1000 kg/ha.

D. Seed treatment with seed dressing fungicides and plant products for the management of major fungal diseases

Ten treatments viz., carbendazim 25 SD (3g/kg seed) carbendazim 50 WP (2g/kg seed), thiram (3g

kg seed), hexaconazole (0.2%), mancozeb (3g/kg seed), neem seed powder (2%), *Eucalyptus* leaf powder (2%), *Terminalia catappa* leaf powder (2%), *Pongamia pinnata* leaf powder (2%) and control were tested in a RBD with three replications and a spacing of 45 cm x 10 cm. GG 2 cultivar was used. The natural incidence of aflaroot and collar rot diseases was very low. However, seed treatment with thiram (3g/kg seed) and neem seed powder (2%) improved the initial plant stand by 16% with a yield of 2331 kg/ha and 9.51 per cent with a yield of 1643 kg/ha respectively. It was interesting to note that seed treatment with carbendazim WP @ 2g/kg seed reduced the disease intensity of ELS by 57 per cent, LLS by 23 per cent and rust by 34 per cent and realized yield of 1843 kg/ha

E. Survey and detection of PStV

During summer 1996 groundnut experimental plots of Main Oilseeds Research Station, Junagadh, Sardar Krushinagar and Deesa Centres of GAU were surveyed for the incidence of PStV by a joint team comprising scientists from GAU and NRCG, Junagadh, ICRISAT, and NBPGR, Hyderabad and Plant Quarantine Station, Bhavnagar. It was revealed that there was a stray incidence of the PStV during summer 1996 and this was due to secondary infection. The suspected plants showing PStV like symptoms were destroyed.

A survey for PStV incidence was also carried out during August, 1996 in collaboration with GAU, Junagadh Scientists. There was no incidence of PStV during kharif at both GAU and NRCG, Junagadh. In all, 8279 seed samples received from various sections of the NRCG and Main Oilseeds Research Station, GAU, Junagadh were indexed for PStV through ELISA. Out of these, 6911 samples were ELISA negative for PStV.

Project: Studies on seed pathological aspects with special reference to seed health and aflatoxin in groundnut.

(M.P. Ghewande, J.B. Misra and S. Desai)

Higher aflatoxin load in the exportable commodities like HPS-grade kernels and deoiled groundnut cake is serious export barrier having a strong bearing on the export performance of these commodities. Practically all the seed lots meant for different purposes like seed, oil extraction, consumption and exports are potent carriers of a wide range of fungi in and on their seed surfaces. The seed-borne fungi play an important role in determining the quality and longevity of seeds. Constitutional losses in seeds are also caused due to fungal deterioration in storage.

Research on various seed pathological aspects of groundnut helps in understanding and solving the seed health problems during production, storage and distribution of disease-free seeds to the farmers. So far,virulent isolates of *Aspergillus flavus* have been maintained and their aflatoxin production

potential has been worked out. Sources of resistance to *A.flavus* seed colonization have been identifie
Promising bold seeded genotypes with less load of aflatoxin and desirable agronomic traits have be
identified. Seed health testing of some releaseed varieties was done. Survey to study aflato
contamination of groundnuts and their products is under way.

A. Evaluation of bold-seeded genotypes for resistance to pre-harvest aflatoxin contaminatio

A field trial was conducted during kharif 1996 for evaluating resistance to pre-harvest aflato
contamination. Pod infection, seed infection and seed colonization ranged from zero to 2.7 per c
0.66 to 2.33 per cent and 1.7 to 4.33 per cent, respectively. The cultivars GG 20 and BAU 13 w
found to be free from pod infection. While, M 13, ICG 239, NRCG 2863 and NRCG 7276 had low
pod infection. M 13 had lowest seed infection. The genotype NRCG 5850 had colonization by *A.fla*
The incidence of aflaroot disease caused by *A.flavus* ranged from 0.63 to 3.5 per cent. The genot
NRCG 7276 had the minimum incidence of 0.63 per cent.

B. Evaluation of bold-seeded genotypes for resistance to *in vitro* seed infection and colonizat and aflatoxin contamination

Twenty-two bold seeded genotypes (11 germplasm accessions, 7 advanced breeding lines, 4 relea
varieties) along with susceptible and resistant checks were tested *in vitro* for resistance to
infection and colonization and aflatoxin contamination by *A.flavus*. Out of these, the access
NRCG 4829, NRCG 3014, NRCG 481 and NRCG 2750 and the cultivars GG 11 showed mode
level of resistance to seed colonization. However, aflatoxin (B1) level ranged from a level, being
detectable to the 1981 ppb level. Aflatoxin was not in a detectable level in five genotypes viz.
accessions NRCG 671, NRCG 7277 and NRCG 5363 and the breeding lines JSSP(HPS) 19 and
224.

C. Survey to study aflatoxin contamination in groundnuts and their products

A preliminary survey to study aflatoxin contamination of groundnuts and their products was init
collected market samples of groundnut in Wardha and Aurangabad markets of Maharashtra and
villages near Junagadh. Among the pod samples collected from the four village under IVLP progra
only one sample contained aflatoxin of detectable levels (69 ppb). Samples of cake, pod and k
collected from Wardha Oil Mills and market did not show any aflatoxin contamination. Howev
one pod sample collected from Aurangabad market contained aflatoxin to the level of 99 ppb.

ENTOMOLOGY

Project: Integrated pest management in groundnut

(V.Nandagopal, M.P.Ghewande and P.K.Ghosh)

Farmers are yet to adopt Integrated Pest Management (IPM) as advocated and apply the commercially available pesticides indiscriminately leading to inadequate control of the target pests and also cause environmental hazards. Components of the IPM, which are feasible, simple to use, available locally, and adaptable by the farming communities have been tried under field conditions. Three years of experimentation over kharif and rabi/summer seasons have established certain components of the IPM to be efficient in the management of pests and increased the pod yields.

The following components that were considered as parts of IPM for experimentations.

1.Seed treatment with carbendazim @ 2 g/kg of seeds

2. Weedicide application (Basalin @ 1.5 Kg a.i./ha)

3. Soil application of carbofuran @ 25 kg/ha.

4. Trap/barrier crops : red gram cv.BDN 1,soybean cv. Gujarat 1, castor cv. GAUCH 1 and bajra cv. MH 169.

5. Pesticides mixtures (0.025% Dithane M 45+ 0.05% Bavistin + 2% crude neem oil in teepol + 0.04% endosulfan + 0.02% phosphamidon) + culture filtrates of *P.islandicum*

6. Pheromone traps (leaf miner + *Spodoptera* + *Helicoverpa*)

7. Intercultural operations

A. IPM

The population of the major insects were monitored at intervals using sweep nets and foliage sampling if the defoliators occur. During the summer, the population of thrips and jassids were below the economic threshhold level(24,55 jassids/sweepnet of 14 per cent efficacy for pod filling and maturity stage, respectively) through out the crop growth with an highest population of 2 numbers/sweep/5m and 1.5 numbers/sweep/5m row of groundnut of jassids and thrips, respectively. In kharif, only after 60 DAS, a spray mixture of pesticides was given when the population of both jassids and thrips exceeded the ETL. The pre-spray and the post spray populations are given in Table 22. The spray with the mixture of pesticides has given a good control of jassids (0.72 numbers/m/sweepnet). However, While the population of thrips increased (2.2 numbers/m/sweepnet). In both farmer's practice and in control treatments there was an indication of of increase in the population. The damage due to defoliators was meagre and had no effect on the crop.

Table 22. Mean jassid and thrips population per five sweeps in IPM (kharif 96).

Treatment	Jassid		Thrips	
	Pre-spray	Post-spray	Pre-spray	Post-spray
T1	20.6	3.6	6.6	11.8
T2	21.2	4.0	7.0	13.4
T3	26.8	15.8	10.8	12.2
T4	10.8	15.0	4.2	7.6
CD(p=0.05)	4.36**	4.23**	2.66*	2.65*

The groundnut pod yields in summer crop was the highest (2386 kg/ha) in the treatment wh included seed treatment with Bavistin @ 2 g/kg of seed + soil application of carbofuran @ 25kg/h 0.025% Dithane M-45 + Insecticide mixture (N.O.2% + Phosphamidon 0.02% + Endosulfan 0.04 + Pheromone traps ((leaf miner + *Spodoptera* + *Helicoverpa*) + Fluchloralin @ 1.5 kg a.i./ha + t hand weeding after inter culturing. The gross monetary return was the maximum in above treatm with Rs.32165/ha as against Rs.32035 in control (Table 23) indicating that there was no effect of t IPM components in summer because of non-occurrence of pests in adequate density.

The pod yields in kharif were similar in the best treatment and in control (971 kg/ha and 1027 kg/h respectively. The higher pod yield in the control was due to the absence of the exclusive rows for tr crops. However the gross monetary return was the maximum (Rs. 27023/ha) in the treatme combination seed treatment with carbendazim @ 2 g/kg seed + Trap crops one middle row aft each 4 rows of groundnut + intercropping of one middle and 2 boarder rows of pigeonpea after ea 3/4 rows of groundnut) + pheromone traps (leaf miner + *Spodoptera* – *Helicoverpa*)+ insecticid mixture (2% crude neem oil + 0.04% endosulfan + 0.02% phosphamidon + 0.025 % dithane M 45 0.05% carbendazim) + culture filtrate of *Penicillium islandicum* + pre emergence application Fluchloralin @ 1.5 kg a.i./ha + one hand weeding + one interculturing. In the case of control and t farmers practice the gross monetary returns were Rs. 13964/ha and Rs.13233/ha, respectively (Table 2

B. Monitoring for major insects in groundnut

The major insect pest were monitored using sticky traps and sweepnet. In a drum trap, the aph population was the highest during January (1768 aphids/trap/week) which subsequently decrease In the case of leaf miner, it was again the highest during January with 17 males/trap/week using s pheromone trap (Fig.1). The correlation with maximum temperature, maximum relative humidity, ra fall and wind velocity with the aphid catch indicated the maximum temperature was negativel correlated with aphids trapped in drum trap (r= -0.457). The leaf miner catch in traps was correlat negatively with maximum temperature and wind velocity (r= -0.664) and (r= - 0.539), respectivel

Table 23. Yields of main and trap crops (kg/ha), returns (Rs) and gross monetary returns (GMR) in IPM during rabi/summer-1996.

Treatment		Groundnut	Soybean	Bajra	GMR (Rs)
RST1	Yield	1768	75	10	
	Returns	24437	376	69	24882
RST2	Yield	1492	43	10	
	Returns	20183	2178	67	20467
RST3	Yield	1867	38	6	
	Returns	24981	191	44	25215
RST4	Yield	2386	-	-	
	Returns	32165	-	-	32165
RST5	Yield	1847	38	6	
	Returns	24383	192	42	24167
RST6	Yield	1594	31	7	
	Returns	21117	154	48	21318
RST7	Yield	1768	44	9	
	Returns	24547	222	61	24830
RST8	Yield	1333	25	8	
	Returns	18192	125	53	18370
RST9	Yield	1632	66	10	
	Returns	22748	329	73	23151
RST10	Yield	2067	36	9	
	Returns	28648	178	64	28890
RST11	Yield	1735	59	7	
	Returns	24279	294	52	24624
RST12	Yield	2457	-	-	
	Returns	32035	-	-	32035
CD (P=0.05)		425*	-	-	5834*

Table 24. Yields of main and trap crops(kg/ha) and gross monetary return (GMR) in IPM during kharif 96

Treatment		Yield of main and trap crops in kg/ha					
		Groundnut	Bajra	Soybean	Redgram	Castor	GMR (Rs)
T1	Yield	873	6	56	821	16	
	Returns	11827	29	557	12312	157	24882
T2	Yield	971	-	58	854	-	
	Returns	13632	-	579	12812	-	27023
T3	Yield	987	-	-	-	-	
	Returns	13233	-	-	-	-	13233
T4	Yield	1027	-	-	-	-	
	Returns	13964	-	-	-	-	13963
CD (P=0.05)		NS					2241

AGRONOMY

Project: Development of suitable agronomic practices in groundnut.

(P.K. Ghosh)

A. Cropping systems

(a) Relay cropping

The farmers of Saurashtra plant wheat in rows spaced at 30cm or 45 cm which is wider than the recommended spacing of 23 cm mainly for the reason of easier interculture operations. Therefore, an experiment was conducted to grow rabi-summer groundnut as a relay crop between widely spaced rows of wheat to increase the cropping intensity. Wheat was sown on 15th Nov.'95 at 30cm and 45 cm row spacing. Groundnut was sown between rows of wheat at different stages of wheat growth viz., heading stage (sown on 19th January), grain filling stage (sown on 31st January), and 15 days before wheat harvest (sown on 10th February). In 30 cm spacing groundnut was dibbled but in 45 cm spacing it was sown in furrows because in the latter spacing furrow opening was possible. Pod yield of groundnut (11.9 q) was the highest when groundnut was sown at grain filling stage but groundnut equivalent yield (32.6 q) was similar when it was sown either at grain filling stage or 15 days before wheat harvest (32.3 q). When groundnut was dibbled in between wheat crop spaced at 30 cm, 2.6 more pod yield and 6.0 q yield more wheat yield, than from 45 cm spacing were obtained (Table 10). The experiment needs to be repeated to confirm the findings.

Table 10. Yield of groundnut as a relay crop with wheat

Treatments	PYG (q/ha)	GYW (q/ha)	GEY (q/ha)
Time of sowing			
Heading	6.33	32.69	25.94
Grain filling	11.91	34.45	32.60
15 days before harvest	11.02	35.48	32.32
C.D at 5%	3.50	6.64	6.17
Method of sowing			
Furrow(45 cm)	8.44	31.23	26.35
Dibbling(30 cm)	11.07	37.20	33.39
C.D.at 5%	2.86	5.46	7.21

PYG : Pod yield of groundnut GYW : Grain yield of wheat, GEY : Groundnut equivalent yield. Price of per q of wheat and groundnut=Rs. 900 and Rs. 1500 respectively.

(b) Crop sequences

Fertilizer response

Fertilizer requirements of the four rabi crops: wheat, gram, sunflower, and mustard were evaluated in two crop sequences namely, i) kharif groundnut followed by a rabi crop and ii) kharif fallow followed by a rabi crop. Four levels of fertilizer (0,50%, 100% and 150% of the recommended doses of N, P were applied to rabi crops. Kharif groundnut was grown with recommended doses of fertilizers. The result of third year of experimentation showed that Gram responded up to 50% ; mustard up to 100% and wheat and sunflower up to 150 % of the recommended dose of N and P when grown after kharif groundnut. About 13.7 and 29.4 per cent lower yield of wheat and gram, respectively were obtained when they were grown after kharif groundnut than when grown after kharif fallow. But not much difference in fertility status of soil in terms of available N, P and K was observed between the fallow plot and the plot with kharif groundnut. However, not such decline in yield of sunflower and mustard was observed between two crop sequence. The cause of stunted growth of plants of wheat and gram following kharif groundnut are being investigated by a microbiologist.

Cultivars

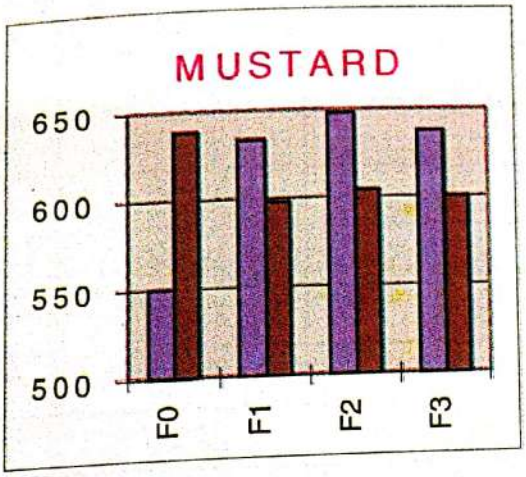
Groundnut-wheat rotation is followed in the northern and western parts of India. Different groundnut cultivars have different patterns of dry matter accumulation, nodulation and N_2 fixation. Wheat may, therefore, respond differently when grown after different cultivars of groundnut. Ten cultivars of each of spanish(VUL) and virginia (HYR) habit types were grown during the kharif season with the recommended agronomic practices. After harvest of the kharif groundnut, wheat was sown in the same plots. The variation in yield of wheat due to cultivar of groundnut was very wide (24.4 q after ICGS 21 and 36.0 q after ICGS-76) when grown after VUL the cultivar of groundnut but narrow (22.9-27.7 q/ha) when grown after the HYR cultivation. This result confirmed the finding of the previous year.

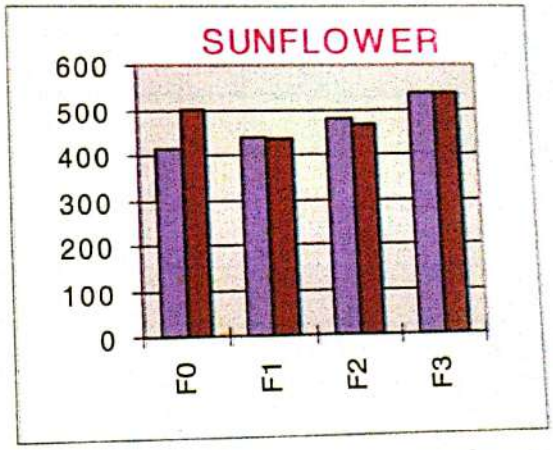
(c) Intercropping

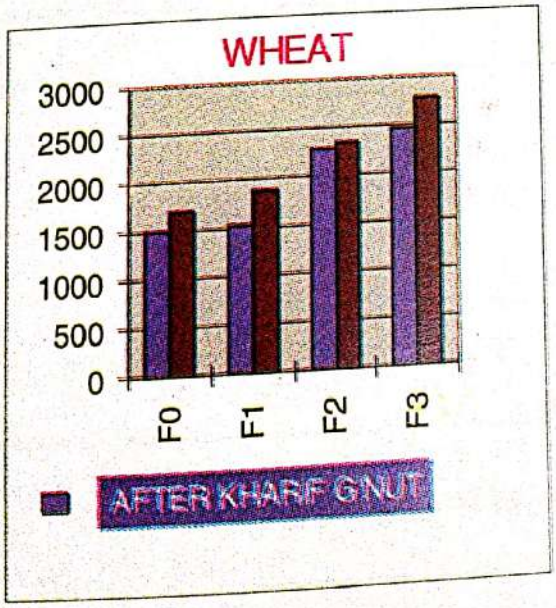
Nitrogen response

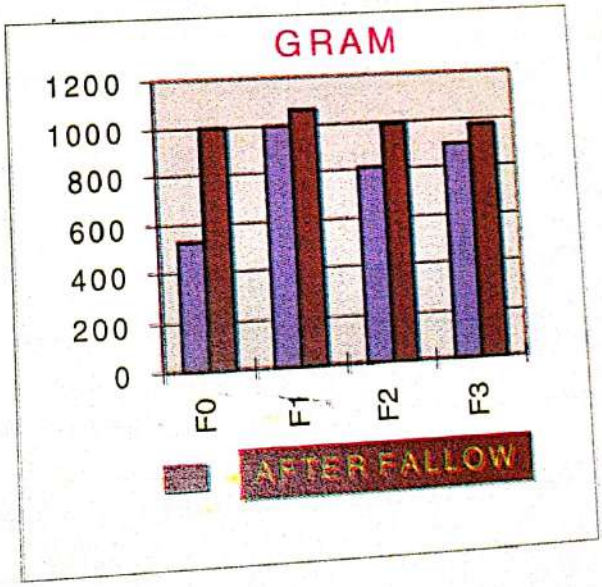
The experiment was conducted during kharif 1996 with groundnut as the base crop (grown with the recommended fertilizer doses) and sunflower, pearl millet and pigeonpea as the intercrops to study the magnitude of response of intercrops to nitrogen. For intercrops, three levels of N (0, 50 and 100 percent of the recommended doses) were applied along with the recommended doses of P as furrow placement. The recommended dose of N for groundnut, sunflower, pearl millet and pigeon pea were 12.5, 40, 80 and 25 kg/ha, respectively. In the groundnut + sunflower system, sunflower responded

up to 50% of the recommended N and the system had the highest total Groundnut Equivalent Yield(GEY) and Land Equivalent ratio(LER). In the groundnut + pigeonpea system, pigeonpea did not respond to applied N (Table 11). In the groundnut + Pearl millet system, the yield of pearl millet increased with increasing level of N but yield of groundnut decreased. However, decrease in groundnut yield due to first increment of N level (i.e. 50% of recommended dose) was nominal and the GEY and LER were the highest at this dose of N.









Seed/ grain yield (kg/ha) of winter crops after kharif groundnut/ kharif fallow

Table 11. Nitrogen economy in groundnut intercropping

Intercrops system	pod yield (q/ha)	Seed yield (q/ha)	GEY (kg/ha)	LER
Sole G'nut	14.8		14.80	1.00
Sole sunflower	—	5.1	3.40	1.00
Sole pearlmillet	—	16.8	9.77	1.00
Sole pigeon pea	—	9.2	11.52	1.00
G'nut + sunflower (2:1)				
0 N	14.2	5.0	18.39	1.93
50% N	17.5	5.7	22.20	2.29
100 % N	17.5	5.4	22.05	2.24
G'nut + pearlmillet (1:1)				
0 N	13.7	5.7	17.07	1.26
50% N	13.6	10.2	19.54	1.52
100 % N	9.5	14.3	17.80	1.48
G'nut + pigeonpea (3:1)				
0 N	14.7	10.2	27.40	2.09
50% N	15.3	8.9	26.51	1.99
100 % N	16.9	8.7	27.80	2.07
C.D at 5 %	1.7	5.3		

GEY= Groundnut Equivalent Yield, LER= land equivalent ratio

$$GEY = \frac{\text{Yield of intercrop x price of intercrop produce}}{\text{Price of groundnut}}$$

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

Feasibility of cereal fodders on the bunds of irrigated summer groundnut plots

Rabi-summer groundnut is generally irrigated through border strip method where three to four lines of groundnut are maintained in each strip. To utilize the bunds and borders the experiment was conducted

with different cereal fodders like maize, pearl millet and sorghum to study the feasibility of the system. This system if successful will be able to mitigate the fodder security during the season summer to some extent. The fodder crop was grown on bund. Ist and IInd cuttings were taken at 60 and 106 days after sowing. The highest pod yield of groundnut was recorded when it was grown as the sole crop. Total fresh fodder yield was the highest in pearl millet from two cuttings followed by pearl millet with one cutting and sorghum with two cuttings (Table 12). When the 2nd cuttings of pearl millet and sorghum was allowed,groundnut pod yield was less than that from single cutting but the net return from the system was more with two cuttings than with single cutting. 2nd cutting of bajra and sorghum gave 4.85 and 4.74 tonnes more fodder respectively, than single cutting. Net return was the maximum (Rs.34,445/ha) and so was the B:C ratio (2.48) when two cuttings of pearl millet were taken. Net return (Rs.27,001) and the B:C ratio(1.91) were the lowest in sole groundnut. The results need to be confirmed.

Table 12. Yields and economics of fodder cultivation on bunds of summer groundnut

Treatments	Pod yield (q/ha)	Fresh fodder yield (t/ha)	Cost of cultivation (Rs/ha)	Gross return (Rs/ha)	Net return (Rs/ha)	B:C ratio
Sole groundnut	24.6		12,550	39,551	27,001	1.91
G'nut + maize	23.6	7.04	13,523	45,282	31,759	2.34
G'nut + sorghum (single cut)	20.7	7.81	13,423	41,431	34,184	2.08
G'nut + pearl millet (single cut)	21.9	12.13	13,408	47,607	34,199	2.55
G'nut + sorghum (two cut)	19.6	11.95	13,878	43,674	29,796	2.15
G'nut + pearl millet (two cut)	19.5	16.75	13,863	48,308	34,445	2.48
C.D. at 5%	2.59	4.10		8098.9	7622.5	0.48

Price rate of per q fodder: Approx. Rs100.

Genotypic interactions

Compatibility of different habit groups and genotypes of the base crop and the intercrops is absoluletly necessary for terms of optimum and efficient utilization of natural and applied resources. Hence a set of trials have been initiated in association with plant breeders to study such compatibilities in two intercropping systems. The preliminary results are given below.

Two habit groups of pigeonpea (short & tall) and three habit groups of groundnut (VUL, HYB and

HYR) were evaluated. The highest total groundnut equivalant yield (3838 kg/ha) was recorded (Ta
13) when cv. Somnath (HYR) was associated with Tall habit growth of pigeonpea (cv.BDN 2)
Two growth habit groups of castor (short and tall) and three habit groups of groundnut (VUL, HY
and HYR) were evaluated. The maximum dry matter/plant of groundnut at 30 DAS was 21.7 g
at 50 DAS it was 34.5 g when short type of castor was associated with the cv.B 95 (HYB)
cv.BAU 13 (HYR) of groundnut.

Table 13. Performance of different habit groups of groundnut with pigeon pea as an interc

Groundnut	Groundnut equivalent yield (Kg/ha)		
	Pigeon pea		Mean
	Short type	Tall type	
GG 2(VUL)	2741	3669	3205
B 95(HYB)	3386	3063	3224
Somnath(HYR)	3576	4100	3838
Mean	3234	3610	

B. Mulching

(a) With N application

Previous experiments at the NRCG indicated that the summer groundnut with wheat straw mul
showed N deficiency up to 45 DAS tough the plants recovered later and no yield loss was notice
Hence an experiment was conducted with different methods of N applications as basal, top dressi
and foliar spray directly on wheat straw or on plant grown under wheat straw mulch. Pod yield
groundnut was the highest (31.0 q/ha) when 1/2 (12.5 kg) of the N was applied as basal dose and re
half was sprayed in the form of 2% urea on wheat straw at 20 DAS. Further splitting of urea spra
i.e., 1% each at 20 and 30 DAS did not improve the pod yield of groundnut. The pod yield wa
comparatively lower when 1/2 of N was applied as basal and 1/2 as top dressing.

(b) With Criss cross sowing

Beneficial effects of wheat straw(WS) and black polythene (BP) of 50 micron as mulch and cri
cross(CC) sowing on summer groundnut were tested at the NRCG. An experiment was conducte
to study the combined effect of these components on summer groundnut. In criss-cross sowing, ha
the quantity of seeds were sown in one direction and remaining half were sown in the perpendicul
opposite direction. The highest pod yield of 28.7 q/ha was recorded when CC and WS were combin
compared to 14.4 q in control plot. The ranking of the treatments with respect to pod yield was in th

order of CC + WS (28.7) q/ha> BP> WS(28.7) + BP (26.5 q) > wheat straw (21.5 q) >BP(19.5)> CC (18.24 q) > control (14.4).

(c) Fertilizer management for confectionery groundnut

Not much information is available on management of bold seeded confectionery groundnut. A field experiment was conducted with three bold seeded cultivars (Somnath, B 95 and BAU 13) and six levels of fertilizer viz.(i). recommended doses of N, P and K ,(ii). 25:100:40 kg/ha N,P, K ,(iii). 25:100:60 kg/ha N, P K,(iv) 40:100;60 kg/ha N, P, K,(v) 500 kg gypsum + 40:100;60 kg NPK and (vi) Ferrous sulphate + Zinc sulphate + 500 kg gypsum + 40:100;60 kg NPK. Among the fertilizer combinations, pod yield was maximum in the combination (V). The cultivars did not differ significantly in pod yield.

Project: Studies on integrated weed management in groundnut.

(P.K. Ghosh)

A. Herbicide component in IPM

In a collaborative experiment, 12 treatments were formulated comprising fungicide mixtures, including neem products, insecticide mixture, herbicide (fluchloralin @ 1.5 kg a.i./ha + 1 HW + 1 IC)and trap crops (pearl millet, soybean, pigeon pea, castor etc.). Application of herbicide reduced dry matter of weed during both the seasons.

During the rabi-summer season, the maximum dry matter of weed was recorded (60 and 93 $g.m^{-2}$ at 60 DAS and at harvest) when herbicide component was excluded from the treatment combinations but the weed dry matter was the lowest (15 and 7 $g.m^{-2}$, respectively) when herbicide was included. In kharif 1996, the promising treatments (four) were tested in larger plots (Table 14). Total dry matter of weed at 30, 60 DAS and at harvest was the lowest in the treatment which included seed treatment with carbendazim + trap crops excluding pearl millet and castor + pheromone trap + insecticide mixture + culture filterate of *penicllium islandicum* + herbicide, fluchloralin @ 1.5 kg ai /ha + one hand weeding + one interculture. The highest dry matter of weed was recorded in control plot.

Table 14. Effect of different treatments in IPM on dry matter of weed

Treatments	Dry matter (kg/ha)		
	30 DAS	60DAS	Harvest
T1	395.1	42.9	153.8
T2	260.0	35.8	113.5
T3	304.3	53.0	292.4
T4	354.4	1210.4	1157.0

PLANT PHYSIOLOGY

Project: Studies on abiotic stresses in groundnut.

(Y.C. Joshi and P.C. Nautiyal)

A. Low and high temperature stress tolerance in groundnut

In the Western part of Rajasthan, the possibilities of the groundnut cultivation in the command area of the Indira Gandhi Nahar Pariyojana, especially in the rabi or the summer seasons have increased. However, genotypes having cold tolerance at the germination phase and high temperature tolerance at the pod formation phase are essential for groundnut to be successful in this area. Cold tolerance and to some extent high temperature tolerance are necessary for the sowing also in some areas of Uttar Pradesh, Punjab and Haryana under spring groundnut. Keeping this in view, experiment was initiated with 70 genotypes the at ARS, Agricultural Research Station, Durgapura and the Regional Research station, Hanumangadh, of the Rajasthan Agricultural University. The crop was sown during first week of February 1996 to study the effect of low temperatures at the germination phase, when daily minimum and maximum temperatures were 6-7°C and 20-22°C, respectively, and the second sowing was done during the first week of March to study the effect of high temperatures (36°C- 44°C) at the pod development phase. In general, the number of mature pods and pod yield were low in all the genotypes sown in February as compared to the crop sown in March. Variations for low and high temperature tolerance was observed in the germplasm. The following genotypes were found preliminary to be relatively better with respect to pod yield for suboptimal temperatures at germination followed by high temperature stress at pod development phase.

At Hanumangadh: ICG 3704,ICGV 86031, TG 22, ICG 4446, ICGS 76, Somnath, CSMG 84-1 and RG 337, 340.

At Durgapura: ICGV 86707,ICGV 86607, ICG 3143, ICG 3098, TAG 24, TG 22, ISK 9406 and RG 337.

B. Photosynthesis (Pn) in soil moisture deficit stress and low light conditions

The performance of twelve spanish genotypes in low light, and soil-moisture-deficit stress conditions was studied during the summer season of 1996. Biomass accumulation, pod yield and Pn rate were recorded under normal irrigation (100 per cent cumulative pan evaporation, cpe; T1), soil moisture deficit stress condition (25 per cent cpe, T2), and low solar radiation created by covering the plots with a rain-out shelter (ROS), (T3). All the treatments were created 40 days after sowing till 80 days after sowing. In general, the pod yield, total biomass and Pn rate decreased due to soil moisture deficit stress and low radiation in ROS. The yield of genotypes, TG 26, GG 2, ICGS 44, and TAG 24

did not decrease significantly due to soil moisture deficit stress. The genotypes viz., SG 84, SB XI and S 5 showed higher pod yield in T3 as compared to T2. The Pn rate was higher in T1 followed by T2 and T3 (Table 15). Among the genotypes the reduction in the pod yield due to soil moisture deficit stress and low light condition was least in GG 2. However, Girnar 1 gave the highest pod yield under the low light condition. Possibly GG 2 and Girnar 1 may suit intercropping with crops which shade groundnut crop at 40 to 80 DAS. Further studies are required to asses the suitability of these groundnut genotypes.

Table 15. Pod yield and photosynthesis rates of groundnut genotypes under normal irrigation (T 1), soil moisture-deficit stress (T 2) and low light condition in ROS (T 3)

Genotype	T1		T2		T3	
	Pod yield	Pn	Pod yield	Pn	Pod yield	Pn
TG 26	303	10.61	319	5.39	182	5.16
GG 2	284	9.12	255	6.47	229	5.36
ICGS 44	276	9.96	245	6.44	124	5.21
TAG 24	473	9.53	384	7.56	140	5.23
SG 84	302	8.36	141	4.57	184	5.31
SB XI	232	6.73	156	7.16	197	4.97
S 5	402	9.66	114	6.06	170	4.56
PBS 8	328	9.23	233	5.69	170	4.97
TG 22	222	9.74	116	6.18	122	6.60
Girnar 1	460	8.54	299	8.09	265	4.49
Jyoti	363	6.39	184	6.15	199	5.68
JL 24	276	6.49	160	5.91	184	5.27
Mean	326.75	8.70	217.17	6.31	180.5	5.23

CD(P=0.05) : Pn rate- Variety - NS Treatment - 1.16 Variety x treatment - NS

Pod yield= $g.m^{-2}$ Pn (photosynthesis rate) = μ $mol.m^{-1}.s^{-1}$ at 80 days after sowing.

C. Role of potassium in biomass production in soil moisture deficit stress conditions

The role of K application on dry mass accumulation and pod yield under normal moisture condition (T1, irrigation at 100 per cent cpe) and soil moisture deficit stress (T2, irrigation at 25 per cent cpe) was assessed during the summer season of 1996. Combination of soil moisture deficit stress tolerant genotype, GG 2 and a sensitive genotype, JL 24 and three rates of K, 0, 20 and 40 $kg.ha^{-1}$ formed the treatments. K was applied in the form of P_2O_5 at the time of sowing. The normal irrigated crop did

not respond to K application. However, under soil moisture deficit stress condition, pod yield was higher in GG 2 (2269 kg.ha^{-1}) as compared to the JL 24 (1417 kg.ha^{-1}), when K was applied @ 20 kg.ha^{-1} The rate of photosynthesis (Pn) and stomatal conductance (g) were higher in the cv. GG 2 under both normal and soil moisture deficit stress condition. Inspite of high K (160 ppm) in the soil the plant responded to the addition of K under soil moisture condition.

D. Studies on water use efficiency

(a) Selection for water use efficiency (WUE)

Under a collaborative (ACIAR-ICAR-ICRISAT) research project, **Selection for Water use Efficiency in groundnut**, an experiment with 68 groundnut genotypes belonging to different habit groups was conducted during three kharif seasons (1993, 1995 and 1996), to study genotypic differences in specific leaf area (SLA) (cm^2.g^{-1}) or leaf thickness, biomass, pod yield, Harvest index (HI), partitioning and water use efficiency. The crop was subjected to three treatments viz. irrigated - 100 per cent cpe (T1), rain-out shelter - 25 per cent cpe (ROS, T2) and rainfed (T3). Results of this experiment are discussed in a physiological model given below.

$$Y = T \times WUE \times HI$$

where, Y= pod yield, T= transpiration, WUE= water use efficiency and HI= harvest index.

WUE was calculated by estimating the carbon isotope ratio, delta, (C^{13}/C^{12}). The delta varied significantly (P= 0.05) among the genotypes and relationship between delta and SLA was positive (Table 16). The pod yield was strongly influenced by transpiration, WUE (measured by SLA) and HI. The yield determining traits, WUE and HI were negatively associated. No relationship between biomass and pod yield could be established.

Table 16. Correlation coeeficients for delta and various physiological parameters under different conditions during kharif 1995.

Parameters	T1	T2	T3
Delta vs SLA	0.30	0.44	NS
Delta vs leaf weight	0.35	-0.46	NS
Delta vs vegetative weight	0.40	-0.47	NS
Delta vs transpiration efficiency (TE)	NS	-0.36	NS

T1: irrigated; T2 : soil moisture-deficit stress; T3: rainfed. Rainfed treatment was under severe drought condition between 30 DAS to 90 DAS.

The tolerance of soil moisture deficit stress in groundnut may be incorporated by selecting for traits like high WUE, T and HI (contributing to the productivity under soil moisture deficit stress condition)

rather than by yield alone. The significant relationship between delta and SLA as a surrogate of delt could be used as a screening tool to assess WUE.

(b) Leaf gas exchange and water relations of low and high SLA lines

In kharif 1996, ten genotypes were selected based on their SLA and WUE, from the above experimen for detailed studies on leaf water relation, and photosynthesis (Pn). The study was conducted unde irrigated (Control,T1), and rainfed (T3) conditions. Under rainfed conditions the crop faced a mil soil moisture deficit stress at the time of pod development. At 80 DAS, the Pn, leaf conductance an transpiration, in general, were higher in T1 as compared to T3. Diurnal trend in the Pn rate wa noticed and it was maximum at 900 to 1000 h. However the day mean Pn was higher (10.85 μ mo m^{-2} s^{-1}) at 40 DAS than at 80 DAS (7.695 μ mol m^{-2} s^{-1}). Similar trend was noticed in case of lea conductance and transpiration. Photosynthesis in general was high in the low SLA lines as compare to high SLA lines. Studies on leaf water relations, leaf anatomy in relation to leaf gas exchange an RuBP carboxilase activity need to be initiated.

Project: Physiology and biochemistry of seed viability and dormancy in groundnut.

(P. C. Nautiyal and J. B. Misra)

A.Seed viability

(a) Chemical fortification of groundnut seeds

Pods obtained from summer (January-May, 1996) produce of cv. GG 2 and the germplasm line NRC(6919 were stored at ambient conditions. After three months of storage, these pods were shelled and seed were soaked in GA_3(2.89 x 10^{-5} M), IAA (5.71 x 10^{-5}) and 2.85 x 10^{-4} M, $ZnSO_4$(0.05M), ascorbic aci (5.68 x 10^{-4} M), iodine(0.02 M), KI(0.01 M), ABA (3.78 x 10^{-5} M), catechol (9.083 x 10^{-5} M), CaCl (0.05M), IBA (2.46 x 10^{-4} M), CCC (6.33 x 10^{-4} M), DMSO (1.408 x 10^{-3} M), NaCl (10^{-3} M), NaH_2PO_4(10 $^{-4}$ M) and KH_2PO_4(0.0367 M), and distilled water for four hours to invigorate the seeds, as these chemical have been reported to invigorate seed viability in several crop species. The seeds were dried at room temperature to 6-7 percent moisture. Seeds were stored after drying in polyethylene bags and a set of seeds which received no treatment were also stored in polyethylene bags to serve as the control. The seeds were studied for germinability and seedling vigour after eight months of storage. GG 2 reated with NaCl, and chlorocholine chloride showed 72% and 70% germination, respectively, whereas he control seeds showed only 42% germination. However, the seeds of NRCG 6919 maintained 86 nd 80% germinability, in the seeds soaked in distilled water and seeds stored in polyethylene bags ithout any treatment (C), respectively. This shows the high viability potencial of NRCG 6919.

(b) Effect of drying temperatures on seed germinability

Summer season (1996) produce of cv. GG 2 were dried immediately after harvest in ovens at temperatures of 30, 35, 40, 45 and 50°C till they attained a moisture level between 10 and 12 per cent. After drying, the pods were stored in cotton cloth bags and the seeds were studied after 2 and 8 months storage for germinability and electrical conductivity of seed leachate. After 2 months of storage germination percent was low in the seeds dried at 45°and 50°C as compared to the seeds obtained from the pods dried between 30° and 40°C. After 8 months of storage, the germination percentage declined in all the seeds dried at various temperatures, however seeds dried at lower temperatures (below 40°C) maintained higher germinability as compared to the seeds dried at higher (above 40°C) temperatures.

(c) Effect of pod maturity and ageing on biochemical composition and germination of seed

Kharif season (1995) produce of the groundnut cultivars GG 2, Girnar 1, ICGS 11 (spanish), and Kadiri 3, TMV 10, GAUG 10 and M 13 (virginia) were categorized into three maturity groups, based on the inside coloration of the shell viz., i. mature ii. medium mature, and iii. immature. Fresh seeds after three months of storage and aged seeds after twelve months of storage were studied for the changes in biochemical constituents. Reducing sugar, total sugar, free fatty acids, o-dihydroxy (OD) phenols, and total phenols decreased significantly with increasing maturity of seeds. The decrease was however much more pronounced for od-phenols. Ageing for one year decreased significantly all the constituents and the decrease was more pronounced in case of od-phenol and total phenols. The varieties differed significantly in their initial composition and also in their response to ageing (Table 17). In general, after 15 months of ageing, the germination percentage was superior in the mature and medium mature seeds as compared to immature seeds.

B. Seed dormancy

(a). Fresh seed dormancy and in situ seed sprouting

Thirty nine groundnut genotypes belonging to different habit group were screened for fresh seed dormancy and *in situ* sprouting of seeds in the field during the kharif season of 1996. Number of plants having sprouted pods, number of pods sprouted per plant at the time of harvest, and laboratory seed germination percentage of normal, and with ethrel treated seeds were recorded immediately after harvest (Table 18). Among the spanish types maximum number of pods with sprouted seed were recorded in TAG 24 (30%) followed by GG 2 (21%) and Girnar 1 (18%). The spanish types namely SB XI, and Jyoti did not show the signs of *in situ* sprouting of seeds. The spanish genotypes viz. TAG 24, JL 24 and TMV 2 showed more than 95 % germination both under normal, with ethrel treatment conditions. Most of the genotypes including the spanish types showed fresh seed dormancy

though the degree of dormancy varied among the genotypes (range 12%-100%). However, after 15 days of harvest most of the spanish genotypes showed more than 90% germinability, except ICGS 76, TG 26, TG 22, ICGS 37 and TKG 19 A (<50%).

Table 17. Effect of pod maturity and ageing on biochemical composition of seed

Variety	RS	TS	FAA	ODP	TP
Effect of varieties					
TMV 10 (HYB)	5.214	11.807	0.845	0.583	0.708
Kadiri 3(HYB)	4.775	10.089	0.572	0.613	1.120
GAUG 10 (HYR)	6.184	14.299	0.859	0.810	1.268
M 13 (HYR)	6.407	17.568	1.091	0.647	1.598
GG 2 (VUL)	5.886	13.144	0.913	0.614	1.808
ICGS 11 (VUL)	4.042	9.226	0.452	0.457	1.278
Girnar 1(VUL)	4.977	8.766	0.622	0.507	0.977
CD (P=0.05)	0.622	1.077	0.069	0.134	0.180
Treatment					
Fresh	5.598	14.003	0.810	0.760	1.529
Aged	5.111	10.253	0.720	0.449	0.973
CD (P=0.05)	0.332	0.576	0.037	0.071	0.096
Effect of maturity					
Mature	4.892	10.580	0.704	0.525	1.290
Medium	5.223	12.290	0.722	0.588	1.158
Immature	5.950	13.515	0.868	0.700	1.305
CD (P=0.05)	0.407	0.705	0.045	0.087	0.110

RS= reducing sugars, TS= total sugars, FAA= free amino acids, ODP=o-dihydroxy phenol, TP=tota phenol

Table 18. *In situ* seed sprouting and fresh seed dormancy in some groundnut genotypes of different botanical groups

Genotype	Seed type	% Plants sprouted	% Pods sprouted	Germination %		
				1	2	3
TAG 24	ND	29.27	29.40	98	100	98
GG 2	ND	38.46	20.99	80	100	100
JL 24	ND	17.87	16.01	95	100	97
Girnar 1	ND	7.69	18.13	88	98	95
Jyoti	ND	3.03	5.65	38	91	96
SB XI	ND	0.00	0.00	29	99	100
ICGS 44	D	0.00	0.00	03	98	100
ICGS 11	D	0.00	2.26	18	92	94
Kadiri 3	D	0.00	0.00	12	90	99
BG 3	D	0.00	0.00	0.0	60	0.0
TMV 10	D	0.00	0.00	06	70	06

ND = Non dormant type, D= Dormant type

1= germination percentage of fresh seed, 2= germination percentage of fresh seed treated with ethrel, and 3 = germination percentage of seeds after 15 days of harvest.

Project: Inorganic nutrient requirement and their disorder in groundnut.

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

A. Nutrition of bold seeded groundnut

(a) Effect of macro and micronut rients on yield and pod filling

Field experiments were conducted to know the effects of Ca, K, and B and their interactions on the yield and pod filling in TKG 19A (bold seeded) and 7085-1 (normal seeded) groundnut genotypes during kharif and rabi-summer of 1996. Application of Ca, K, and B alone or in combinations improved the pod filling, (increased the shelling out turn) and pod and seed yields. Application of 100 kg.ha^{-1} Ca, 100 kg.ha^{-1} K and 2 kg.ha^{-1} B increased pod yield by 21.4, 21.7 and 11.9 per cent over control during rabi-summer and 14.6, 20.2 and 10.2 per cent pod yield and 9.6, 6.2 and 4.2 per cent 100 seed-mass over control during kharif, respectively. However the combined application of Ca + B, K + B, Ca + K, and Ca + K + B increased 25.1, 25.6, 34.2 and 37.5 per cent pod yield over control during rabi-

summer and 20.1, 15.0, 23.6 and 39.2 per cent pod yield over control during kharif. There was a improvement in the shelling out turn, 100-seed mass and SMS percentage. The SMS percentage increased from 82 to 87 per cent in 7085-1 and from 78 to 89 per cent in TKG 19A. This has indicated the role of these nutrients for better pod filling and hence, increasing the seed mass of the Hp varieties which are otherwise not getting sufficient mineral nutrients in this calcareous soil.

(b) Influence of various levels of Ca and K, in nutrient solution, on the growth and yie of bold seeded groundnut

Sand culture experiment was conducted under two levels of Ca and K (high, 200 ppm and Low, 50 ppm in pots to find out the interaction of these nutrients with the bold-seeded groundnut genotypes, BAU 1 ICG 88398,B 95 and BG 3. Ca alone at 200 ppm and both Ca and K, at 200 ppm gave 10 and 10.5 p cent higher pod yield than 50 ppm, respectively. But increasing the level of K to 200 ppm alone caus reduction in growth and pod yield. Nutrient analyses of the plant samples is in progress. It was al observed that the interaction effect was more pronounced on bold seeded variety than NRCG 6919, normal seeded groundnut.

B. Methods of nutrient application

(a) Comparison of effects of soil application and seed dressing of macro- and micro- nutrien

The field experiments during kharif 1996 showed that various macro- or micro- nutrients when appli in furrows gave positive response in general and increased yield, yield attributes, shelling out turn a 100-seed mass and seed size of groundnut. However, as seed dressing only $FeSO_4$, $MnSo_4$, CaC and $ZnSO_4$ could increased the yield and other parameters. Application of boric acid, Cupric chlori and ferric chloride caused reduction in field germination hence should not be used as seed dressin It was interesting to note that the response of Cu was observed and Cupric chloride applied furrows showed maximum response in terms of yield and yield attributes.

(b) Comparison of efficiency of micronutrient application through different methods

Field experiments were conducted to assess the efficiency of application of Fe, Zn and B through dr irrigation in comparison with soil and foliar applications during summer and rabi seasons (mid October first week of March) in calcareous soil with medium fertility. Fe, Zn and B were applied three times at 3 50 and 70 DAS in soil, through foliage spray and through drip irigation. Application through drip irrigation though did not show much influence on plant height, chlorophyll content and oil content,but increased th yield and shelling out turn.

It was interesting to note that drip application of water alone also increased 8.9-25.1 per cent pod yiel over flood irrigation. The micronutrients applied through drip irrigation increased the fertilizer use efficienc as the same amount of micronutrient applied through drip showed high yields over their soil and folia

applications. The drip system of irrigation also kept the soil loose for peg penetration and pod development and hence increased the number of pods, shelling percentage (pod filling) and 100 seed mass.

C. Macronutrient deficiencies and yield losses

(a) Macronutrient deficiencies of groundnut in calcareous soil and effects of external appliation of fertilizers on growth and yield

A pot experiment was conducted to differentiate the individual effects of N, P, K, Ca, S, and Mg and their deficiencies occurring in groundnut in calcareous soil with medium fertility and the effects of external application of these macronutrients were studied by taking four groundnut genotypes. It was observed that application of micronutrients alone decreased pod yield over control (without micronutrients) in all the genotypes. However, these micronutrients when accompanied with macronutrients increased the pod yields (from 25-57 per cent depending upon the genotypes). It was observed that non supply of nitrogen during sowing showed severe yellowing during the early growth stages upto 50 days, but soon after the nodules developed this yellowing was reduced clearly indicating that basal N application is essential for early vigour. Though genotypic variations were noticed, non-application of macronutrient produced less pod and fodder yields. The differences in growth and pod biomass were much pronounced at 55 DAE. The order of nutrients in terms of reduction in pod yield due to non-application was Ca, N, S, K, P and Mg which showed its importance in this particular soil. The genotype 6919 was found to be N-efficient and showed less yield losses due to minus N, the genotype 7085-1 due to minus P, K and Mg and GG2 due to S.

The yield losses due to the deficiencies of N, P, K, Ca S and Mg in groundnut grown in this calcareous soils were to the tune of 26.8, 12.6, 19, 29.9, 20.2 and 18.3 per cent, respectively indicating that all these macronutrients are essential for harvesting high yield in this calcareous soil.

D. Iron-chlorosis

(a) Effectiveness of iron containing compounds in alleviating iron-chlorosis of groundnut

Soil application of iron containing compounds namely FeEDTA, FeEDDHA, $FeSO_4$ and iron citrate in their two concentrations were compared in pots for alleviating lime-induced iron-chlorosis (LIIC) of groundnut using both Fe inefficient and efficient genotypes during kharif 1996. Four Fe-efficient, GG2, CSMG84-1, TAG-24 and TG-26 and four Fe-inefficient PBS-13, PBDR-36, VRI-3 and I-2 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 increased chlorophyll and Fe^{2+} contents of leaves, and pod yield. 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 shows better performances with iron sources than the Fe-efficient one.

(b) Maintenance and multiplication of iron-efficient and inefficient lines and their further screening

Twenty Fe-efficient and five Fe-inefficient groundnut genotypes were maintained through field multiplications for further experimentation. The yield trials in the field for consecutive five years have revealed that the genotypes having NRCG Acc.No 7085-1, 7085-3, 2588 and 6919 of spanish group and 7599 of valencia group have got good potential. The PStV free seeds of two of the Fe-efficient groundnut genotypes namely FeESG-8 and FeESG-10-1 were multiplied both at Bhubaneswar and at Dantiwada for acquiring sufficient seed for testing them in AICRP(G) system. During kharif 1997, these genotypes are under multiplication at Bhubaneswar, ICRISAT Hyderabad and at NDDB, Anand. Also an effort was made to find out the iron nutrition behavior of groundnut varieties in red laterite soil by screening the groundnut varieties and germplasm lines being grown at Off Season Centre, Bhubaneswar during kharif 1996. It was interesting to note that the Fe-efficient groundnut genotypes such as TG 24, TG 26, VRI 2, TG 17 and SG 84 also did well in red soil. In contrast the Fe-inefficient one VRI 3 and TG 3 still showed chlorosis in the red soil inspite of abundance of iron.

E. Studies on the nutrient-efficient groundnut genotypes

(a) Ca, Fe and S nutrition in efficient and inefficient groundnut genotypes

Sand culture pot experiments were conducted to study the growth, pod yield and nutrient content of Ca, S and Fe-efficient and inefficient groundnut genotypes under low (1/4) and normal (Full dose) concentration of Fe, S and Ca nutrition. The crop was grown and various observations were recorded. The genotypic differences were noted and it was observed that the Fe, S and Ca efficient genotype showed more chlorophyll (both Chla and b), and carotene contents than the inefficient genotypes. The clear-cut symptoms of these deficiencies were noticed in the groundnut under low supply of these nutrients which reflected on their pod yield. It was interesting to note that the nutrient efficient genotypes showed better growth and yield than the inefficient one both at low and high levels of that particular nutrient in the solution. The nutrient content and uptake of these efficient and inefficient genotypes are being determined.

(b) Problems and prospects of groundnut cultivation in North- East Hill regions

A survey of the North-Eastern Hill regions, through the ICAR Research Complexes (at Barapani Tripura and Tura), was made to find out the problems and prospects of groundnut cultivation in those as well as neighboring regions. Based on the detail survey it was found that though the groundnut has got very good prospect in the NEH Region, the low soil pH, temperature, Al, Fe and Mn toxicities and P and Ca deficiencies, rapid loss of seed viability of the rabi/summer season produce are the major problems of groundnut cultivation in NEH region. To cope up with the related problems five short long term experiments were recommended which are being conducted at ICAR Res Complex at Tripura, Manipur, Barapani and Tura.

project: Biological nitrogen fixation and phosphate solubilization in groundnut.

(K.K.Pal)

A. Biofertilizers

(a) *Bradyrhizobium*

The IGR 6 and IGR 40 developed at this Centre and NC 92, TAL 1000 and TAL 1008 were supplied to different AICRPG centres and Agricultural Universities for agronomic trials. Factors responsible for the efficiency of IGR 40 and IGR 6 are yet to be identified. Again, there is the need for the development of efficient strains of *Bradyrhizobium* tolerant to soil acidity for rice-fallows and for north-eastern states.

(b) Phosphate Solubilizing Microorganisms

Existing PSM like *Aspergillus awamori*, *Bacillus polymyxa* and *Pseudomonas striata* were supplied to different AICRPG centres and Agricultural universities for different agronomic trials. A fungus (PSF 1) has been isolated from groundnut rhizosphere which efficiently solubilises tri-calcium phosphate. The effect after inoculation of this fungal isolate is yet to be studied . Emphasis will be given on rhizosphere competent, phosphate solubilizing fluorescent pseudomonads.

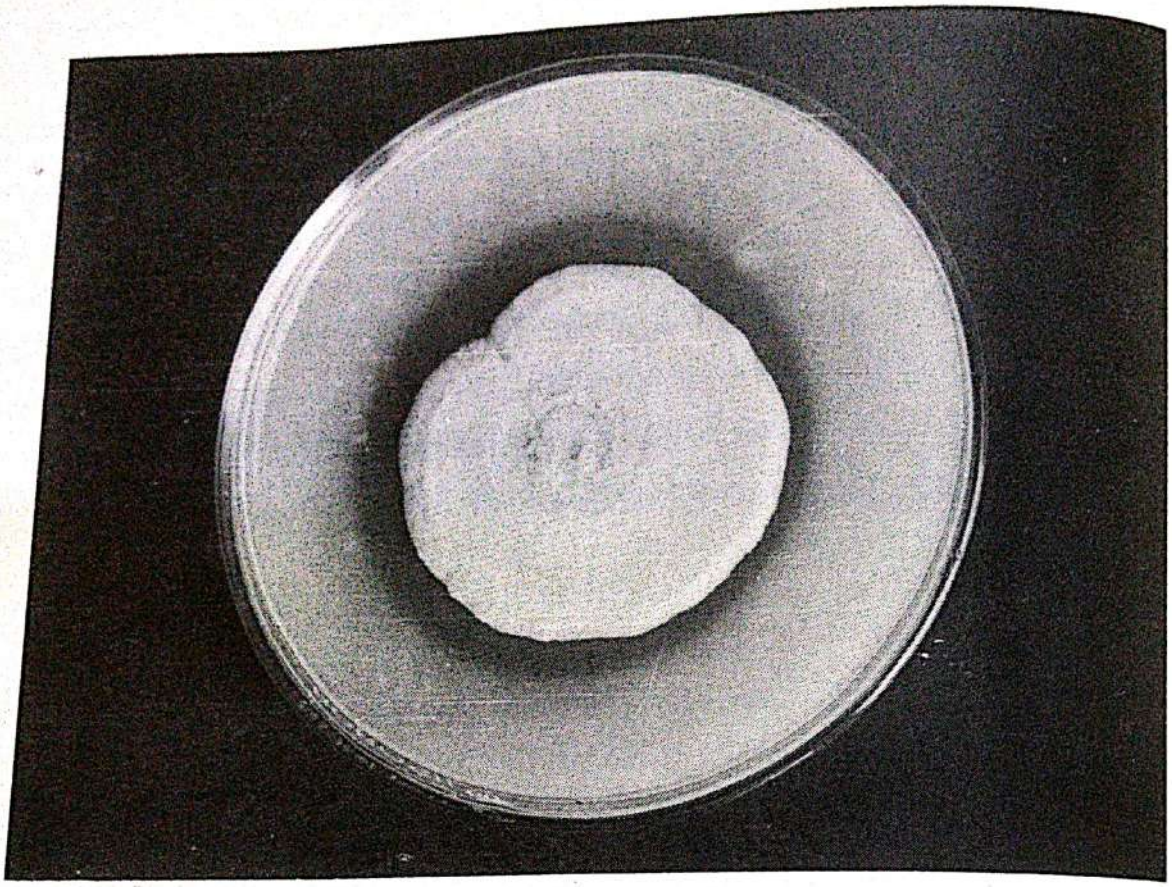
(c) Plant growth promoting rhizobacteria (PGPR)

Free living bacteria are found abundantly in the rhizosphere of crop plants and have the capacity to influence the crop growth immensely either by producing siderophores, IAA, organic acids, etc. or by fixing atmospheric nitrogen and ammonification. They may also inhibit deleterious/pathogenic rhizosphere microorganisms and thus sustain plant growth. Crop specific PGPR have been isolated for various crops. Two hundred and twenty seven isolates of different physiological groups of bacteria were isolated from rhizotic zones of groundnut grown without any fertilizer. All these isolates were purified and maintained to identify potent PGPR for groundnut.

(d) Biodegradation of pesticides

Increased and indiscriminate use of pesticides lead to environmental pollution. Thrust is needed for the degradation of such xenobiotics. Pendimethalin (weedicide) and chloropyrephos (insecticide) are widely used in groundnut cultivation. However, their persistence in the soil can result in serious environmental pollution. Hence, ten pendimethalin degrading and five chloropyrephos degrading bacteria

were isolated by enrichment techniques from groundnut rhizospheric soil samples. Among these fluorescent pseudomonads and bacilli were predominant. Detailed studies on their identification degraded products, relative efficiency of the isolates, and their effect on plant growth are underway



TCP soulbilisation by a fungal isolate from groundnut rhizosphere

BIOCHEMISTRY

project: Biochemical aspects of groundnut quality and composition.

(J.B. Misra)

A. Oil and protein contents of seeds of groundnut genotypes

Seeds of groundnut are valued both as an oilseed and a protein rich food. Evaluation of groundnut genotypes for oil and protein contents in their seeds is an important activity for identifying the superior types.

Oil and protein contents were determined in 60 samples comprising cultivars and germplasm accessions. The genotypes having oil more than 52 per cent were Girnar 1, NRCG 879, Kadiri 3, GG2 and UF 70103 and those having less than 45 per cent were BAU 12, TMV 2, TMV 7, SB XI, TMV 12, TPT 1 and TKG 19 A. Cultivars JL 24, ICGS 1, SB XI, TMV 12, M 335, TPT 1, BG 3 and TPT 2 were identified to contain more than 25 per cent protein, (Tables 19 and 20).

B. NIR-spectrophotometry of seeds for direct determination of oil and protein contents in a non-destructive manner

Optical densities (OD) of seeds of 67 groundnut samples (having oil and protein contents in the range of 41-54 percent and 18-29 per cent, respectively) were determined at 12 different wavelengths (918, 928, 940, 950, 968, 975, 985, 998, 1010, 1023, 1037, and 1045 nm) in the near-infrared region. The data (ODs) thus obtained was analyzed with the help of a computer programme to develop regression equations using various combinations wavelengths. One of such equations, gave a significant correlation between the predicted values of oil and actual values of oil content. (r = of 0.716**; n = 58) indicating that there exists a possibility of predicting oil content of groundnut samples in a non-destructive manner on the basis of NIR spectrophotometry. For protein content, however, satisfactory equation could not be obtained. Scope exists for improving the predictability by using a larger number of samples.

C. Evaluation of precision of conventional nitrogen-to-protein conversion factor for groundnut

Protein content of groundnut seeds is generally calculated by determining the nitrogen content of seeds and multiplying the same by a factor of 5.46. This practice is based on an old finding that the major groundnut protein viz. arachin contains 18.31 per cent nitrogen.

Table 19. Oil and protein contents of seeds of groundnut genotypes collected from Pl
Breeding section

S.No.	Genotype	Oil (%)		Protein (%)	
		Soxhlet	SPGR	K-N	FC
1	Girnar 1	54.1	53.2	18.8	22.0
2	NRCG 9	51.9	50.7	18.7	24.5
3	RB 46	50.6	49.6	20.4	24.9
4	NPF 101	51.0	51.0	19.5	22.6
5	NPF 140	51.4	48.4	20.9	23.1
6	5-S	52.0	50.2	19.9	23.8
7	GG-2	52.2	50.8	19.4	20.2
8	Kadiri 3	51.1	50.8	19.3	22.5
9	J-11	46.5	49.4	18.3	23.5
10	ICGS 44	51.1	50.9	18.7	23.1
11	JL 24	49.5	50.4	27.1	24.1
12	M 13	50.4	49.6	19.0	19.9
13	PBS 15	48.3	47.0	19.4	22.9
14	SB XI	47.2	46.6	24.8	23.9
15	RB 90	50.8	50.9	20.4	21.4
16	RB 15	51.0	49.2	19.3	22.2
17	NCAc 2821	51.3	50.9	18.9	19.5
18	CGS 3	51.8	50.8	18.6	20.5
19	Acholi white	50.3	47.8	23.8	21.0
20	CGS 7-B	51.6	49.8	23.4	20.7

Table 20. Oil and protein contents of groundnut genotypes collected from Genetic Resources section

S.No.	Genotype	Oil (%)		Protein (%)	
		Soxhlet	SPGR	K-N	FC
1	NRCG879	52.9	51.7	21.3	21.1
2	NRCG3162	46.4	—	22.6	—
3	NRCG9541	50.2	48.8	19.9	20.6
4	NRCG7719	48.6	49.5	21.4	24.5
5	NRCG5199	49.9	—	22.0	—
6	GG12	46.8	46.8	24.4	25.1
7	ICGS11	51.1	51.7	18.8	21.9
8	NCAc15746	51.2	53.6	17.4	20.3
9	Co 1	51.7	48.3	24.9	25.0
10	NRCG750	47.9	50.5	20.2	22.0
11	BAU 13	49.9	51.4	21.9	22.4
12	BAU 12	44.7	48.8	24.7	23.4
13	JL 24	50.3	50.2	28.2	25.3
14	Punjab-1	—	—	19.3	—
15	Kadiri 3	52.4	50.0	22.1	22.2
16	NRCG5235	47.1	49.6	23.5	24.5
17	NRCG2750	50.8	52.0	20.4	21.3
18	Selection 230	47.0	48.2	20.3	20.1
19	NRCG1014	47.5	48.8	22.6	22.5
20	J-11	48.1	46.0	23.7	24.1
21	GG11	47.3	—	22.4	—
22	M13	47.0	48.6	22.4	22.2
23	M522	51.9	49.5	24.5	25.0
24	NRCG749	49.6	53.5	21.4	20.7
25	TMV2	44.6	44.8	24.9	22.2
26	CSMG84-1	46.9	45.0	19.2	23.0
27	ICGS-1	47.8	46.3	24.7	25.8
28	M37	49.2	50.0	27.5	25.2
29	TMV7	41.2	41.4	23.1	23.0
30	SB IX	42.8	40.9	26.1	25.4
31	ICGV86590	48.8	47.9	24.8	23.8
32	ICGS76	46.4	44.6	23.9	25.4
33	ICGS5	48.8	47.0	24.6	25.4
34	Karad 4-11	47.9	45.2	24.9	25.1
35	UF-70103	53.7	51.5	18.4	20.7
36	TMV12	43.0	40.3	25.6	23.7
37	M335	48.9	49.1	26.2	25.5
38	RG141	48.8	47.4	24.0	26.5
39	SG-84	51.0	50.4	24.1	24.8
40	TPT-1	44.0	43.9	25.7	24.4
41	BG3	48.2	48.0	25.9	24.6
42	TKG19A	43.6	43.4	24.4	23.4
43	TPT2	46.4	46.4	25.1	24.7
44	TAG24	45.4	46.9	19.3	20.2
45	GG-3	51.8	49.3	24.3	24.7
46	ICGV86325	46.8	46.0	23.1	22.9

KN= Kjeldahl N x 5.46; FC = Folin Ciocalteau's Reagent; SPGR= Specific gravity method

Using published data on the amino acid analysis of groundnut genotypes, the nitrogen-to-protein conversion factors for whole groundnut seed and also for arachin and conarachin were calculated. It was found that the nitrogen-to-protein conversion factor for arachin and conarachin as well is that for whole seed is affected both by genotype and location. The value of true factor for total proteins for a given sample may lie anywhere between 5.3 to 5.7. Thus the protein content obtained by using the conventional factor of 5.46 (or say 5.5), may have a precision of ±0.7 per cent for the samples having 3.5 per cent N (approx. 18 per cent protein), and as the nitrogen content increases the precision decreases to reach ±1.0 per cent for the samples having 5.5 per cent N (approx. 30 per cent protein). This implies that the protein content of two samples thus calculated could be taken really different only when there is a difference of at least 0.7 to 1 per cent in their calculated values. Likewise the the actual protein content of two samples could be different even if the values thus calculated are equal.

D. Service to other sections

Rendering service to other sections of NRCG by analyzing their experimental materials has been one of the important activities of Biochemistry section. The particulars of the service rendered are shown in table 21.

Table 21. Service rendered to other sections

Source of sample	No. of samples	Content analysed
Plant Physiology	252	Oil
Plant breeding	228	Oil
Genetic resources	210	Oil
Genetic resources	36	Protein
Genetics and Cytogentics	15	Ether extract in leaves
Farmer	2	Aflatoxin
Farmer	7	Oil
Farmer (TAR-IVLP)	117	Aflatoxin
PC Unit	716	Oil
P C Unit	48	Sucrose

Transfer of technology

Project: Technology Assessment and Refinement Through Institutional Village Linkage Programme (IVLP)

The ICAR has launched this new project 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 being executed at the NRCG., Junagadh. The findings for the reporting year are given here.

A. Groundnut + pigeonpea intercropping and its management (Demonstration)

Results of demonstrations in 73 farmers fields one acre each indicated that groundnut intercropped with pigeonpea in 1:1 ratio was found remunerative than other ratios (2:1, 3:1). The gross monetary return of Rs.43968/ha was realized in 1:1 ratio of Groundnut + pigeonpea intercropping. While it was Rs.25452/ha in farmers practice (sole crop).

B. Paired-row planting of groundnut with one row of pigeonpea as an intercrop + IPM to improve kharif groundnut yield (OFR)

Results indicated that the combination of paired row, inter crop and IPM, the gross monetary return ranged from Rs.31,395/ha to 33,795/ha in various IPM treatments. The highest pod yield of groundnut was recorded when castor cake was applied alongwith or without carbendazim which resulted in highest gross monetary return of Rs.33795/ha whereas in farmers' practice (sole groundnut), the gross return was Rs.25500/ha indicating a net monetary return of Rs.3835/ha (Based on one OFR).

C. Improvement of yield of wheat through proper irrigation and spacing (Demonstration)

Twenty eight demonstrations one acre each were conducted on closer spacing (22.5 cm row to row) to increase productivity of wheat. Results of 28 demonstrations showed that there was an improvement in wheat yield by 11.6 per cent in closer spacing over the farmers'practice (45 cm row to row).

D. Improvement in milk yield of miltch cattle using balanced diet (Demonstration)

Sixty demonstrations were conducted on the use of balanced diet to improve milk yield of buffalow in four villages.

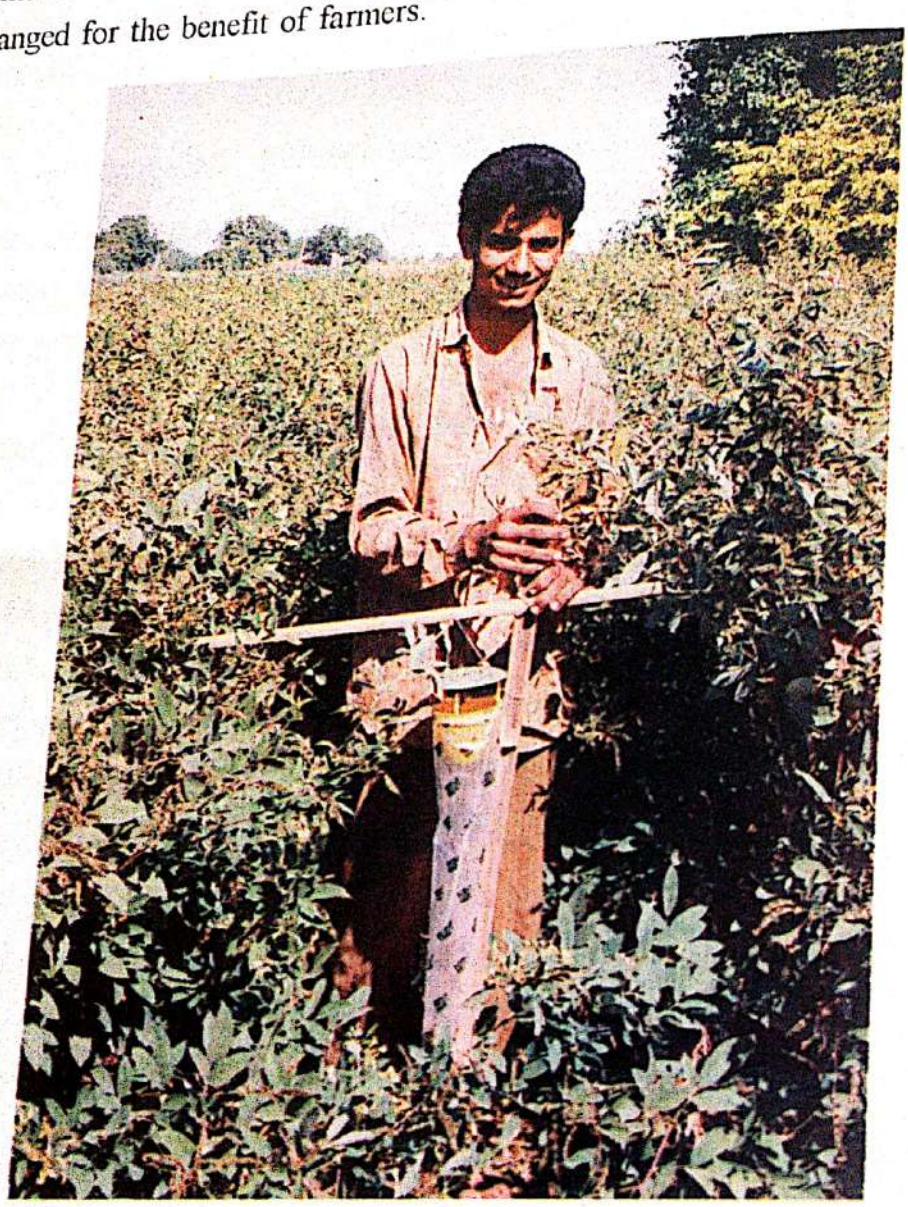
Two months data showed that in the case of buffalo, there was an increase of 3.5 L per day with balanced diet with a net monetary return of Rs.510/month/family.

E. Programme for landless families (Kitchen gardening)

In this programme, fruit saplings of Mango (55), Coconut (50), Sapota (50), Guava (120), pomegrenate (30) and Lemon (100) were planted in home steads of 121 landless families to sustain their livelihood.

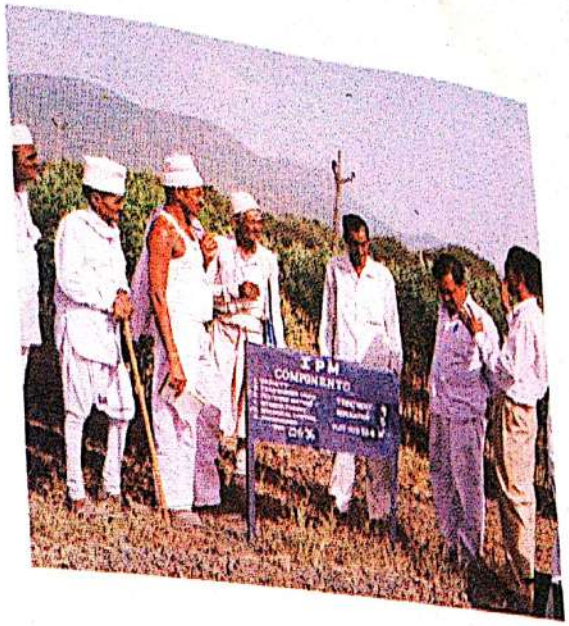
F. Farmers' Training

Farmers' Training in two areas, (1) Fertilizer Management in Groundnut, castor and cotton and (2) Animal Husbandry was organised from October 7-10, 1996 for the project area farmers (53). The necessary training material like training manual in local language was distributed during the training programme. Lectures, group discussions and visits to fields and related animal husbandry departments were arranged for the benefit of farmers.

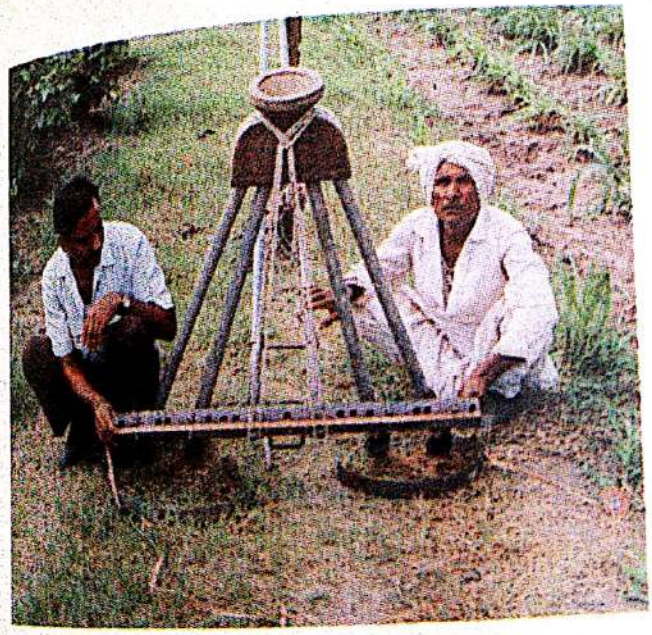


A farmer setting up a pheromone trap in his field

An agricultural labour planting the mango sapling in his homesead



NRCG staff explaining about IPM



An implement being demonstrated to the farmer

Scientists visiting the farmers' filed

Publications

A. Published

Chandran, K. and Rajgopal, K. Pollen viability and longevity in cultivated groundnut (*Arachis hypogaea*. L). *International Arachis Newslett.* (communicated).

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Ghosh, P.K and Sojitra V.K.1997. Groundnut and pigeon pea intercropping: a risk avoiding and remunerative practice for rainfed farming in the Saurashtra region of Gujarat. *Indian farming* 46 :28-30.

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C. Chapters in books/reviews

Ghewande, M.P., and Nandagopal, V. 1996. Integrated pest management in groundnut (*Arachis hypogaea* L.) on India. *Integrated Pest Management Reviews* (In Press).

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D. Presented in workshops/seminars/symposia

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Other information

A. Total staff strength of SC, ST, OBC as on 31.3.97

	Sanctioned	Filled Up	SC	ST	OBC
Scientific Staff	39	20	5	-	-
Tecnical Staff	38	37	5	6	1
Administrative Staff	18	18	4	1	-
Supporting Staff	21	20	3	3	7
Total	116	95	19	10	8

B. Expenditure Statement for the year 1996-97 (RUPEES IN LAKHS)

Head	Non Plan(RE)	Plan(RE)	Non Plan	Plan
Estt. Charges including LSP & PF	64.60	7.00	65.95	7.00
T.A.	02.00	2.50	2.00	2.80
Other Charges (including equipments)	03.40	62.50	3.40	62.50
Works	-	38.00	-	31.51
Other Contingencies	-	-	-	-
Total	70.00	110.00	71.35	103.81

TECHNICAL PROGRAMME

The list of the projects as on 31.3.1997 along with the details on project leader, date of start and likely date of completion is as below:

Project No.	Title
P1-81/97-01/IGFN-F-30/0332	Collection, maintenance, evaluation, documentation and distribution of genetic resources of cultivated groundnuts and related *Arachis* species
PI-88/0030-IGN-F30/0332	Breeding & genetic studies for improving yield and quality in groundnut
P1-88/0030-IGN-F30/0332	Breeding for resistance to biotic and abiotic stresses in groundnut
P1-85-05-IGN-F30/0332	Characterization & utilization of wild *Arachis* species for groundnut improvement
P1-93/97-06-IGN-F30/0332	Embryo rescue, micropropagation and haploid production in groundnut
P1-92/97-36-IGN-F27/0332	Development of suitable agronomic pratices in Groundnut
P1-92/97-36-IGN-F27/0332	Factors affecting yield in groundnut through variation in plant population
P1-89/97-09-IGN-H20/0332	Studies on economically important fungal and viral diseases of groundnut
P1-89/97-33-IGN-H10/0332	Studies on major insect pests of economic importance in Groundnut
P1-93/97-12-IGN-F60/0332	Physiology and biochemistry of seed viability and dormancy in groundnut
P1-89/97-13-IGN-H20/0332	Studies on seed pathological aspects with special reference to seed health and aflatoxin in groundnut
P1-83/97-15-IGN-F60/0332	Studies on abiotic stresses in groundnut
P1-83/97-16-IGN-F60/0332	Studies on inorganic nutrient disorders in groundnut

P1-93/97-17-IGN-F26/0332	Studies on nitrogen fixation and phosphorus solubilization in groundnut
P1- F60/03329588/ 35-IGN- -	Biochemical basis of resistance to biotic and abiotic stresses in groundnut
P1-88/95-35-IGN-F60/0332	Biochemical analysis of groundnut quality and composition

B. Externally funded projects

NARP	Biotechnological approaches for increasing and sustaining yield in major field crops Sub project 1: Crop Improvement;Objective 6:Groundnut Disease Resistance
	Studies on water use efficiency in groundnut
ACIAR	Breeder seed production for annual oilseed crops:
ICAR	National Seed Project

INSTITUTIONAL ACTIVITIES

Honours and Awards

Dr. M.P. Ghewande has been identified as **National Coordinator for India for aflatoxin research** at the Asia Working Group Meeting on Groundnut Aflatoxin Management organised by ICRISAT Asia Centre, Patancheru, A.P., India under CLAN from 27-29 May, 1996 at the Ministry of Agriculture and Rural Development, Hanoi, Vietnam.

Dr. J.B. Misra was given a citation for the **Second best Poster Presentation** for the paper entitled 'Prototype of an arachilipometer for predicting oil content of groundnut kernels' authored by J.B. Misra, S.K.Yadav and R.S. Mathur. The paper was presented by Dr. Misra at the National Seminar on 'Role of Engineering Techniques in Increasing Agricultural Productivity' (College of Agriculture, Nagpur, December 5-6, 1996).

Dr. Pal was awarded a **certificate of merit for outstanding research findings during his Ph.D. programme** in Agricultural Sciences by the Indian Science Congress Association during the 84th session of Indian Science Congress held at New Delhi from 3-8th January, 1997.

Institute seminars

Date	Topic	Speaker
25-4-97	Impact of SATCRIS services on development	Prof. T.N.Rajan
28-6-96	Asia working group meeting on groundnut aflatoxins management	Dr.M.P.Ghewande
24-1-97	The study tour of the USA on "Promoting groundnut as food crop for sustained nutritional security	Dr.M.S.Basu
27-1-97	Perspectives on mineral nutrition of plants	Prof.R.C.Pant

Committee meetings

Date	Meeting
4-11-96	Third Management committee meeting
27-3-97	D.P.C. meeting

Research advisory committee

Based on the panel suggested by the Director, NRCG, the Council has communicated the constitution of the research advisory committee for the Centre vide their Office Order No. F.No.12(9)/96-IA.III dated 31.12.1996 as below.

Chairman

Dr. S.S. Rajan, Ex. Advisor to FAO, Bangalore

Members

Crop Improvement

Dr. P.S. Reddy, Ex-Project Director, DOR, Hyderabad.
Prof. V.J. Patel, Director of Campus, GAU, Junagadh Campus.
Dr. S.N. Nigam, Principal Groundnut Breeder, ICRISAT, Patancheru.

Crop Protection

Dr. Anupam Verma, Dean & Jt. Director (Edn.), IARI, New Delhi.
Dr. S.N. Puri, Director, NC on IPM, New Delhi.

Crop Production

Dr. M.V. Kanzaria, Ex-Principal, College of Agriculture, GAU, Junagadh.

Farmers' Representative

Mr. S.M. Asif, Editor, Pathar ki Masjid, Patna, Bihar.
Kum. Meena Thakur, President, Mahilla Youth Congress, VPU, Upleta, Rajkot.

ICAR Representative

Asstt. Director General (OP), ICAR, New Delhi.
Director, NRCG

Member-Secretary

Dr. M.P. Ghewande, Sr. Scientist, NRCG

Institute management committee

The Indian Council of Agricultural Research has approved the constitution of the the Institute Management Committee with the following officials.

Chairman

Dr. A. Bandyopadhyay, Director, NRCG

Members

Asstt. Director General (OP), ICAR, New Delhi.
Mr. S.M. Asif, Editor, Pathar ki Masjid, Patna, Bihar.
Kum. Meena Thakur, President, Mahilla Youth Congress, VPU, Upleta, Rajkot.
Dr. P.K. Joshi, Sr. Scientist (Microbiology), CSSRI, Karnal
K.K. Solanki, Principal Scientist & I/C, CIFT Research Stn., Veraval
Dr. R. Laxminarayana, Project Coordinator (Tobacco), GAU, Anand
Jt. Director (Agril. Extn.), Sardarbagh, Junagadh
Jt. Director (Agriculture), Krishi Bhavan, Kanke, Ranchi.
Dr. D.D. Malaviya,Principal, College of Agriculture, GAU, Junagadh
Mr. G.C. Prasad, Finance & Accounts Officer, NRCG

Member-Secretary

Shri Rajeev Lal, Admn. Officer, NRCG.

The 3rd IMC meeting was held on 4.11.96. The Director, NRCG chaired the meeting. Dr. D.D. Malaviya, Dr. R. Laxminarayana, Dr. K.K. Solanki, Dr. P.K. Joshi, FAO and A.O. attended the meeting. The progress of the work was reviewed and the house expressed their satisfaction. The salient recommendations were that of construction of boundary wall, quarters, processing-cum-produce storage rooms, garages and staff recreation hall in the same order of priority. The committee also recommended proposals pertaining to man power and equipment which were essential for executing the mandate of the Centre. The Committee also emphasised recognition of specialists of AMA for the Centre.

In-house review meetings

In-house review meeting for the kharif season was held from 6 to 7 May, 1996. The work done reports of various projects was reviewed and work programme for the kharif 1996 was finalised. The

major emphasis was laid on rejuvenation of the germplasm accessions and elite material which was destroyed due to PStV infection. Decision was taken to sow only ELISA-tested material in all the experiments to contain spread of the virus. Trials pertaining to cold tolerance, integrated pest management, management of soil-borne pathogens, cropping systems, interspecific hybridization, genetical studies, tolerance of soil-moisture- defiit stress, integrated nutrient management and and monitoring of insect-pests and pathogens were approved.

The In-house review meeting for the review of the progress made in various projets during rabi-summer 1996 and plans rabi-summer 1997 were disussed 4.1.97. The Chairman emphasised that the Centre should concentrate on basic, applied and strategic research so as to emerge as a centre of excellence for groundnut research in the Country. The activities of the Centre should be focussed on specific themes. Since, the prespective plan document was being prepared for the Centre, the mandate of the Centre may be to cater to the needs of the NARS. Workdone reports for the rabi-summer 1996 were presented and after thorough disussions, tehnial programme for the rabi-summer 1997 was approved keeping in view the mandate of the Centre and the annual action plans of the various researh projects.

A. Training

Dr. K.K. Pal attended the Foundation Course on Agricultural Research Service (55th FOCARS) at NAARM from 22nd March - 21st August, 1996.

Dr. Ms. Dey proceeded for Foundation Course on Agricultural Research Service (58th FOCARS) at NAARM commencing form 7th January 1997.

Mr. Y.C. Joshi, Head, and Dr. P.C. Nautiyal, Scientist (SS) attended a training course on modelling drought resistance trial in groundnut using PARCH-Nut model at ICRISAT from 11 to 14 Dec., 1996. The programme offered hands on training to the scientists on the use of groundnut model PEARCH-Nut, with an emphasis on modelling crop growth when water is not limiting, modelling for water-limited crop growth and drought resistance traits, adopting and applying the model to suit the local situations, and using the model for selection of genotypes with superior performance in drought-prone environments.

Dr. J.B. Misra, Senior Scientist (Biochemistry) underwent a training on "Advanced Techniques on Plant Molecular Biology and Biochemistry" at the Advanced Centre for Plant Boichemistry, IARI, New Delhi, from 13.1.97 to 1.2.97.

Dr. T Radhakrishnan attended the training on Bt-Technology held at the National Research Centre on Plant Biotechnology, New Delhi from 12.1.97 to 1.2.97.

Dr. S. Desai participated at the National Level Training Programme on Immunological and Biochemical Techniques for the Detection of Plant Viruses at S.V. University, Tirupati, A.P., India, 19.7.96 to 7.8.96.

Dr. P. Manivel attended the training on "Breeding for Quality produce" from 6.11.96 to 20.11.96 held at School of Genetics, Tamil Nadu Agricultural University, Coimbatore.

Dr.R.K. Mathur attended the the training on "Approaches for improving quantitative traits in crops". from 22.1.97 to 20.2.97 at School of Genetics, TNAU, Coimbatore.

Sh. A. D. Parmar and Sh. R. T Thakkar attended the training on ARFIS from 21.4.96 to 23.4.96, at NAARM, Hyderabad, and from 24.9.96 to 25.9.96 at CAZRI, Jodhpur.

B. Visits

Abroad

Dr. M.P. Ghewande, Sr. Scientist and Head, Plant Pathology attended the Asia Working Group Meeting on Groundnut Aflatoxin Management organised by ICRISAT Asia Centre, Patancheru, A.P., India under CLAN from 27-29 May, 1996 at the Ministry of Agriculture and Rural Development, Hanoi, Vietnam.

He presented a paper entitled "Aflatoxin Contamination of Groundnut and its Management in India" in Session II - Country Reports on the present status and future prospects of research on the groundnut aflatoxin problem.

He also visited the Post-Harvest Technology Institute (PHIT), and the National Institute of Plant Protection (NIPP), Ministry of Agriculture and Rural Development, Hanoi, Vietnam.

This meeting was a good opportunity for him to enrich his knowledge and to learn from other Asian countries experiences in groundnut aflatoxin management.

Within the Country

Dr. A. Bandyopadhyay	Micro-Mission-I Review Meeting at IARI, New Delhi, 22.6.96 to 28.6.96
	Peer Review meeting of Perspective Plan of the Centre, Delhi, 31.7.96 to 04.8.96
	Mid-Year Review Meeting of Directors, Delhi, 13.10.96 to 18.10.96
	To discuss certain matters reg. NRCG with DDG(CS), Delhi, 23.10.96 to 26.10.96
	Discussion with the Scientists of Agril. and Food Engg., IIT reg., Collaborative Project Calcutta, Kharagpur and Bhubaneshwar, 20.12.96 to 28.12.96 -
	Meeting of ICAR Regional Committee No. VI, Bikaner, 22.01.97 to 26.1.97

Dr. M.P. Ghewande	Annual Rabi/summer Groundnut Research Workers' Special Group Meeting held at the ICRISAT, on April 19-20, 1996.
	First National Workshop of the Pilot Project on Technology Assessment and Refinement through Institution-Village-Linkage Programme (IVLP) at IVRI, Izatnagar (Bareilly) from 3-5 February, 1997.
	National Symposium on Plant Pathogens and Environment, 9th Zonal Meeting (WZ) of the Indian Phytopathological Society and 19th Annual Meeting of the Society of Mycology and Plant Pathology at Dr. Babasaheb Ambedkar Marathwada Univ., Aurangabad from 10-13 January, 1997. Chaired the session on Diseases of Cereals in the IPS meeting.
Dr. J.B. Misra	AGRESCO meeting of Plant Physiology and Biochemistry of the Gujarat Agricultural University at College of Agriculture, Junagadh between 18-19, April 1996.
	National Seminar on 'Role of Engineering Techniques in Increasing Agricultural Productivity' (College of Agriculture, Nagpur, December 5-6, 1996).
Drs. S. Desai, P.K. Ghosh, A.L. Singh	2nd International Crop Science Congress
Dr. Radhakrishnan T	3rd Agricultural science congress at PAU, Ludhiana, March 12-15
Dr. P. Manivel	The Annual Seed Review meeting at ICAR, New Delhi on 19.2.97 and presented the physical and technical report of the Project NSP III part II.
Dr. K.K. Pal	37 th Annual Conference of AMI held at Chennai from 4- 6th Dec., 1996
	84th Session of Indian Science Congress held at New Delhi from 2-8th January, 1997.

NRCG

Dr. A. Bandyopadhyay Director

PLANT GENETIC RESOURCES

Dr. N.R. Bhagat	Senior Scientist
Dr. K. Rajgopal	Scientist(SS)
Sh. K. Chandran	Scientist (On study leave)

PLANT BREEDING

Dr. A. Shome	Senior Scientist
Dr. R.K. Mathur	Scientist
Dr. P. Manivel	Scientist
Sh. M.Y. Samdur	Scientist

CYTOGENETICS

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

PLANT PATHOLOGY

Dr.M.P. Ghewande	Senior Scientist
Dr. S. Desai	Scientist (SS)

ENTOMOLOGY

Dr. V. Nandagopal	Scientist (SS)

PLANT PHYSIOLOGY

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

BIOCHEMISTRY

Dr. J.B. Misra	Senior Scientist
Sh. D.M. Bhatt	Technical Officer

AGRONOMY	
Sh. Devi Dayal	Scientist (SS) (on study leave)
Dr. P.K. Ghosh	Scientist
MICROBIOLOGY	
Dr.K.K. Pal	Scientist
Ku.S.M. Chauhan	Technical Officer
FARM SECTION	
Dr. R.S. Tomar	Farm Superintendent
Sh. H.B. Lalwani	Technicl Officer
Sh.V.K. Sojitra	- do-
Sh. H.M. Hingrajia	- do-
Sh. C.P. Singh	- do-
Sh. Dashi	- do-
LIBRARY	
Sh. N. Karthikeyan	Information & Documentation Officer
ADMINISTRATION	
Sh.G.C.Prasad	Finance & Accounts Officer
AICRPG	
Dr. M.S. Basu	Project Coordinator
Sh. A.L. Rathna Kumar	Scientist (on study leave)
Dr. Chuni Lal	Scientist
Sh. D.L. Parmar	TechnicalOfficer (on study leave)
Sh. Prem Narayan	Tehnical Officer

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