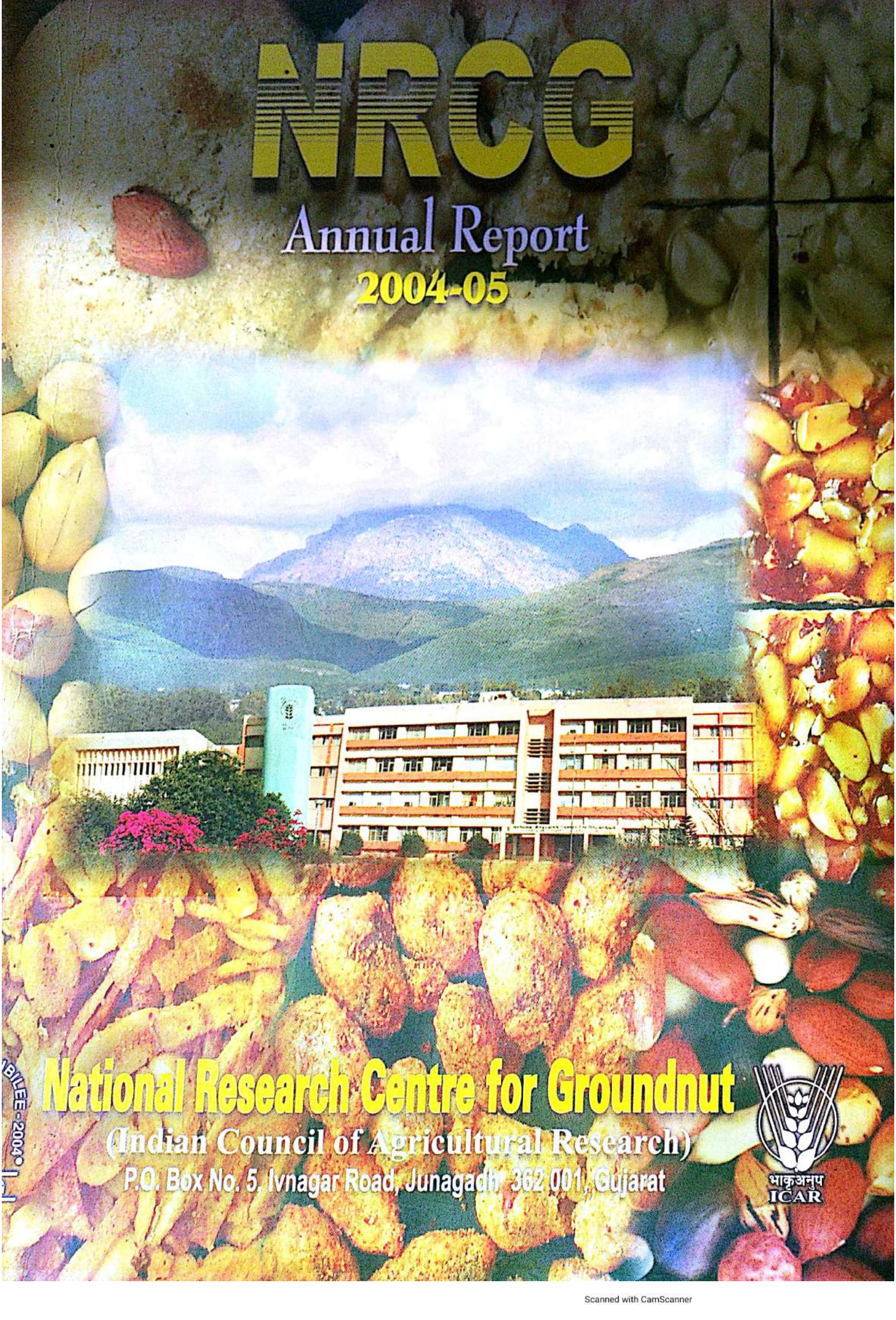
NRCG

Annual Report

2004-05



National Research Centre for Groundnut

(Indian Council of Agricultural Research)

P.O. Box No. 5, Ivnagar Road, Junagadh 362 001, Gujarat

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Preface

The National Research Centre for Groundnut completed 25 years of eventful existence on 1st October 2004. Since its inception, the Centre has grown in expected line and has achieved high degree of scientific excellence. Although considerable progress has been made in the past 25 years to increase groundnut productivity and production, still there exist several important issues to be addressed so as to reach sustainability in groundnut production in the country. There is also an emerging need to diversify the use of groundnut and its byproducts to make the groundnut farming profitable and competitive. This annual report summarizes the major activities of the Centre during 2004-05 and aimed to highlight the Centre's research thrust and technologies developed in different fronts.

A number of fresh crosses were effected during the period and selections were made from segregating populations. Segregating materials from many crosses were supplied to a number of AICRP-G centres located throughout the country for location specific selection and varietal development. Many Spanish and Virginia entries were found promising for yield, earliness or tolerance of moisture deficit stress. Besides, a number of advanced breeding lines have showed resistance to soil-borne and foliar fungal diseases. On germplasm management, a total of 2346 accessions have been assembled, 500 accessions characterized and 190 accessions have been deposited to National Genebank at NBPGR, New Delhi. Nearly 1900 accessions were supplied to 28 indenters. A new isolate of *Trichoderma harzianum* (T-170) showed promising antagonistic effect against soil-borne fungal pathogens. In IPM experiment based on the cost of cultivation and the yields of groundnut and the intercrop, intercropping with castor gave higher CBR followed by seasmum and pigeon pea. The yield economics worked out has shown that intercrop with castor gave the highest income followed by pigeon pea. Soil application of either fresh leaves of karanj or neem or wild sorghum @ 250 kg/ha is found to be good for the management of collar rot and stem rot. Although the application of farm yard manure, biofertilizers, and bioinsecticides, improved the soil organic carbon and nitrogen content as well as population of beneficial soil microflora, the maximum yield of groundnut crop could be realized only when these components were applied in conjunction with the recommended doses of chemical fertilizers. Donors for high and low temperature tolerance have been identified among the wild Arachis species and their accessions. A number of genotypes have been identified for Ca- and P-efficiency. Protocols for transformation have been standardized for developing transgenics in respect of *Bt*, coat proteins, and osmotins. Molecular characterization of released varieties and germplasm accessions using SSRs is in progress. Technologies have been developed for producing cellulase and amylase enzymes from groundnut shell and de-oiled groundnut cake, respectively through microbial processes. Besides, attempts have been made to utilize groundnut shell and haulm for producing oyster and milky mushrooms. A number of edible products including peanut butter and other confections were tried at laboratory level.

Human resource development has been quite satisfying in that a number of DPCs held for promotion. A number of externally funded projects, both national and international, are under operation and significant findings are expected in the near future.

I sincerely thank all the concerned for helping in the publication of this annual report.

(M. S. Basu)
Director

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- विभिन्न जैविक दबावों के प्रति सहिष्णुता / प्रतिरोधकता के समावेशन हेतु तीस, $\Delta^{13}C$ एवं $\Delta^{18}O$ के लिए मैपिंग संख्या विकास हेतु चार-चार, बीजावरण के रंग की अनुवांशिकता हेतु दो, तना; पुष्प एवं बीजचोल के रंग की संलग्नता के अध्ययन एवं उत्पादन दक्षता हेतु क्रमशः दो एवं एक नये संकरों को बनाने का प्रयास किया गया।

- पृथकीकृत पीढ़ियों को अग्रिम पीढ़ियो में बढ़ाकर चयन प्रक्रिया को जारी रखा गया। कुल 184 चयन किए गये और F_1 पौधों की पहिचान की गयी।

- कुल 42 नई प्रजननिक लाइनें विकसित की गयी। विभिन्न जैविक / अजैविक दबावों हेतु विकसित कुल 312 अग्रिम कल्चरों का अनुरक्षण किया गया तथा 81 अग्रिम प्रजननिक लाइनों का बहुगुणन किया गया।

- स्टेशन परीक्षण में चार अग्रिम प्रजननिक लाइनों नामतः PBS 24004, 12160, 36044 एवं 30073 को योग्य पाया गया तथा इन्हें AICRP परीक्षण में मूल्यांकन हेतु प्रस्तावित किया जायेगा। PBS 24030 को मूंगफली के AICRP परीक्षण के अर्न्तगत जोन I में सभी स्तरों पर योग्य पाया गया तथा पहिचान हेतु प्रस्तावित किया जा चुका है। एक अन्य प्रविष्ट JUN 21 की IVT I के अर्न्तगत सूखा परीक्षण हेतु जांच की गयी।

- ISGVT XI के अर्न्तगत मूल्यांकित किए गये 14 कल्चरों में से ICGV 96390 एवं ICGV 97245 ने चेक GG2 से प्रतिदिन के हिसाब से उच्च एवं सार्थक उत्पादन दिया तथा दो प्रविष्टियां ICGV 96333 एवं ICGV 97257, 75% पुष्पण के दिनों के हिसाब से अगेती पायी गयी।

- विभिन्न प्रबन्धित सूखा पद्धतियों के अर्न्तगत अग्रिम प्रजननिक लाइनों के मूल्यांकन से संकेत मिला कि मौसम के मध्य में दिया गया पानी का दबाव सुइयों के विकास के साथ होता है और फलियों एवं दानों की उपज को सीमित रखने में फलियों का आरम्भीकरण बहुत ही निर्णायक होता है।

- अगेती परिपक्वता के लिए मूल्यांकन किए गये जनन द्रव्यों में से PBS 21023 को ग्रीष्मकाल में 95 दिन में परिपक्व होते हुये पाया गया तथा PBS 28008, 29063, 30076, 21031, 11066, 12038, 11026, 18062, 18029, 14050 एवं HNG 10 को खरीफ मौसम में 95 दिन में परिपक्व होते हुए पाया गया।

- बीज का आकार बढ़ाने के उद्देश्य से 30 नये संकर बनाने का प्रयास किया गया। पृथकीकृत पीढ़ियों में बड़े आकार की फलियों के लिए बाह्य आकारकीय लक्षणों के आधार पर कुल 85 चयन किए गये। F_6 पीढ़ी के पदार्थ से 5 अग्रिम प्रजननिक लाइनों की पहिचान की गयी। कन्फेक्शनरी गुणवत्ता के लिए एक्रीसैट, हैदराबाद से 17 अग्रिम प्रजननिक लाइनें प्राप्त की गयी।

- बड़े बीजाकार वाले मूल्यांकित किए गये 23 जननद्रव्यों में से PBS 29034 एवं ICGV 99101 का उत्कृष्ट चेक GG 20 की तुलना में उच्च व सार्थक फली उत्पादन अभिलेखित किया गया। अग्रिम प्रजननिक लाइन PBS 29077 में उच्च व सार्थक बीजाकार पाया गया। जिन जननद्रव्यों में तेल की मात्रा कम पायी गयी वह जनन द्रव्य हैं: PBS 29062, 19011, 29056, ICGV 99101 एवं ICGV 00428 जननद्रव्य PBS 29062, 29030, 22008 एवं 19007 में प्रोटीन की मात्रा उच्च पायी गयी।

- उच्च लागत की परिस्थितियों में अग्रिम प्रजननिक लाइन ICGV 99101 ने तीन वर्षों तक बेहतर प्रदर्शन किया और GG 20 की तुलना में इसमें लगभग 20% उच्च फली उत्पादन एवं 10% उच्च दाने की उपज का अभिलेख किया गया।

- कृत्रिम निष्पर्णीय प्रयोग में के सभी स्तरों एवं अनेक संयोगों में पर निष्पर्णीयता के प्रतिशत के बढ़ने के साथ-साथ उपज में सार्थक कमी दर्ज की गयी।

- वर्ष 2004 की वर्षाऋतु के दरम्यान प्रक्षेत्रीय परिस्थितियों में जननद्रव्य PBS 20971 एवं PBS 14010 ने जैसिड के प्रति उच्च स्तरीय प्रतिरोधकता दर्शायी तथा NRCG-10828, 12698, 10818, ICG 12367, 12620, 12621, 9981, 7846, 15119, 11721, 2462, 3037, 4032, 5403, 9889, 2701, 2748 एवं 4248 को मूंगफली की पर्णसुरंगी के प्रति प्रतिरोधक पाया गया।

- आइ पी एम के एक प्रयोग, जो की मूंगफली में लागत व उपज एवं अरण्डी वअरहर के साथ अन्तरशस्यन पर आधारित था, में अरण्डी ने उच्च CBR (1:3.76) के बाद तिल ने 1:3.65 एवं अरहर ने 1:3.60 दिया। उपज की आय एवं व्यय ने दर्शाया कि कन्ट्रोल जिसने कि रु. 28940 / है. दिया, की तुलना में अरण्डी के साथ अन्तरशस्यन ने अधिकतम आय रु. 39,492 / है. दी और उसके बाद अरहर के अन्तरशस्यन से रु. 37,848 / है. प्राप्त हुआ।

- विभिन्न प्रकार के पांच ट्रैपों यथा: छोटा एवं बड़ा एक्रिलिक स्टिका ट्रैप, प्लास्टिक ट्रे ट्रैप, वोटा-टी ट्रैप (अरण्डी का तेल), वोटा-टी ट्रैप (पानी+मिट्टी का तेल) का प्रयोग ए. मोडिसेल्ला के पतंगों को पकड़ने में किया गया जिसमें से अन्य दूसरों की अपेक्षा वोटा-टी ट्रैप ने उच्च सार्थकता दर्शायी। पानी व मिट्टी के तेल के साथ वोटा-टी ट्रैप, से नरों की पकड़ (194.8/ट्रैप/दिन) की अपेक्षा अरण्डी के तेल के साथ वोटा-टी ट्रैप से नरों की पकड़ अच्छी (196.89/ट्रैप/दिन) पायी गयी।
- वर्ष 2004 के खरीफ मौसम में अगेती व पछेती पर्णधब्बा, रस्ट व तना सड़न रोगों के विरुद्ध कुल 372 जननद्रव्यों (180 जननद्रव्यों की दूसरे वर्ष तथा 192 जननद्रव्यों की प्राथमिक) की छंटनी की गयी।
- जननद्रव्य CS 168, CS 86, PBS 29058, CS 19 एवं CS 160 अगेती पर्णधब्बा के विरुद्ध प्रति रोधकता रखते पाये गये; CS 168, CS 185 एवं PBS 12169 पछेती पर्णधब्बा के विरुद्ध तथा CS 168, CS 151, CS 25, CS 19 एवं CS 157 तना सड़न के विरुद्ध प्रतिरोधक पाये गये जब कि जननद्रव्य CS 168 बहुआयामी रोग प्रतिरोधक पाया गया ।
- प्रक्षेत्रीय परिस्थितियों में 192 जननद्रव्यों की छंटनी की गयी जिसमें ICR 12 को पछेती पर्णधब्बा, रस्ट व तना सड़न के विरुद्ध बहुआयामी रोग प्रतिरोधक पाया गया। परिणामों की पुष्टि खरीफ 2005 में करने की आवश्यकता है।
- कंक्रीट ब्लॉक की परिस्थितियों के अर्न्तगत CS 19 एवं PBS 29017 ने अगेती पर्णधब्बा के प्रति प्रतिरोधकता दर्शायी।
- प्रयोगशाला की परिस्थितियों के अर्न्तगत कॉलर रॉट के रोगजनक के विरुद्ध GG 2 (रोग ग्राह्य) एवं J 11 (प्रतिरोधक) सहति कुल 98 जीन प्ररूपों का मूल्यांकन किया गया। जिनमें 16 जीन प्ररूपों यथा JAL 05, CS 65, CS 81, CS 17, CS 245, CS 64, CS 78, CS 140, CS 79, CS 104, C 85, CS 101, CS 149, CS 113, CS 164 एवं CS 188 ने ए. नाइजर के विरुद्ध प्रतिरोधक प्रतिक्रिया दर्शायी।
- पांच आइसोलेटों यथा: T 170, T 28, T 126, T 00 एवं T 04 जिन्होंने दोहरे कल्चरों में उत्कृष्ट विरोधी दक्षता दर्शायी, की जांच खरीफ 2004 में कंक्रीट ब्लॉक परिस्थितियों में की गयी कन्ट्रोल में कॉलर रॉट एवं स्टेम रॉट (क्रमशः 164.63% एवं 32.45%) की अपेक्षा आइसोलेट T 170 (टी.हारजियानम से सम्बद्ध) में कॉलर रॉट एवं स्टेम रॉट का प्रभाव न्यूनतम (क्रमशः 27.15% एवं 10.83%) अवलोकित किया गया ।
- पर्णधब्बा के प्रथम प्रकट होने पर 50% सांद्रण के साथ V.lecanii के छनित कल्चर का 15 दिन के अन्तराल पर दो पर्णीय छिड़काव एवं Trichoderma harzianum द्वारा 4 ग्रा./कि.ग्रा. बीज की दर से बीजोपचार करने पर अगेती व पछेती पर्णधब्बा व रस्ट में अधिकतम घटोत्तरी दर्ज की गयी ।
- कॉलर रॉट एवं स्टेम रॉट के प्रबन्धन हेतु करंज, नीम या ज्वार की ताजी पत्तियों का बुआई के समय 250 कि.ग्रा./है. की दर से मृदा के कूँड़ में अनुप्रयोग करने पर बराबर अच्छा परिणाम प्राप्त हुआ।
- मृदा व पानी की क्षारीयता का पर्णीय रोगों के विकास व प्रबलता पर प्रभाव के प्रयोग से स्पष्ट हुआ है कि जैसे-जैसे क्षारीयता बढ़ती है, प्रमुख फंफूदी जनित पर्णीय रोगों की प्रबलता घटती है।
- ऐरैचिस जाति व उनके 41 एक्सेशनों में से उच्च एवं निम्न तापक्रम के प्रति सहिष्णु दाता श्रोतों की पहिचान की गयी।
- पानी की कमी से प्रेरित उच्च तापक्रम के दबाब से मूंगफली में पत्ती का फैलाव, वृद्धि एवं परागण प्रभावित हुआ, पाया गया ।
- सूखा सहिष्णु प्रजातियों में 30 से.मी. तक की गहराई तक लम्बी मूसला जड़ के साथ अधिक संख्या में द्वितीयक जड़ें पाई गयी ।
- मूंगफली में मृदा पानी की क्षारीयता की सहिष्णुता पर तीन वर्ष के प्रक्षेत्रीय अध्ययन के परिणामों से निष्कर्ष निकला कि सूखा की अवधि व संवेदनशील अवस्थाओं में 2dS/m की क्षारीयता युक्त पानी से मूंगफली में सिचाई की जा सकती है । मूंगफली को मध्यम संवेदनशील फसलों के वर्ग में रखा जा सकता है और गेहूँ की फसल के साथ चक्र में उगाया जा सकता है।
- देश में जारी अनुसंधान कार्यक्रम के अवलम्बन हेतु 2346 एक्सेशनों के संग्रहण द्वारा कार्यसाधक संग्रह को समृद्ध बनाया गया तथा 28 मांगकर्ताओं को 1899 एक्सेशन भेजे गये। दीर्घावधि के परिरक्षण हेतु 190 एक्सेशनों को NGB में रखा गया ।
- अठारह गुणात्मक एवं 31 मात्रात्मक गुणों के लिए 500 एक्सेशनों का लक्षण निश्चयन किया गया तथा इच्छित सस्सीय गुणों हेतु आशाजनक एक्सेशनों की पहिचान की गयी ।

- DUS की आवश्यकता पूर्ति हेतु 22 विमोचित प्रजातियों का 20 गुणात्मक एवं 29 मात्रात्मक गुणों के लिए लक्षण निश्चयन किया गया। प्रजाति कोपरगांव 3 एवं ओ जी 52-1 में लाल रंग का बीजावरण तथा बी. ए. यू. 19 में गहरे लाल रंग का बीजावरण होता है।
- राष्ट्रीय जांच के दिशा निर्देशों के लिए 94 विमोचित प्रजातियों का 18 गुणात्मक व 18 मात्रात्मक गुणों हेतु लक्षण निश्चयन किया गया।
- दो सौ एक सेशनों के प्रमुख संग्रह को $\Delta^{13}C$ एवं $\Delta^{18}O$ के आंकलन हेतु उगाया गया। पत्तियों व तनों के नमूनों को विश्लेषण हेतु यू.एस.ए. बंगलौर भेजा गया ।
- केन्द्र पर विकसित किए गये 184 एक्सेशनों के एक प्रमुख संग्रह का 18 गुणात्मक एवं 31 मात्रात्मक गुणों के लिए लक्षण निश्चयन किय गया। इस संग्रह ने विभिन्न गुणों के लिए विचारणीय भिन्नता दर्शायी ।
- जंगली जातियों के 5 चयनों का प्रतिनिधित्व करने वाले 96 एक्सेशनों का अनुरक्षण किया गया।
- बाम्बारा मूंगफली के 10 एक्सेशनों का 15 गुणात्मक एवं 8 मात्रात्मक गुणों के लिए लक्षण निश्चयन किया गया। अन्य एक्सेशनों की तुलना में Uniswa Red प्रजाति के पुष्पों का रंग और रंजक भिन्न पाया गया ।
- पादप महामारी की परिस्थितियों में 304 एक्सेशनों की छंटनी में से 18 एक्सेशन GLM के प्रति प्रतिरोधक पाये गये।
- खरीफ 1998 में जिन 775 एक्सेशनों एवं खरीफ 1999 में 525 एक्सेशनों का लक्षण निश्चयन किया गया उनका एक डाटा रिट्रीवल सिस्टम GRIS का विकास किया गया।
- खरीफ 2004 में उगायी गयी 56 प्रजातियों में से 7 प्रजातियों की पहिचान उच्च तेल धारक (>52%) के रूप में की गयी। वर्षों वर्ष मूंगफली की खेती करने पर TMV 12 प्रजाति के दानों में तेल की मात्रा स्थिर (Cv 0.4%) रही। GG 20 लिए 2.6 मूल्य के साथ 27 प्रजातियों का O/L अनुपात 2.0 से अधिक पाया गया। प्रोटीन की अधिकतम मात्रा (30.1%) Tirupati 4 प्रजाति में पायी गयी जब कि न्युनतम मात्रा (20.1%) Chitra प्रजाति में पायी गयी।
- फिनोलिक्स, रिड्यूसिंग सुगर, फ्री अमीनो एसिड्स और सुक्रोज की मात्रा के लिए मूल्यों का औसत क्रमशः 0.2-0.5%, 0.1-0.2%, 0.1-0.4% और 7.5-14.7% पाया गया।
- लगभग बनावट एवं संरचना के संयुक्त आधार पर मूंगफली की सात प्रजातियों में से मूंगफली का बटर बनाने के लिए सोमनाथ प्रजाति को उत्तम पाया गया।
- दो सूक्ष्मजीवों Aspergillus awamori MTCC 548 एवं Penicillium roqueforti MTCC 933 ने प्रोटिएज एन्जाइम उत्पन्न करने के लिए दक्षता दर्शायी कि उन्हें Solid Substrate Fermentation (SSF) के अवस्तर के रूप में मूंगफली की खली में सफलता पूर्वक उपयोग किया जा सकता है। इस प्रक्रिया का व्यवसायिक दोहन किया जा सकता है। मूंगफली की तेल रहित खली के स्तरी फर्मेन्टेशन से अम्लीय, क्षारीय एवं उदासीन प्रोटिएज उत्पन्न करने में Bacillus subtilis MTCC 1789 (Standard) की अपेक्षा एक नया आइसोलेट Bacillus sp. P5, जो कि मृदा से प्राप्त हुआ, अधिक दक्ष पाया गया।
- यद्यपि F.Y.M., जैव उर्वरक और जैव कीटनाशियों के प्रयोग से मृदा में कार्बनिक कार्बन और नत्रजन की मात्रा के साथ-साथ लाभकारी सूक्ष्मजीवों की मात्रा बढ़ती है लेकिन जब इन तत्वों को संस्तुत रासायनिक उर्वरकों की मात्रा के साथ मिलाकर दिया जाता है तो मूंगफली की फसल से अधिकतम उत्पादन लिया जा सकता है।
- एन.आर.सी.जी. फार्म पर खरीफ 2004 में किसानों के लिए किसानों की पद्धति {Farmers' practice (FP)} की तुलना में एक संकलित अफ्लाटॉक्सिन प्रबन्धन {Integrated aflatoxin management package (IP)} प्रयोग किया गया। इस प्रयोग में कन्ट्रोल (FP) की अपेक्षा IP में अफ्लाटॉक्सिन की मात्रा में 46.5% तक की कमी पायी गयी ।
- एन.आर.सी.जी. में बाहरी वित्तीय सहायता प्राप्त परियोजना (ROPS17) के अर्न्तगत 350 आइसोलेटों में से A. flavus के लगभग 150 आइसोलेट्स को पृथक किया गया तथा इन्हें लाइओफिलाइज्ड परिस्थितियों में अनुरक्षित किया जा रहा है।
- इन-विट्रो परिस्थितियों के अर्न्तगत A. flavus के विरुद्ध ट्राइकोडर्मा से सम्बन्धित 8 जातियों के 17 आइसोलेटों की प्रतिरोधकतात्मक गतिविधियों का अध्ययन किया गया । आइसोलेट T 071 एवं T 29 ने 50% से अधिक वृद्धि निषेधक क्षमता दर्शायी।

Summary

- Fresh crosses were attempted to incorporate tolerance/resistance to different biotic (30) stresses, to develop mapping population for $\Delta^{13}C$ (4) and $\Delta^{18}O$ (4), genetics of seed coat colour (2), linkage studies on stem, flower and testa colour (2) and yielding ability (1).
- True F¹s were identified, segregating generations were advanced to the next respective filial generations and selection was carried out. Total 184 selections were made during the year.
- Forty-two new advanced breeding lines were developed. A total of 312 advance cultures developed for different biotic/abiotic stresses were maintained. Eighty-one advanced breeding lines were multiplied.
- Four advanced breeding lines, namely PBS 24004, 12160, 30044 and 30073 have qualified station trials and will be proposed for evaluation under AICRP-G trials. PBS 24030 has qualified all the stages of testing under AICRP-G trials in Zone I, and has been proposed for identification. Another test entry JUN 21 was tested under drought trials in IVT I.
- Out of 14 cultures evaluated under IX ISGVT, ICGV 96390 and ICGV 97245 gave significantly higher per day productivity over the best check, GG 2; and two entries, ICGV 96333 and ICGV 97257, were earlier in days to 75% flowering.
- Evaluation of advanced breeding lines under different simulated drought patterns indicated that mid-season water stress coinciding with peg development and pod initiation is the most crucial in limiting pod and kernel yields.
- Among the genotypes evaluated for early maturity, PBS 21031 was found to mature in 95 days during summer season, and PBS Nos. 28008, 29063, 30076, 21031, 11066, 12038, 11026, 18062, 18029, 14050 and HNG 10 matured in 95 days during kharif season.
- For increasing seed size 30 new crosses were attempted. Phenotypic selections were operated for large pod size in segregating generations and 85 selections were made. Five advanced breeding lines were identified from the material in F_6 generation. Seventeen confectionery quality advanced breeding lines were acquired from ICRISAT, Hyderabad.
- Among the 23 large seeded genotypes evaluated, PBS 29034 and ICGV 99101 recorded significantly higher pod yield over the best check, GG 20. Advanced breeding line PBS 29077 had significantly higher seed size. Genotypes with low oil content were PBS Nos. 29062, 19011, 29056, ICGV 99101 and ICGV 00428. Protein content was high in PBS Nos. 29062, 29030, 22008 and 19007.
- Advanced breeding line ICGV 99101 recorded nearly 21% higher pod yield and 10% higher kernel yield over GG 20 over three years, and found to perform better under high input conditions.
- In Artificial defoliation experiment there was significant increase in yield loss with increase in per cent defoliation in all the stages and in their combinations.

- The genotypes PBS 29071 and PBS 14010 have shown high level of resistance to jassids, and genotypes NRCG- 10628, 12698, 10818, ICG 12367, 12620,12621, 9981, 7846, 15119, 11721, 2462, 3037, 4032, 5403, 9889, 2701, 2748 and 4248 are found to be resistant to groundnut leaf miner under field conditions during the rainy season of 2004.
- In IPM experiment based on the cost of cultivation and the yields of groundnut and the inter crop, intercropping with castor gave higher CBR (1:3.76) followed by seasmum (1:3.65) and pigeon pea (1:3.60). The yield economics worked out has shown that intercrop with castor gave the highest income of about Rs. 39,492 followed by pigeon pea (Rs. 37,848) compared to the control which gave Rs. 28,940 per hectare.
- Out of the five different types of traps *viz.*, Acrylic sticka trap (small), Acrylic sticka trap (bigger), Plastic tray trap, Wota-T trap (Castor oil), Wota-T trap (water+ kerosene) tried against A. modicella, catches of male moths were significantly higher in Wota-T trap than in all other traps. Wota-T trap with castor oil was found superior (196.89 male moths/trap/day) which was on par with Wota-T trap having water and kerosene as trapping material (194.8 males/trap/day).
- A total of 372 genotypes (second year screening of 180 genotypes and preliminary screening of 192 genotypes) were screened against ELS, LLS, rust and stem rot diseases under field condition during the rainy season of 2004.
- The genotypes CS 168, CS 86, PBS 29058, CS 19 and CS 160 possessed promising resistance against ELS; CS 168, CS 185 and PBS 12169 against LLS and CS 168, CS 151, CS 25, CS 19 and CS 157 against stem rot. The genotype CS 168 possesses multiple disease resistance.
- Among 192 genotypes screened under field conditions the genotype ICR 12 possessed multiple disease resistance against LLS, rust and stem rot. The results need confirmation during kharif 2005.
- CS 19 and PBS 29017 showed resistance to early leaf spot under concrete block conditions.
- Out of 98 genotypes including susceptible (GG 2) and resistant check (J11) evaluated against collar rot pathogen (*Aspergillus niger*) under laboratory conditions, 16 genotypes *viz.*, JAL 05, CS 65, CS 81, CS 76, CS 245, CS 64, CS 78, CS 140, CS 79, CS 104, CS 85, CS 101, CS 149, CS 113, CS 164 and CS 188 showed resistant reaction against *A. niger*.
- Five isolates showing promising antagonistic ability in dual culture *viz.*, T 170, T 28, T 126, T 00 and T 04 were further tested under concrete block conditions during kharif 2004. The minimum incidence of collar rot (27.15%) and stem rot (10.83%) as compared to control (64.63% and 32.45%, respectively) were observed with the isolate T 170 belonging to *T. harzianum*.
- The maximum reduction of ELS, LLS and rust were recorded by seed treatment with *Trichoderma harzianum* @ 4g/kg seed and foliar application of culture filtrate of *V. lecanii* at 50% dilution on the first appearance of the leaf spots followed by two spray at 15 days interval.

- Soil application of either fresh leaves of karanj or neem or wild sorghum @ 250 kg/ha is equally good for the management of collar rot and stem rot, and should be applied in furrow at the time of sowing.
- Experiments to study the effect of soil and water salinity on development and severity of foliar diseases revealed that as the salinity increased the severity of major foliar fungal diseases decreased.
- Among the wild *Arachis* species and their accessions (nos. 41) donor sources for both high and low temperature tolerance were identified.
- Water-deficit induced high temperature stress affected leaf expansion growth and pollination in groundnut.
- Drought tolerant cultivar was found to have long tap root and more number of secondary roots around the 30 cm soil depth.
- Results of the three years field studies on tolerance of groundnut to soil and water salinity concludes that supplement irrigation to groundnut during the dry spell and at sensitive stages can be given having salinity of 2 dS/m. Groundnut is classified as moderately sensitive crop and can be taken up in rotation with wheat.
- The working collection was enriched by assembling 2346 accessions to support the ongoing programme in the country 1899 accessions were supplied to 28 indenters. For long term conservation 190 accessions were submitted to NGB.
- A set of 500 accessions were characterized for 18 qualitative and 31 quantitative traits. Promising accessions for desirable agronomic traits have been identified.
- Twenty-two released varieties were characterized for 20 qualitative and 29 quantitative traits to meet the DUS requirement. The varieties Kopergaon 3 and OG 52-1 had red testa.
- Ninety-four released varieties of groundnut were characterized for 18 qualitative and 18 quantitative characters for confirmation of National Test Guidelines.
- A core collection of 200 accessions was grown for estimation of $\Delta^{13}C$ and $\Delta^{18}O$. The leaf and stem samples were sent to U.A.S., Bangalore for analysis.
- A core collection of 184 accessions developed at the Centre was characterized for 18 qualitative and 31 quantitative traits. The collection showed considerable variation for many traits.
- Ninety-six accessions representing five sections of wild *Arachis* species are maintained.
- Ten accessions of bambara groundnut were characterized for 15 quantitative traits and eight qualitative traits. The "Uniswa Red" variety had distinct flower colour and pigmentation compared to other accessions.
- Eighteen accessions were found to be resistant to GLM out of 304 accessions screened under epiphytotic conditions.

A data retrieval system, GRIS, was developed with 775 accessions characterized in kharif 1998 and 525 accessions in kharif 1999.

Out of 56 groundnut cultivars grown during kharif 2004, seven were identified as high oil (>52%) cultivars. Over the years of cultivation, cultivar TMV 12 was found to be the most stable for its kernel oil content (CV. 0.4%). The O/L ratio of 27 cultivars was found to be greater than 2.0 with a value of 2.6 for GG 20. The maximum protein content was found in the kernels of Tirupati 4 (30.1%) while minimum was in Chitra (20.1%).

The ranges of values for contents of phenolics, reducing sugars, free amino acids and sucrose were 0.2-0.5%, 0.1-0.2%, 0.1-0.4% and 7.5-14.7%, respectively.

- On the basis of combined taxtural and proximate composition, cultivar Somnath was adjudged to be the best for preparing peanut butter out of seven cultivars.
- In a process that can be commercially exploited, two microbes *viz., Aspergillus awamori* MTCC 548 and *Penicillium roqueforti* MTCC 933 showed the capabilities to successfully utilize groundnut cake as their substrate under solid substrate fermentation (SSF) to produce protease enzyme. A new bacterial isolate from the soil, *Bacillus* sp. P5, was found to be more efficient than *Bacillus subtilis* MTCC 1789 (standard), in producing acidic, neutral and alkaline proteases from de-oiled groundnut cake in slurry fermentation.
- Although the application of farm yard manure, biofertilizers, and bioinsecticides, improved the soil organic carbon and nitrogen content as well as population of beneficial soil microflora, the maximum yield of groundnut crop could be realized only when these components were applied in conjunction with the recommended doses of chemical fertilizers.
- An on-farm trial on integrated aflatoxin management package (IP) vis-à-vis Farmer's Practice (FP) was demonstrated at NRCG to the farmers during kharif 2004. There was a reduction in pre-harvest aflatoxin content by 46.5% in IP as compared to the control (FP).
- Out of 350 isolates, about 150 isolates of *A. flavus* isolated under the externally funded project (ROPS 17) at NRCG was revived and is being maintained in lyophilized condition.
- Antagonistic activity of 17 isolates of *Trichoderma* belonging to eight species was studied under *in vitro* conditions (bangle method) against *Aspergillus flavus*. The isolate T 071 and T 29 showed more than 50% inhibition of growth.

NRCG Celebrates its Silver Jubilee

The NRCG completed 25 years of flourishing existence on 1 Oct., 2004. To commemorate the Silver Jubilee a series of events were organized throughout the year. A National Symposium on "Enhancing Productivity of Groundnut for Sustaining Food and Nutritional Security" was organized during 11-13 Oct., 2004, as part of the Silver Jubilee celebrations. The main theme of the symposium was to increase groundnut productivity in a sustainable manner in both rain-dependent and irrigated production systems. More than 200 scientists from different parts of the country working in the AICRP-G, SAUs, and various National and International Research Organizations of repute participated in the event. The Secretary of Agriculture, Govt. of Gujarat, inaugurated the symposium. During the inaugural session eminent groundnut researchers from different Institutes/SAUs were honoured for their lifetime contribution towards groundnut research leading to increase in productivity and production in diverse agro-ecosystems in the country. Issues related to the groundnut productivity, quality, marketing etc. were discussed under six broad thematic areas. The thematic lectures delivered by eminent speakers were as follows:

The theme area "Integrated nutrient management, water use efficiency, prospects in acid soils and challenges of soil salinity in groundnut" was addressed by lectures such as 'Groundnut based cropping system research' by Dr. A Sarkar, 'Challenges of salinity management in groundnut' by Dr. S Raman, 'Micronutrient in sustainable production of groundnut' by Dr. M V Singh, and 'Integrated nutrient management in groundnut' by Prof. R P S Ahlawat.

Under the theme area "Organic farming, bio-fertilizers and integrated pest management in groundnut", Dr. G V Ranga Rao delivered lecture on 'Progress and prospects of pest management and integrated pest management in groundnut', Dr. S J Kolte on 'Management of soil borne diseases of groundnut: Role of organic farming', and Shri Bhimsibhai Ahir on 'Prospects and problems of organic groundnut cultivation and marketing'.

The thematic lectures delivered on "Post-harvest processing, aflatoxin management and export promotion" were 'Policy intervention in groundnut export' by Shri G Chandrashekhara, 'Phytosanitary issues for trade in groundnut' by Dr. R D V J Prasad Rao, 'Management of aflatoxin in groundnut' by Dr. M S Basu, and 'Current status of groundnut export and future prospects' by Shri Kishor Tanna.

Dr. R K Chowdary and Prof. A K Misra addressed the theme area "Quality seed production, distribution and marketing".

The thematic lecturers on "Conventional and non-conventional approaches to improvement of groundnut" were delivered by Dr. P S Reddy, Ex-Director, NRCG, giving a brief

account on 'The history of groundnut breeding efforts in India'; Dr. M S Basu on behalf of Dr. S N Nigam on 'Yield potential versus yield barriers in groundnut'; Dr. S K Sen on 'Non-conventional strategies for surmounting biotic stress in crop plants', and Prof. M Udaykumar addressing the issues related to the water use efficiency (WUE) in groundnut.

The lead speakers who addressed the theme area "Post-harvest technologies and scope for enhancing dietary consumption and value addition of groundnut" were Dr. S D Kulkarni and Shri Vikram P Duvani. Elaborate discussions were held on the scope of promoting groundnut for direct consumption, and delegates from seed companies and processing industries actively participated in the debate.

Each session was followed by discussion and synthesis. Besides oral presentations, poster sessions were also held on Oct. 11 and 12. More than 180 posters covering wide spectrum of research findings under the different theme areas were exhibited. A panel of judges evaluated the posters on each day and the best poster awardees were felicitated in the concluding ceremony.

The recommendations emanating from different sessions were presented in the valedictory session chaired by the Dr. N B Singh, ADG (O&P). The chairman in his concluding remarks stressed the need for organizing such symposia once in every three years so that the groundnut researchers can update themselves the latest research trends and needs, and can prioritize the research programmes back in their respective organizations.

PROJECT 01: BREEDING AND GENETIC STUDIES ON BIOTIC AND ABIOTIC STRESSES IN GROUNDNUT

(CHUNI LAL, A.L. RATHNAKUMAR, K. HARIPRASANNA, M.P. GHEWANDE, V. NANDAGOPAL, P.C. NAUTIYAL AND A.L. SINGH)

Sub project 01: Breeding and genetic studies on biotic stresses in groundnut

1 Hybridization

During kharif 2004, 30 crosses were attempted in a diallel mating design to study the biotic stress resistance components and a total of 5172 buds were pollinated and 1228 probable hybrid pods were harvested with 23.7% success.

2 Selections and generation advancements

The F1 generation of crosses effected during kharif 2003 was sown and true hybrids were identified. From the segregating generations selections were made and bulked separately for further advancement to their respective filial generations/yield evaluation. The total selections made in segregating generation during kharif 2004 are given in Table 1.

Table 1. Selections made in segregating generation and generation advancements

Gen.	Purpose	Crosses sown	Seln. sown	Seln. made
F_1	Collar rot resistance	2	--	21 spp
	Resistance to collar, stem rot and PBND	5	--	17 spp
	A. blight resistance	1	--	6 spp
	Thirps and jassids tolerance	2	--	17 spp
	Stem rot, rust/LLS tolerance	1	--	15 spp
	Leaf miner & *Spodoptera* resistance	2	--	15 spp
	Disease resistance	6	--	42 spp
F_2	Foliar diseases resistance	1	1	1
	Collar rot resistance	1	8	8
F_3	Collar rot resistance	19	20	24
F_4	Collar rot resistance	2	3	0
F_5	Collar rot resistance	4	9	10
	ELS resistance	4	10	10
F_6	LLS/Rust resistance	5	8	10

Sub project 02: Breeding and genetic studies on abiotic stresses in groundnut

1 Hybridization

During kharif 2004, a total of 13 crosses were attempted for different purposes, like

developing mapping population for $\Delta^{13}C$ (4) and $\Delta^{18}O$ (4), genetics of seed coat colour (2), linkage studies on stem, flower and testa colour (2) and yielding ability (1). For these crosses a total of 1692 buds were pollinated and 424 probable hybrid pods were obtained with 25.1% success.

2 Selections and generation advancements

True F¹s were identified based on the vigour and morphological traits in F¹ generation and segregation observed in F2. The single plant progenies were bulked in the early generation and empirical selection was practiced in the later generations. The total selections made in segregating generation during kharif 2004 are given in Table 2. A total of 32 advanced breeding lines were identified for their further maintenance, multiplication, evaluation and utilization as parents in the future breeding programmes.

Table 2. Selections made in segregating generation and generation advancements

Gen.	Purpose	Crosses sown	Seln. sown	Seln. made
F_1	1. To increase shelling percent	2	--	11 spp
	2. High Harvest Index	1	--	5 spp
	3. Early maturity	4	--	35 spp
	4. Cold tolerance	4	--	14 spp
	5. Seed Coat Colour	6	--	34 spp
F_2	1. Gene transfer from wild species	2	2	4
	2. Fresh seed dormancy in SB	2	2	2
	3. Drought tolerance	30	30	30
F_3	1. Reti. for multiple allele	4	4	7
	2. To increase shelling percent	1	1	3
	3. Fresh seed dormancy	4	4	4
F_4	1. Drought Tolerance	8	61	72
	2. Pod smoothness	1	1	2
	3. Iron chlorosis resistance	12	19	8
	4. Drought and High HI	2	6	4
F_5	1. Specific leaf area	1	3	1
	2. Fresh seed dormancy	3	26	19
	3. Fe resistance	4	4	3
F_6	1. Yielding ability	2	4	6
	2. Earliness in Virginia	6	14	11

3 Multiplication and maintenance of advanced breeding lines

During kharif 2004, 109 advance cultures developed for different abiotic stresses were maintained. A total of 88 advanced breeding lines were sown in kharif 2004 for seed enhancement. Of these, 24 lines did not germinate and got rejected as natural selection against them. Similarly, 52 mutants and 191 WUE lines were multiplied of which three mutants and 37

WUE lines did not germinate. Seeds of 17 advance cultures were multiplied during the season and 195 kg pods were harvested.

4 Genetics and combining ability studies for WUE traits

Substantial genetic variability existed among the parental lines and F_1s for SPAD, SLA, $\Delta^{13}C$, $\Delta^{18}O$, total dry matter production and fodder yield. The mean squares for general combining ability were highly significant for all the characters studied. Except for harvest index (HI), significant values for specific combining ability were also observed for all the characters, indicating that HI is under the influence of genes that are principally additive in gene action. All the four leaf morpho-physiological characters (SPAD, SLA, $\Delta^{13}C$ and $\Delta^{18}O$), demonstrated highly significant differences due to reciprocals indicating the role of maternal parent in the inheritance of these characters. The magnitude of general combining ability was higher for all the characters when compared with specific combining ability. This signifies the preponderance of additive gene action in the inheritance of these characters.

Good general combiners and superior specific cross combinations were identified for different traits studied. On perusal of the general combining ability effects of the parents involved in the superior specific cross combinations identified for the different characters studied, it was observed that the excellence of these crosses was irrespective of the general combining ability (poor, average or good) of the parents involved. Two crosses, namely TMV 2 NLM x ICGV 86031 and ICGV 86031 x CSMG 84-1, identified as good specific combiners for SCMR and SLA, respectively, involved parents with high x high gene combining ability, suggesting an additive x additive type of gene action, which can be fixed in subsequent generations if no repulsion phase linkages are involved.

5 Station trials for yield evaluation

Four different yield evaluation trials under the nomenclature of Preliminary Spanish Bunch Yield Evaluation Trial (PSBYET), Preliminary Virginia Yield Evaluation Trial (PVYET), Spanish Bunch Yield Evaluation Trial (SBYET) and Virginia Yield Evaluation Trial (VYET) were conducted in kharif 2004. The advanced breeding lines developed with different breeding objectives were evaluated in these trials. In all the trials observations on days to flower initiation and 50% flowering, number of primary and secondary branches and number of nodes, hundred kernel weight (HKW), sound mature kernels (SMK), shelling percentage (SP), specific leaf area (SLA), SPAD chlorophyll meter reading (SCMR), pod yield (PY) and kernel yield (KY) were recorded and analyzed statistically. The results of various station trials for yield evaluation are given trial wise here under:

5.1 Preliminary Spanish Bunch Yield Evaluation Trial (PSBYET)

A total of 65 advance Spanish cultures were evaluated for yield performances in a RBD with 3 replications along with three checks (GG 2, JL 24 and SB XI). The check variety GG 2 recorded the highest pod yield among the check varieties, whereas it was SB XI when comparison was done for kernel yield. Out of 65 genotypes tested, nine gave significantly higher

yield over the best check GG 2 for pod yield, and no genotype could surpass the best check SB XI for kernel yield. These nine genotypes will be tested for another two years in advance trials.

5.2 Preliminary Virginia Yield Evaluation Trial (PVYET)

A total of 40 advance Virginia cultures were evaluated for yield performances in a RBD with 3 replications along with 4 checks (GG 20, Kaushal, M 335 and Somnath). In general yield levels achieved in this trial were very low. GG 20 gave the highest pod and kernel yields and no test entry could surpass this check variety. This trial will be repeated as such in next year.

5.3 Spanish Bunch Variety Yield Evaluation Trial (SBVYET)

A total of 27 advance Spanish cultures were evaluated in advance trial in a RBD with 3 replications along with 3 checks. SB XI was adjudged to be the best check both for pod and kernel yields. No test entry surpassed this check both for pod and kernel yields.

Of the 27 entries, 13 advance Spanish cultures were in second year of evaluation. Over two years the pod yield ranged from 992 to 1848 kg/ha among the test entries, the highest being in the advance culture 30012. Among the check varieties, JL 24 registered the highest pod as well as kernel yields. No test entry surpassed this check variety in yield performance.

5.4 Virginia Variety Yield Evaluation Trial (VVYET)

A total of 27 advance Virginia cultures were evaluated along with 3 check varieties. The pod yield ranged from 443 to 1325 kg/ha, the highest being in the test entry ICGV 00394. No test entry surpassed the best check variety; however, ICGV 00394 gave numerically higher yield.

Seventeen advanced breeding lines were in second year of testing. Across two years highest pod yield was registered in the check variety M 335, whereas for kernel yield, GG 20 was the best check. Compared to the best check, 24004 recorded significantly higher pod yield and numerically highest kernel yield across the test entries and checks (Table 3).

Table 3: Top performing Virginia advance breeding lines over two seasons (kharif 2003 and 2004)

S.No.	Genotypes	PY (kg/ha)	KY (kg/ha)
1	24004	1538*	998
2	24040	1337	874
3	13020	1291	975
4	ICGV 00394	1209	791
5	22023	1162	824
6	GG 20	1143	816
7	Kaushal	1148	770
8	M 335	1149	710
9	Somnath	1078	661
	CD (0.05)	286	203

6 Evaluation for WUE and drought tolerance

6.1 Evaluation under simulated drought patterns

During rabi/summer 2004, 48 advance cultures were evaluated along with two checks (ICGS 44 and ICGS 76) in a split plot design with two replications under irrigated condition and three simulated drought patterns *viz.*,, early-season, mid-season and end-season moisture stress.

Observations were recorded on pod and kernel yields on plot basis. Shelling percentage of genotypes was calculated from a random sample of pods drawn in each replication. Analysis of variance revealed significant differences due to genotypes, drought patterns and interaction of drought patterns x genotypes for pod and kernel yield. However, for shelling percent, only variance due to genotypes was significant. When analysis of variance was performed on individual drought pattern basis and mean values were compared, the check variety ICGS 76 was found to be the best check in all the three managed drought patterns.

Genotypes JUN 7, JUN 9 and JUN 37 were found to yield significantly higher over the best check variety ICGS 76 under all the simulated drought patterns (early-, mid- and late-season drought). JUN 8, JUN 37, JUN 38 and JUN 39 were found promising for early as well as for managed late season droughts.

6.2 Evaluation under rain-fed situation

During kharif 2004, the same set of cultures was evaluated under regularly irrigated and rain-fed situations. The yields obtained in all the genotypes were very low. No differences were observed between yields obtained in rain-fed situations compared to the irrigated situations.

7 Evaluation for early maturity

7.1 Evaluation during summer season

During rabi/summer 2004, 18 advanced breeding lines were evaluated for earliness following a novel approach of harvesting at 85, 95 and 105 days after sowing (DAS) and assessing the relative yield reduction due to advance in harvesting. Single row was harvested at 85, 95 and 105 DAS, and observations were recorded on pod and kernel yields, shelling percentage and proportion of mature pods and kernels. Relative yield reduction at 85 and 95 DAS harvest was taken as index of maturity. Reduction in pod yield ranged from 39 to 70% on 85 DAS harvest and -1 to 60% on 95 DAS harvest over the yield obtained on 105 DAS. Similarly, for kernel yield it ranged from 60 to 92% on 85 DAS and 8 to 73% on 95 DAS harvest. The Spanish genotype 21031 was found to mature in 95 days.

7.2 Evaluation during kharif season

The trial was repeated during kharif 2004. Analysis of variance across the stages revealed significant differences due to stages of harvest, genotypes and stages of harvest x genotypes interactions for % mature pods, sound mature kernels, pod and kernel yields. For shelling percent and hundred seed mass significant differences were observed due to stages

of harvest and genotypes. Per cent reduction in pod and kernel yields observed at 85 and 95 DAS over 105 DAS indicated that the genotypes 28008, 11066, 12074 and 11029 resulted in <10% reduction in pod yield at 85 DAS, and 28008, 29063, 30076, 21031, 11066, 11026, 18062 and 12038 resulted in <1% reduction in pod yield at 95 DAS. Similarly for kernel yield, 12074, 11066, 11029 and 18064 resulted in <10% reduction at 85 DAS, and 28008, 29063, 30076, 21031, 11066, HNG 10, 12038 , 11026, 18062, 18029 and 14050 resulted in <1% reduction at 95 DAS.

8 IX International Short-duration Groundnut Varietal Trial - 2001 (IX ISGVT)

IX International Short Duration Groundnut Trial - 2001 comprising 14 test entries was evaluated along with two check varieties (Chico and GG 2) in a triple lattice square design in kharif 2004. The observations were recorded as per the guidelines obtained from ICRISAT, Hyderabad. Comparison of genotypic means showed that the check variety GG 2 was superior for final plant stand, pod yield and kernel yield per hectare, productivity (based on pod yield) per day, shelling outturn and hundred kernel weight; and Chico was superior for proportion of sound mature kernels, days to maturity, days to 75% field emergence, flower initiation and 75% flowering. Both GG2 and Chico gave 52% oil content. When test entries were compared with the best check variety, two test entries ICGV 96390 and ICGV 97245 gave statistically higher per day productivity; and two entries ICGV 96333 and ICGV 97257 were earlier in days to 75% flowering. For rest of the traits studied none of the test entries were found superior over the best check variety.

9 Supply of segregating materials produced in kharif 2004

Information on the availability of segregating materials in different generation was circulated among all the AICRP-G centres. Segregating materials (F_3 - F_6) of 35 crosses attempted for attaining different breeding objectives were supplied to 13 AICRP-G centres (Bhubaneshwar, Kadiri, Udaipur, Latur, Coimbatore, Rahuri, Vriddhachalam, Anand, Jalgaon, Jagtial, Ludhiana, Digraj and Akola).

10 Advance lines under AICRP-G trials

A test entry PBS 24030 has qualified all the stages of testing in Zone I, and has been proposed for identification. Another test entry JUN 21 was tested under drought trials in IVT I in kharif 2004. Four test entries, namely PBS 24004, 12160, 30044 and 30073 have qualified station trials and will be proposed for evaluation under AICRP-G trials.

PROJECT 02: INTEGRATED PEST MANAGEMENT (IPM) IN GROUNDNUT BASED PRODUCTION SYSTEM

(V. NANDAGOPAL, M.P. GHEWANDE, T.V. PRASAD AND VINOD KUMAR)

SUB PROJECT 01: INTEGRATED INSECTS AND NON-INSECT PEST MANAGEMENT IN COMPLEX, DIVERSE AND RISK-PRONE (CDR) GROUNDNUT BASED PRODUCTION SYSTEM

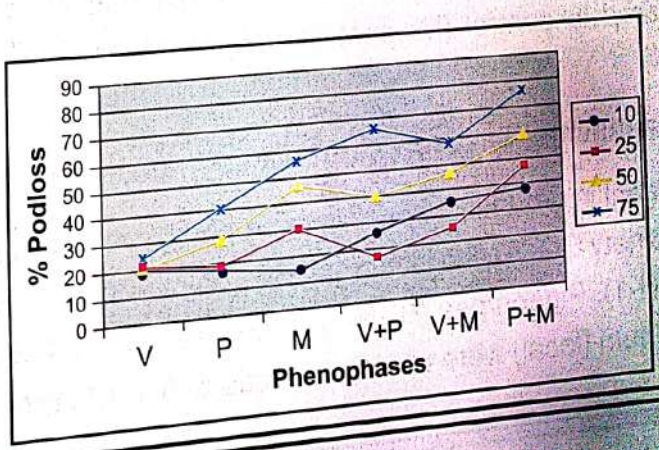
(V. NANDAGOPAL AND T.V. PRASAD)

1 Yield loss in groundnut due to artificial defoliation

A field experiment was conducted during post rainy seasons of 2004 to understand the yield loss mechanism when a definite portion of leaf area is removed, which in turn simulated the damage by insects. Cultivar GG2 was sown in 3 rows of 2m length at 45 cm spacing between rows and 10 cm between plants in a row. There was a gap of 2m all around the plot. The treatments (defoliations) included five levels of defoliations *viz.*,, 0, 10, 25, 50 and 75% at different phenophases of crop such as vegetative, pegging, maturity and their combinations. The defoliation was carried out in such way that 60% of the upper leaves and 40% of the lower leaves were removed representing a particular percentage defoliation. Each treatment was replicated thrice. Oil content was estimated in collaboration with Biochemistry section.

The results indicated that, there was significant increase in yield loss with increase in percentage defoliations in all the stages and in their combinations (Fig.1). The percent loss in pod yield ranged from 21.09 to 25 during vegetative stage, during pegging it was from 17.86 to 40.99, during maturity it was from 15.76 to 56.80, during vegetative + pegging the yield loss ranged form 26.64 to 66.27, during vegetative + maturity it was from 36.22 to 58.33 and during pegging + maturity the loss ranged from 38.49 to 76.98% at 10 and 75% defoliation respectively compared to control. The results indicated that defoliation at any stage of the groundnut crop results in loss in yield. However, there was no significant variation in the oil content with increase in percentage defoliations in all the stages and in their combinations.

Fig. 1. Per cent yield loss in groundnut over control at different phenophases due to artificial defoliation



2 Screening of segregating and stabilized lines of groundnut against major insect pests in collaboration with GRS

2.1 Screening of PBS lines against storage pest, *Caryedon serratus*, under laboratory conditions

Six PBS lines *viz.*,, PBS 30115, 30125, 18006, 30089, 24022 and 30001 were screened under laboratory conditions using cv. GG 20 as check against *Caryedon serratus*. ten pairs of adults of Caryedon serratus were released per treatment. The treatments were replicated thrice. Observation on Oviposition, percentage damage and shelling percentage were recorded.

Results indicated that PBS 18006 has shown moderate resistance (16 mean no. of eggs / 25 pods and 51.2% damaged kernels) against *Caryedon serratus* compared to cv. GG 20 (45 mean no. of eggs / 25 pods and 75.5% damaged kernels) and other cultures tested.

2.2 Screening of PBS lines against jassids under field conditions

Out of 86 genotypes screened for jassids under field conditions during the rainy season of 2004, PBS 29071 and PBS 14010 have shown high level of resistance recording no population compared to other cultures tested with a range of 1 to 15 jassids/5 sweeps.

2.3 Screening against groundnut leaf miner (GLM) under field conditions

In variability museum, out of 45 genotypes screened for groundnut leaf miner (GLM), during kharif 2004 the per cent damage ranged from 3 to 67. The genotypes NRCG 10628, 12698 and 10818 are found to be resistant.

Out of 259 accessions screened in repatriation material for GLM during kharif 2004, lines viz.,, ICG 12367, 12620,12621, 9981, 7846, 15119, 11721, 2462, 3037, 4032, 5403, 9889, 2701, 2748 and 4248 are found to be resistant recording less than 1% damage.

3 Screening of Botanical oils against Caryedon serratus under laboratory conditions

Seven botanical oils (Almond oil, Clove oil, Jasmine oil, Karanj oil, Amla oil, Rose oil and Sandal wood oil) were tested against Caryedon serratus under laboratory conditions by using hexane as solvent. cultivar GG 2 was used as check. The treatments were replicated thrice. Five pairs of adults of Caryedon serratus were released per treatment.

Results indicated that oviposition preference was minimum in Jasmine oil (4 mean no. of eggs/25 pods) compared to control (hexane) (10.33 mean no. of eggs/25 pods) and other botanical oils tested.

4 Integrated Pest Management in groundnut based intercropping system

An IPM experiment in groundnut based inter cropping system was taken up during kharif 2004 with groundnut variety GG-20 and intercrops viz., Bajra (Mh 179), Sorghum (local), Maize (local), Castor (GAUCH-1), Pigeon pea (BDN-2), Cow pea (local), Green gram (local) , Black gram (local) and Sesamum (local) were used in the ratio of 9:1 with three replications. Plot size was 6 x 5 m^2.

The intercrop sesamum found to be good in reducing the jassid population compared to other intercrops (Table 1). The intercrops like green gram and maize also shown promise in reducing the population of jassids. Castor and maize as intercrops increased the thrips population (11 and 11.67%) while black gram and bajra reduced the thrips population (4.67 and 4.35%) at 30 DAS (Table 2).

Table 1. Jassid population in IPM (Kharif 2004)

Treatment	30 DAS	45 DAS	60 DAS	75 DAS	90 DAS
Groundnut + Maize	1.67	3.33	1.33	1.00	2.67
Groundnut + Sesamum	3.67	2.67	0.00	0.67	1.33
Groundnut+Greengram	3.33	3.67	1.00	2.67	3.33
Groundnut alone	3.67	4.00	1.33	4.33	5.00

Table 2. Thrips population per 5 sweeps/5m length row of groundnut in IPM (Kharif 2004)

Treatment	30 DAS	45 DAS	60 DAS	75 DAS	90 DAS
Groundnut + Bajra	4.33	2.33	1.00	1.33	0.33
Groundnut + Maize	11.67	2.33	0.67	1.33	1.33
Groundnut + Castor	11.00	1.00	0.33	2.00	1.33
Groundnut+Black gram	4.67	2.00	2.00	1.33	0.33
Groundnut alone	8.67	1.33	1.33	1.67	1.00

The defoliation in general was very low and there was no significant difference in the damage levels in different inter cropping system on groundnut. In the case of damage to intercrops, the damage was very low in intercrops like pigeon pea and castor. There was very spectacular damage on green gram (12.93%) and black gram (9.58%) after 45 DAS (Table 3).

Table 3. Per cent defoliator damage on intercrops in IPM (Kharif 2004)

Treatment	30 DAS	45 DAS	60 DAS	75 DAS	90 DAS
Groundnut+Castor	0.17	0.45	2.43	0.82	2.17
Groundnut+Cowpea	0.15	6.08	5.93	6.13	4.52
Groundnut + Green gram	0.15	12.93	6.28	2.90	12.70
Groundnut + Black gram	0.53	9.58	6.35	5.87	8.75

Based on the cost of cultivation and the yields of groundnut and the intercrop, the CBR was worked out. Intercropping with castor gave higher CBR (1:3.76) followed by seasmum (1:3.65) and pigeon pea (1:3.60). The yield economics worked out has shown that intercrop with castor gave the highest income of about Rs.39,492 followed by pigeon pea (Rs.37,848) compared to the control which gave Rs. 28,940/ha (Table 4).

Table 4. Groundnut yield (kg/ha) in IPM (Kharif 2004)

Treatments	Pod yield (kg/ha)	Inter crop grain yield	Cost of cultivation/ha	Gross Monitory return/ha	Net return/ CBR
G'nut+Sesamm	1145.67	283.33	9400	34373	1:3.65
G'nut + Castor	1021.11	1192.00	10500	39492	1:3.76
G'nut + Pigeon pea	802.00	1363.00	10500	37848	1:3.60
Groundnut	1446.78	-	8200	28940	1:3.5

Basic cost of cultivation : Rs. 8200/ha

5 Development of sex pheromone based technology as a major component of IPM in groundnut based cropping system

5.1 Development of efficient sex pheromone trap for groundnut leaf miner (GLM)

A completely randomized field experiment with three replications was conducted during Kharif 2004. Five traps *viz.*,, Acrylic sticka trap (small), Acrylic sticka trap (bigger), Plastic tray trap, Wota-T trap (Castor oil) and Wota-T trap (water+ kerosene) were evaluated for efficient trapping of male moths of GLM.

Out of the five different types of traps tried against *A. modicella,* catches of male moths were significantly higher in Wota-T trap than in all other traps. Wota-T trap with castor oil was found superior (196.89 male moths/trap/day) which was at par with Wota-T trap having water and kerosene as trapping material (194.8 males/trap/day). Even the bigger acrylic trap which was found to be superior in the previous trial was found to trap only 66 male moths/day (Fig. 2).

The cost of the Wota-T trap (Fig. 3) used in this trial is about Rs. 39 per trap. There was no significant difference between castor oil and water + kerosene as trapping material in Wota-T trap indicating that these can be efficiently used for trapping of GLM however, castor oil in the Wota-T trap is recommended for ease and economic considerations.

Fig. 2 GLM mean moth catches/ day in different types of traps

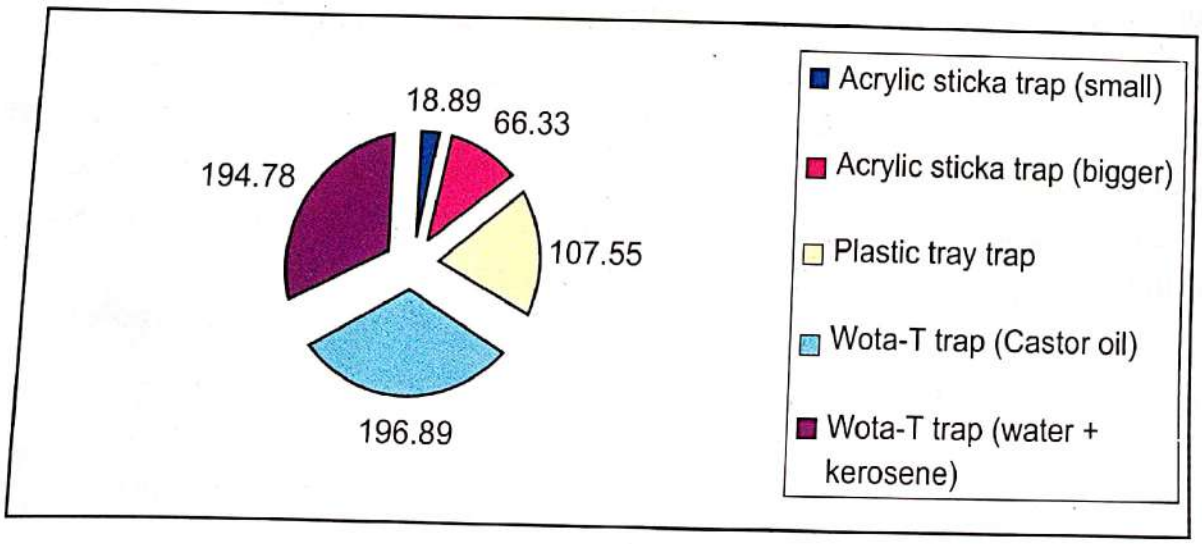
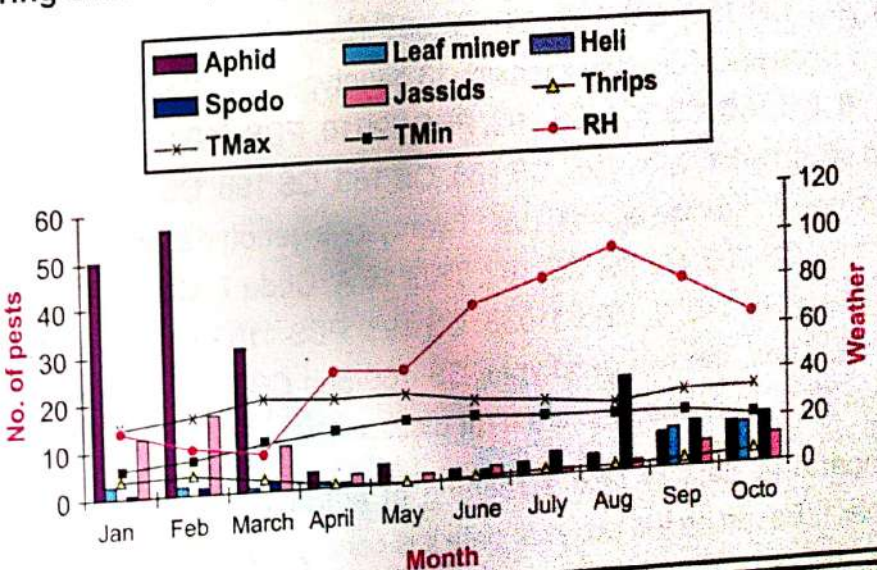


Fig. 3 Wota- T trap

6 Monitoring of the major insect pests of groundnut

In the monitoring programme of the major insect pests of groundnut, *Helicoverpa armigera, Spodoptera litura* and *Aproaerema modicella* were monitored using pheromone traps. Aphids like *A. craccivora* and *Hysteroneura setariae* were monitored using cylindrical sticky trap. The jassids and thrips were monitored using the sweep net in monthly sown crops. The aphid population was highest during January and February and tend to decline from there on. Jassids and thrips population started building up from January and decreased from March onwards. The leaf miners continue to be present in low numbers, probably in the alternate host plants. *Helicoverpa* moth catches were nil, whereas highest *S. litura* moths were recorded in the month of August (Fig.4).

Fig. 4 Monitoring of insect pests of groundnut



Sub project 02: Integrated management of major diseases (ELS, LLS, rust, collar rot, stem rot and PBND) of groundnut

(M. P. GHEWANDE AND VINOD KUMAR)

1 Disease resistance

Sixty-seven genotypes were evaluated against peanut bud necrosis disease vis-a-vis yield of groundnut during summer 2004 under field conditions. The results indicated that the incidence of PBND ranged from1.67 to 17.14%. The minimum incidence of PBND (1.67%) was recorded in the genotypes TIR 42 and TIR 16 with pod yield of 292 g and 290.5 g/per 3m-row, respectively. Other genotypes, which recorded below 5% disease incidence of PBND were OG 52-1, CS 86, CS 168, PBS 14050, PBS 19012, CS 77, Code1-1, PBS 12160, ICR 10, ALR 2 and CS 160 as against 17.14% incidence in Code 5-3 with pod yield of 235 g/3m-row. The genotype PBS 11042 recorded the highest yield (306.5g/3m row) followed by CS 24 (294.5g/3 m row) and TIR 42 (292g / 3m row).

Eighteen genotypes were evaluated against stem rot (*S. rolfsii*) in concrete block in artificially inoculated condition during the summer season of 2004. Out of which four genotypes *viz.*,, Code 1-1, PBS 11067, CS 115 and DH 8 were found to be highly resistant recording less than 10% disease incidence and five genotypes *viz.*, CS 151, Code-1, CS 13 and CS 19 were resistant recording below 20% disease incidence.

A total of 372 genotypes (second year screening of 180 genotypes and preliminary screening of 192 genotypes) along with susceptible checks (GG 2 and GG 20) were evaluated against ELS, LLS, rust and stem rot diseases under field condition during the rainy season of 2004. In case of stem rot, each genotype was artificially inoculated with *Sclerotium rolfsii* pathogen at 30 days latter emergence. Observations on foliar fungal diseases were recorded by adopting a 1-9 modified scale, while in case of stem rot, the percentage of incidence was recorded before and after harvest.

Second year screening of the promising genotypes (180) in kharif 2004 revealed that four genotypes *viz.*, CS-168, CS 160, CS 72 and Kadiri 3, showed promise against ELS recording below 3.5 grades of disease intensity, 13 genotypes *viz.*, CS 185, CS 168, CS 153, CS 74, CS 75, CS 198, CS 160, CS 207, CS 192, PBS 29010, PBS 11038, PBS 12169 and Kadiri 3 against LLS and seven genotypes viz.,, CS 185, CS 168, CS 198, CS 159, CS 160, PBS 30159 and PBS 12169 showed promise against rust. Twenty-one genotypes *viz.*, CS 168, CS 200, CS 20, CS 204, CS 110, CS 209, CS 35, CS 102, TKG 19 A, Code 7, CS 25, CS 159, CS 160, CS 201, CS 88, CS 116, PBS 11072, PBS 11038, CS 193, PBS 11029, DH 8 recorded below 20% stem rot incidence. Thus, the two genotypes CS 160 and CS 168, possess multiple disease resistance against ELS, LLS, rust and stem rot diseases.

The comparative data of field screening of genotypes of kharif 2003 and 2004 is presented in Table 1. Based on the two year data it is concluded that the genotypes CS 168, CS

86, PBS 29058, CS 19 and CS 160 possess resistance against ELS, the genotypes CS 168, CS 185 and PBS 12169 against LLS, and the genotypes CS 168, CS 151, CS 25, CS 19 and CS 157 against stem rot. The genotype CS 168 possesses multiple disease resistance.

A total of 192 new genotypes were also screened for multiple disease resistance in the first year under field condition. No genotype was found resistant against ELS. The results showed that nine genotypes *viz.*, CS 66, CS 70, CS 76, CS 85, ICR 12, CS 124, CS 222, CS 233 and PBS 2500 recorded 4.0 or below grade of LLS indicating resistance against LLS. Four genotypes *viz.*, CS 85, ICR 12, CS 222 and CS 233 showed promise against rust. The incidence of stem rot ranged from 1.72 to 83.04%. Nineteen genotypes *viz.*, ICR 12, CS 106, CS 124, CS 156, CS 189, CS 221, CS 224, CS 251, CS 254, CS 260, CS 79, CS 245, JAL 03, JAL 36, JUG 27, PBS 18045, PBS 11070, PBS 15015 and PBS 30061 recorded below 10% stem rot incidence. Hence, the genotype ICR 12 possessed multiple disease resistance against LLS, rust and stem rot diseases.

Twenty groundnut genotypes were evaluated against leaf spots, rust, stem rot and pod rots in concrete block conditions during the rainy season of 2004. Two genotypes *viz.*, CS 19 and PBS 29017 showed resistance to early leaf spot. No valid conclusion could be drawn with regard to stem rot as disease incidence in susceptible check was low.

Twenty new genotypes including susceptible check (GG 20) were evaluated for the first year against stem rot in concrete block conditions during rainy season of 2004. Artificial inoculation was done for S. rolfsii after 30 days of sowing. Out of twenty genotypes, the genotype PBS 29080 showed promise against rust and PBS 21031 against stem and pod rot. The results need confirmation during kharif 2005.

Also, a total of 98 genotypes including susceptible (GG 2) and resistant check (J11) were evaluated against collar rot pathogen (*Aspergillus niger*) under laboratory condition by adopting dry seed resistance technique. Seventeen genotypes *viz.*, JAL 05, CS 65, CS 81, CS 76, CS 245, CS 64, CS 78, CS 140, CS 79, CS 104, CS 85, CS 101, CS 149, CS 113, CS 164 and CS 188 showed resistant reaction against *A. niger*.

2 Evaluation of *Trichoderma* spp. for bio-control efficacy against collar rot and stem rot diseases under laboratory condition

Antagonistic activity of 20 isolates of *Trichoderma* belonging to eight species were studied under in vitro conditions (dual culture) against collar rot (*Aspergillus niger*) and stem rot (*Sclerotium rolfsii*) pathogens of groundnut. Out of these isolates, five *viz.*, T 170, T 28, T 126, T 00 and T 04 showing promising antagonistic ability in dual culture were further tested under concrete block conditions during kharif 2004. *Trichoderma* spp. and the pathogens were multiplied on Sorghum grain medium for 10 days and thereafter were crushed in a grinder, serial dilution was made and the spore count/CFU in the inoculums were worked out. Both the pathogens and *Trichoderma* spp. were mixed in the top 5cm soil @ 1x 10^5 CFU/g soil. The cultivar used in the experiment was GG 2. All the isolates significantly reduced collar rot and

stem rot incidence. The minimum incidence of collar rot (27.15%) and stem rot (10.83%) as compared to control (64.63% and 32.45%, respectively) was observed with the isolate T 170 belonging to *T. harzianum.*

3 Biological control of major fungal foliar and soil borne diseases under field condition

A field experiment was conducted during kharif 2004 to see the effect of seed treatment and soil application of *Trichoderma harzianum* and culture filtrate of *Verticillium lecanii* on soil borne and foliar fungal diseases of groundnut. There was reduction in the disease intensity of early leaf spot, late leaf spot and rust by the treatments (Table 2). The maximum reduction of ELS, LLS and rust was recorded by seed treatment with *Trichoderma harzianum* @ 4g/kg seed and foliar application of culture filtrate of *V. lecanii* at 50% dilution on the first appearance of the leaf spots followed by two spray at 15 days interval. Interestingly, soil application of commercial formulation of *Trichoderma harzianum* (2.5 kg/ha) mixed with castor cake (500 kg/ha) as carrier and applied in furrow at the time of sowing reduced ELS and rust significantly. This may be due to growth promoting activity of *Trichoderma* enabling the plants to defend them better against the leaf spots and rust. The incidence of both collar rot and stem rot was low (< 10%) even in the control. The collar rot was reduced marginally by all the treatments but it was statistically insignificant. The stem rot incidence was reduced significantly by seed treatment with *T. harzianum* alone as well as in combination with soil application of *T. harzianum* (2.5 kg/ha) mixed with castor cake and applied in furrow at the time of sowing.

4 Management of collar rot (*Aspergillus niger*) and stem rot (*Sclerotium rolfsii*) pathogens through organic soil amendment

A field trial in a RBD with three replications and a susceptible variety GG 20, was conducted during the rainy season of 2004 to study the effect of soil application of fresh leaves of karanj (*Pongamia pinnata*), neem (*Azadirachta indica*) and wild Sorghum (*Sorghum halopens*) @ 100, 250 and 500 kg/ha each in furrow at the time of sowing for the management of stem rot. Also, the effect of application of elemental sulphur @ 20 kg/ha was studied for the management of stem rot.

Results indicated that the incidence of stem rot and pod yield varied significantly among treatments. The incidence of collar rot ranged from 8.82 to 21.58%. The lowest incidence of collar rot (8.82%) was recorded in the treatment of soil application of fresh leaves of wild Sorghum @ 250 kg/ha followed by wild Sorghum @ 500 kg/ha (8.89%) and soil application of karanj leaves @ 500 kg/ha (9.14%) as against 21.58% incidence in control.

The incidence of stem rot ranged from 1.73 to 6.63%. Though there was significant reduction in the disease incidence of stem rot in all the treatments, valid conclusion could not be drawn due to low incidence level in control. The incidence of pod rot varied between 29.33 to 36.33%. The reduction in pod rot due to various treatments was found insignificant. However based on the results it can be concluded that soil application of either fresh leaves of karanj or neem leaves or wild Sorghum @ 250 kg/ha is equally good and should be applied in furrow at the time of sowing for the management of collar rot and stem rot.

5 Integrated disease management

A field trial in a RBD with three replications and seven treatments was conducted during kharif 2004. Observations on major fungal diseases viz., ELS, LLS, rust, stem rot and pod rot were recorded. The results (Table 3) indicated that three foliar sprays of fungicide mixture (Carbendazim 0.05% + Mancozeb 0.2%) at 45, 55 and 75 DAS reduced the intensity of ELS by 36.7%, LLS by 34.2% and rust by 21.0% over the control. However, maximum reduction of 40.13% (lowest incidence) in collar rot was realized in seed treatment with *T. harzianum* @ 4 g/kg seed+ soil application of castor cake @ 500 kg/ha+ foliar application of aqueous NSK extract @ 5% at 70 DAS over control. Lowest incidence (4.0%) of stem rot was observed in seed treatment with *T. harzianum* @ 4 g/kg seed + soil application of castor cake @ 500 kg/ha + groundnut intercropped with pearl millet at 3:1 ratio compared to 14.01% in control.

6 Role of soil and water salinity in inducing resistance to major foliar fungal diseases

A pot culture experiment was conducted in rainy season of 2004 to study the effect of salinity on development and severity of foliar fungal diseases. The salinity in experimental pots was developed as a result of saline water irrigation. The electrical conductivity of saturation extract (ECe) of soil (0-15 cm depth) of the experimental pots was taken at the time of harvesting. Four levels of ECiw (Electrical conductivity of irrigation water), namely 0.5 (control), 2.0, 4.0, and 6.0 dS/m and four varieties (GG 2, GG 7, J 11 and JL 24) were tested. The plants were artificially inoculated to bring the infection early in the season for all the pathogens. The severity of early leaf spot, late leaf spot and rust was recorded after 90 days of sowing on a 1- 9 point modified scale. The results (Fig. 1) showed that the level of salinity significantly influenced severity of foliar diseases in all the varieties. In the variety GG 7, the early leaf spot was reduced significantly at salinity level, ECiw 2.0 and ECiw 6.0 over control (ECiw 0.5). Similar was the case with the variety J 11. But in the two varieties *viz.*, GG 2 and JL 24 the reduction in severity was statistically non-significant. The severity of late leaf spot was found highest in the control and as the salinity increased the severity significantly reduced in all the varieties. In case of rust, also the disease severity reduced significantly as the salinity level increased except the variety J 11, where the reduction in disease severity was non-significant.

Table 1 Promising genotypes against leaf spots and stem rot under field conditions during kharif 2003 and 2004

Disease	Genotype	Kharif 2003	Kharif 2004	Pooled
Early leaf spot	CS 86	3.67	*	3.67
	PBS 29058	3.83	3.83	3.83
	CS 19	3.83	3.83	3.83
	CS 168	5.00	3.00	4.00
	CS 160	4.67	3.33	4.00
	CS 72	5.17	3.17	4.17
	GG 20*	6.17	6.17	6.17
	GG 2*	6.33	7.33	6.83

Late leaf spot	CS 185	2.00	2.67	2.33
	CS 168	2.67	2.17	2.42
	PBS 12169	2.67	3.33	3.00
	GG 20*	6.67	5.67	6.17
	GG 2*	6.83	6.67	6.75
Stem rot	CS 168	4.17	18.93	11.55
	CS 151	6.94	27.88	17.41
	CS 25	7.69	15.26	11.47
	CS 19	8.12	19.17	13.64
	CS 157	9.09	27.88	18.48
	GG 20*	28.53	33.69	31.11
	GG 2*	58.53	32.09	45.31
	GG 7*	35.23	90.00	62.61

* Susceptible Check

Table 2 Biological control of soil borne and foliar fungal diseases of groundnut during kharif 2004

Treatment	Disease score (1-9) scale			Collar	Stem
	ELS	LLS	Rust	Rot %	Rot%
T1	6.22	7.11	5.44	6.94 (9.1)	3.62 (6.53)
T 2	5.89	6.78	4.67	7.50 (9.41)	3.37 (6.08)
T 3	6.22	7.11	6.13	7.82 (9.71)	4.79 (6.84)
T 4	6.22	6.22	5.33	7.72 (9.66)	2.70 (5.60)
T 5	5.78	5.89	4.78	7.23 (9.21)	5.42 (7.50)
T 6	6.67	6.44	4.56	6.33 (8.71)	3.90 (6.77)
T 7	7.11	7.11	6.11	7.84 (9.75)	6.21 (8.11)
C.D (5%)	1.17	1.07	1.26	1.29	0.71
C.V. %	10.31	9.20	13.44	13.71	32.42

T1 : Seed treatment with *Trichoderma harzianum* @ 4g/kg seed

T 2 : Soil application of Trichoderma spp. (2.5 Kg/ha) mixed with castor cake as carrier @500 kg/ha

T 3 : Foliar application of C.F. of *V. lecanii* at 50% dilution (1st spray-on appearance of leaf spots, 2nd -15 Days after 1st spray, 3rd -15 Days after 2nd spray)

T 4 : T1+ T2

T 5 : T1+ T3

T 6 : T2 + Two foliar spray of C.F. of *V. lecanii* (1st spray-on appearance of the disease and 2 spray 65 DAS)

T7 Control

Table 3. Integrated disease management of groundnut during Kharif 2004

Treatment	Disease score (1-9) scale			Collar Rot %	Stem Rot%	Pod Rot%
	ELS	LLS	Rust			
T1	6.33	7.67	6.56	8.72 (10.25)	4.23 (7.02)	18.67 (15.02)
T 2	5.89	7.33	6.89	9.47 (10.68)	4.00 (6.91)	26.00 (18.38)
T 3	6.56	7.78	6.56	6.65 (8.86)	7.25 (9.01)	21.33 (16.48)
T 4	5.33	7.11	6.22	7.25 (9.37)	4.62 (7.04)	23.33 (17.27)
T 5	4.22	5.33	5.44	15.21 (13.76)	7.45 (9.20)	21.33 (16.35)
T 6	6.56	7.22	6.22	13.99 (13.58)	5.01 (7.43)	23.33 (17.28)
T 7	6.67	8.11	6.89	17.43 (14.80)	14.01 (13.59)	34.00 (21.38)
C.D (5 %)	1.12	0.57	0.85	3.83	1.29	8.05
C.V. (%)	10.40	4.45	7.50	11.17	34.00	15.49

T1 : Seed treatment with *Trichoderma harzianum* @ 4g/kg seed+Soil application of castor cake @ 500 kg/ha

T2 : T1+ Bajra as intercrop (1:3)

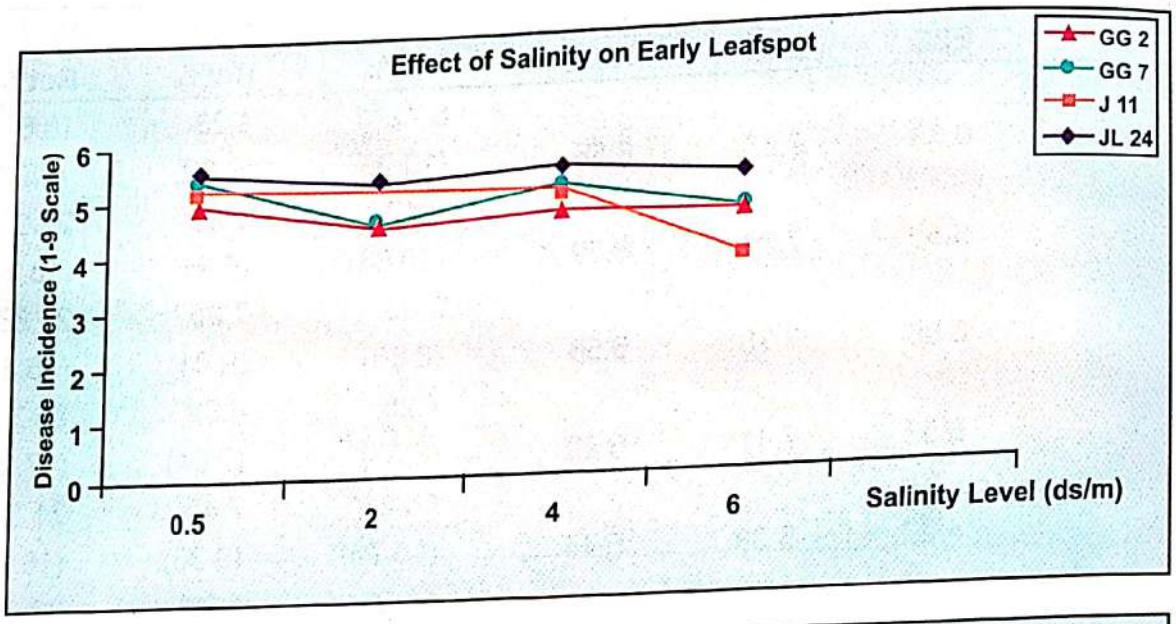
T3 : T1 + Foliar application of aqueous NSK extract @ 5% at 70DAS

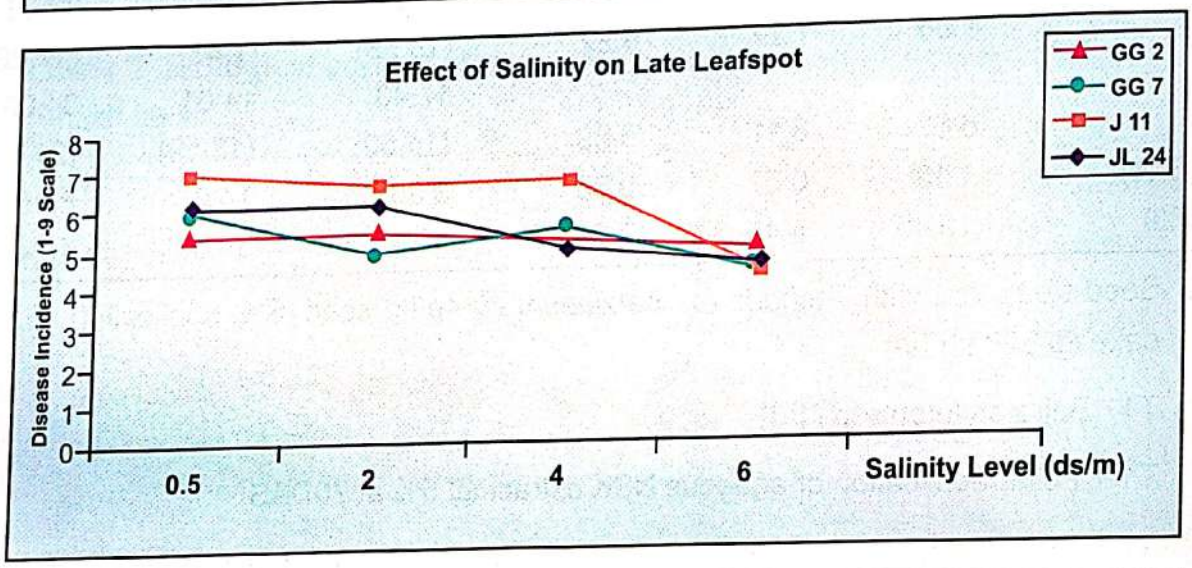
T4 : T3+ Foliar spray of fungicide mixture (Carbendazim (0.05%)+ Mancozeb (0.2%)) at 70 DAS

T5 : Foliar spray of fungicide mixture at 45, 55 and 75 DAS

T6 : Soil application of elemental sulphur @ 20 kg/ha at the time of sowing

T7 : Control





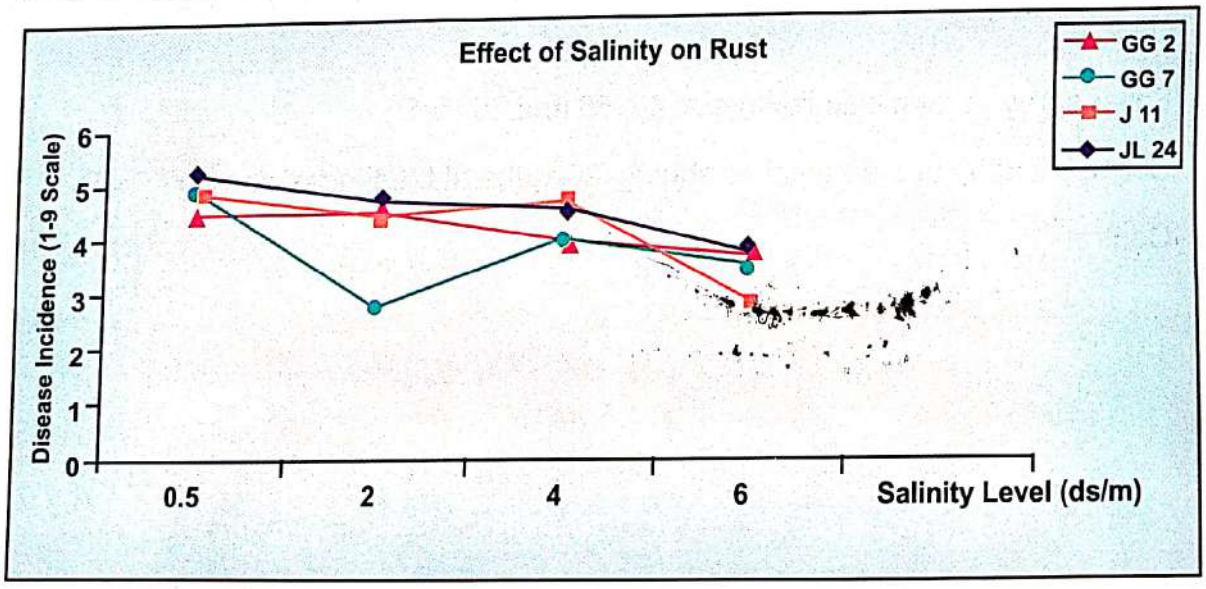


Fig.1 Effect of salinity on the severity of major foliar diseases of groundnut

PROJECT 03: PHYSIOLOGICAL STUDIES IN RELATION TO ENVIRONMENTAL STRESSES IN GROUNDNUT

(P. C. NAUTIYAL, J. B. MISRA AND RADHAKRISHNAN, T.)

1 Selection, multiplication and popularization of high WUE advanced breeding lines

Breeding for sustainable high crop productivity under the rain-dependent cropping system requires physiologically as well as morphologically efficient cultivars. The Centres has already taken a lead in developing high WUE lines based on specific leaf area (SLA) and harvest index (HI) in collaboration with the ICRISAT and ACIAR, Australia. One hundred eighty-one advanced breeding lines, identified on the basis of the equation *i.e.* pod yield = TE x T x HI, and eight parents were multiplied and studied for WUE patterns. Drought tolerant and high WUE lines will be identified for cultivation by the farmers in rain-dependent cropping system, keeping in view, the farmer's participatory mode and farmers preferred cultivars of high WUE.

2 Characterization of wild *Arachis* species for thermotolerance

Forty-one wild *Arachis* species were characterized for tolerance of both high and low temperature. Wild *A. glabrata* accession number 11824 was found tolerant of high temperature, while *A. glabrata,* accession number 11813 for low temperature. In general, the wild *Arachis* species were more thermo-tolerant than the cultivars. In addition, the RI values were found to be positively correlated with the SLA *i.e.* the thicker the leaf the lower the injury. Leaf cuticular wax content has been reported to be of the eco-physiological significance and there was an increase in the epicuticular wax contents in groundnut under the drought like situation. This may help plant to avoid the extra heat load by increased reflectance due to wax and water loss due to cuticular transpiration. In wild *Arachis* species genetic variations in epicuticular wax load seems to have significant role to play. Such role could be movements of water between two compartments and to protect the surface from the physical and chemical effects from its surroundings. In the earlier case temperature is the predominant physical factor influencing the performance of epicuticular wax layer. Thus the leaf temperatures may vary, depending on air temperature, irradiance and transpiration. At the molecular level also the SDS-PAGE of proteins varied in the leaf samples of the wild *Arachis* species varying in SLA, leaf epicuticular wax load and LCMT. Looking into the morphological, physiological, and molecular variations among the wild *Arachis* species and their accessions it is possible to study the genetic map for high temperature tolerance following the quantitative trait loci (QTL) analysis. This may lead to the identification of the specific proteins associated with high temperature tolerance. Such molecular marker maps for heat tolerance exist for many crops. Thus the genetic mapping of the potential physiological and biochemical components of a trait not only provides information on their environment and that trait but also a new way of elucidating the mechanism of plant response to temperature stress. There could be many regions, which require multiple resistant

cultivars for increasing the productivity of the rain-dependent cultivation of groundnut mainly i the semi-arid tropics, precisely. Thus there is possibility to improve thermo tolerance of th cultivated groundnut by making crosses between cross compatible cultivated and wild *Arachi* species.

3 Studies on water-deficit stress induced high temperature tolerance

Groundnut in India is cultivated mostly in the rain-dependent system and is prone t drought of various intensities and duration. A field trial was conducted to find out the rise in so and plant temperatures under simulated drought situations. Both the soil and leaf temperature increased up by 2-3°C due to drought as compared to the plants grown under protecte irrigation conditions (Fig. 1). Among the fifty germplasm accession genetic variability in the canop temperature, SLA, relative water content (RWC), total biomass and pod yield at the final harves was observed. Genotypic variation in in situ pollen germination under limited moisture supply as well as at high temperature in the incubator was also observed, though the study was initiated with the limited number of cultivars. Effect of soil-moisture deficit (a short drought spell) affected the leaf development rate adversely under rain-dependent condition. However, in case of groundnut the leaf expansion rate was found to be most sensitive process than any other physiological process under drought like situations or the limited water supply.

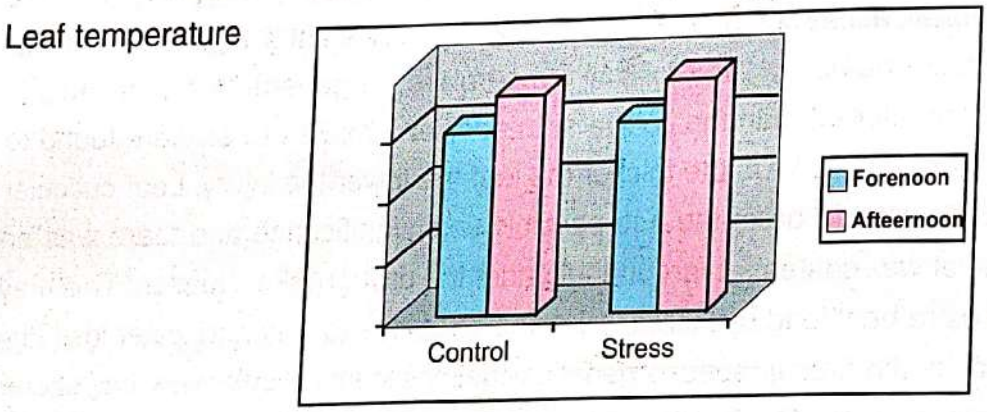


Fig. 1. Leaf temperatures under irrigated (control) and simulated drought conditions during flowering phase in groundnut.

4 Early seedling vigour: A requirement of stressed environments

In many crop plants the early seedling vigour is related with higher biomass product and at times with productivity under water limited environment. Seedling vigour of ground cultivars *viz.*, HNG 10, GG 20, GG 2, TAG 24, Chico, JL 24, Girnar 1, CSMG 84-1, GAUG 10, a ICGS 44 was studied in pot culture experiments. In 30-day old seedlings genotypic variation SLA, hypocotyl dry weight, root dry weight; cotyledon dry weight (at 15 days after emergenc shoot dry weight and total biomass production both in kharif and summer season we observed. In general, low SLA was found associated with total seedling dry matter product and the SLA was lower in Virginia than that of Spanish types. The weight of the cotyledo (15 days after sowing) seemed to be an important criterion for determining the seedling vigo

(Fig. 2). For example, in case of Girnar 1 the initial seedling vigour measured in terms of total dry matter production was lower than that of CSMG 84-1, and the cotyledon dry weight was also lower in Girnar 1 than that of CSMG 84-1. Thus such variations in early seedling vigour in groundnut can be utilized for increasing productivity under water-deficit environment.

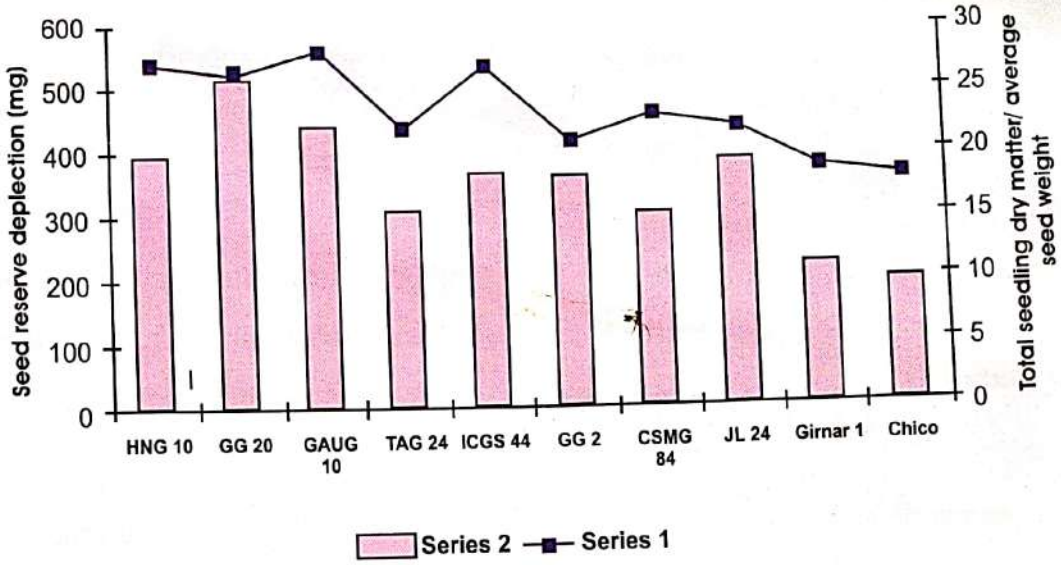


Fig. 2. Total seed reserve depletion (series 2) and seedling vigour in terms of the ratio of dry matter production and average seed weight of ten cultivars used in this study (series 1) of ten groundnut cultivars belonging to Spanish and Virginia groups.

5 Genetic variations in root system

In the literature it is clear that the species which demonstrated the most drought tolerance had the most deeply penetrating root system, in addition the genetic variation in root system also is evident. In groundnut cultivars *viz.*, ICGS 44, ICGV 86031, GG 2, TAG 24, TG 32, TAG 24, ICGS 11, Gangapuri, JL 24, Girnar 1 and Chico, genetic variation for root growth and architecture were quite distinct under normal and water-deficit stress, in root-block studies. Among the cultivars studied, it was confirmed that water use efficient genotypes such as ICGS 44 utilized the available water in the deeper soil layers by showing the highest root numbers in the lower most soil layer *i.e.*, 30 cm or beyond. On the other hand the most drought susceptible cultivar JL 24 showed the least root growth in the deeper soil layers. Under stress conditions root growth was hampered both in terms of root, shoot ratio, and number of roots in different soil layers. The root volume length ratio, and root, shoot ratio also changed significantly under the water-deficit conditions. In many crop plants genetic variations are reported for drought, salt, acid soil resistance, or nutrient acquisition have been reported. There are many success stories in detecting genetic differences in root architect, morphology, and physiology but much of this natural variation appears to be multi- or polygenic in character. Extensive breeding efforts would, therefore, be required to move the desired morphological characters from the source germplasm to agronomically desired breeding line.

PROJECT 04 :INTEGRATED NUTRIENT MANAGEMENT IN GROUNDNUT

(K. K. PAL, A. L. SINGH AND R. DEY)

SUB PROJECT 01: DEVELOPMENT OF BIOFERTILIZER PACKAGES FOR GROUNDNUT

(K. K. PAL AND R. DEY)

1 Plant Growth Promoting Rhizobacteria (PGPR)

1.1 Effect of consortia of PGPR on the growth, yield and nutrient uptake of groundnut

Consortium of compatible and competent strains of plant growth promoting rhizobacteria may contribute significantly in enhancing the growth parameters by expressing beneficial traits. Thus, two consortia *viz.*, consortium A (mixture of four non-fluorescent pseudomonads) and consortium B (mixture of four fluorescent pseudomonads) comprising compatible strains of PGPR were developed and evaluated for their efficiency in enhancing the growth and yield of groundnut during kharif, 2004.

With JL 24

The consortia of compatible PGPR cultures were tested to study th inoculation effects on the growth, yield and nutrient uptake of groundnut, cultivar JL24. Seed bacterization with PGPR consortia resulted in significant enhancement in shelling perantege, shoot length, dry shoot mass, root mass and nodule mass. Inoculation with consortium A (consortia of non-fluorescent pseudomonads) had better effects on the plant growth and yield as compared to cosortium B (consortium comprising four fluorescent pseudomonads). Seed bacterization with consortium A resulted in 18% higher pod yield as compared to consortium B (Table 1).

With GG 2

Seed bacterization with PGPR consortia resulted in increase in growth and yield of groundnut cultivar GG2. Seed inoculation with both consortium A and B resulted in significant increase in shoot length, nodule number and dry mass, root length, shoot and root dry mass, plant and kernel phosphorus. While inoculation with consortium A resulted in increase in pod yield (16%), inoculation with consortium B resulted in yield at par with control (Table 1). Inoculation with consortium A also resulted in significant increase in haulm yield and HKW.

1.2 Effect of PGPR on the growth, yield and nutrient uptake of bold seeded groundnut

The effect of PGPR on the growth, yield and nutrient uptake of bold seeded groundnut was studied during the kharif season of 2004. A total of five bold seeded groundnut varieties were taken to study the inoculation effects of three PGPR cultures, namely PGPR1, PGPR2 and PGPR4. In general, inoculation with PGPR cultures resulted in significant increase in root length,

shoot length, nodule number and mass, haulm yield, shelling percentage, hundred kernel mass and P content in plant and seed (Table 2). However, significant enhancement in pod yield was obtained only with PGPR4 (9.3%) and PGPR1, both at par with each other.

The five bold seeded varieties differed with each other significantly with respect to the parameters tested. The maximum pod yield was obtained with variety M 13 followed by B 95. The cultivars *viz.*, Somnath, BAU 13 and TKG 19A yielded at par. The maximum shelling percentage was obtained in cultivar TKG 19A. The cultivar Somnath gave the highest HKW and SMK.

The best culture x variety combination was PGPR4 x M 13, which resulted in significantly higher pod yield as compared to other combinations. The best culture x variety combination, which resulted in highest oil content was PGPR2 x B95.

1.3 Effect of deficient and overproducing mutants of *Pseudomonas fluorescens* S1(6) (PGPR2) on the growth and yield of groundnut

The effect of deficient, overproducing and isogenic mutants of *P. fluorescens* S1(6) on the growth and yield of groundnut was studied in a pot trial undertaken with groundnut cultivar GG 2. Seed inoculation with M 56 (mutant with more phosphate solubilization than wild type) resulted in the highest pod yield, significantly higher than the wild type and uninoculated control. The population dynamics of these mutant strains were studied in the rhizosphere and rhizoplane of groundnut. In general, population was more in rhizoplane compared to rhizosphere.

1.4 Compatibility testing of representative groups of microorganisms (PSM, PGPR and rhizobia) for identifying suitable combinations by pot and field evaluation

Pair-wise testing of PGPR, PSM and rhizobia resulted into identification of several compatible groups. A total of 7 consortia were tested in a pot trial, to study their inoculation effects on growth and yield of groundnut. Inoculation of majority of the consortia resulted in beneficial effects on plant growth. However, inoculation of only two consortia, consortium 6 (combination of PSM and Rhizobium cultures: consortium BC) and consortium 4 (combination of PGPR and PSM cultures) resulted in significant increase in pod yield of groundnut. In another set of seven consortia tested in pots, the best consortium was consortium 13 (PGPR + rhizobia), followed by 14 (PSM + rhizobia).

A selected number of the promising consortia were also tested in a field trial. The best was consortium 6 (combination of PSM and Rhizobium cultures: consortium BC), as found in pot trial, in terms of pod yield (Table 3).

1.5 Evaluation of PGPR on the growth, yield and nutrient of irrigated groundnut cultivar TG 26

The effect of seed inoculation of groundnut with PGPR cultures was tested in a field trial during the rabi-summer season of 2004 using TG 26 cultivar. Inoculation with Pseudomonas fluorescens PGPR1, Pseudomonas fluorescens PGPR2, Pseudomonas fluorescens PGPR4

and consortia of the PGPR cultures enhanced the growth, yield and nutrient uptake of groundnut, cultivar TG 26 under irrigated conditions (Table 4). The inoculation enhanced the nodulation, plant biomass, plant height etc., over uninoculated control significantly.

1.6 Effect of competitive strains of groundnut-rhizobia on the growth and yield of groundnut

Two newly identified strains of groundnut-rhizobia *viz.*, NRCG4 and NRCG9 were evaluated for nodulation and growth parameters of groundnut cultivar GG 2 under field conditions during rabi/summer of 2004 along with NC92, IGR6 and IGR40. NRCG4 and NC92 performed at par and enhanced the growth, nodulation and yield parameters significantly over control and other strains used.

Table 1. Effect of PGPR consortia on the growth, yield and nutrient uptake of groundnut cultivars, GG2 and JL 24

Treatment	GG 2		JL 24	
	Pod yield (kg/ha)	Haulm yield (kg/ha)	Pod yield (kg/ha)	Haulm yield (kg/ha)
Consortium A	1331	2600	1240	2938
Consortium B	1156	2397	1046	2513
Control	1146	2403	1043	2530

Table 2. Effect of PGPR on the growth, yield and nutrient uptake of bold seeded groundnut during kharif, 2004

Treatment	Pod yield (kg/ha)	Haulm yield (kg/ha)	Oil (%)	Nodule number at 45 DAS / plant
A. Culture				
PGPR1	2330	5873	52.70	57.5
PGPR2	2206	6091	52.60	57.0
PGPR4	2345	5837	52.43	54.3
Control	2148	5358	51.70	45.6
B. Variety				
M 13	2541	5963	51.46	50.2
Somnath	2142	5746	53.08	52.1
B 95	2286	5995	52.92	52.9
BAU 13	2145	5892	52.08	57.6
TKG 19A	2175	5353	52.25	55.2

Table 3. Effect of consortia of PGPR, PSM and rhizobia on the growth, yield and nutrien uptake of groundnut, cultivar GG 2 during kharif 2004

Treatment	Pod yield (kg/ha)	Haulm yield (kg/ha)	Nodule number at 45 DAS
Con A	1686	3275	43.5
Con B	1608	3647	42.0
Con C	1672	4060	48.5
Con AB	1661	3800	39.7
Con AC	1509	3685	56.0
Con BC	1975	3807	58.5
Con ABC	1631	3297	53.7
Control	1447	3245	32.2

Table 4. Effect of PGPR on the growth, yield and nutrient uptake of groundnut cultivar TG 26 under irrigated condition during rabi summer 2004

Treatment	Pod yield (kg/ha)	Haulm yield (kg/ha)
PGPR1	1941	2621
PGPR2	1894	2449
PGPR4	1956	2414
Consortium A	1599	2104
Consortium B	1711	2216
Consortium C	1883	2430
Control	1580	2095

Sub project 02: Mineral nutrient requirement and their disorders in groundnut

(A. L. Singh)

1 Ca and P nutrition of groundnut with various pod and seed-sizes

After getting the response of P and Ca in relation to pod and seed sizes in pot experiment, a field experiment was conducted further to confirm the effect of Ca and P to find out the role of these nutrients. A total of 36 groundnut genotypes with varying pod structure and sizes (length 1.64-4.7 cm, width 0.74-1.68 cm) and seed sizes (length 0.5-1.8 cm, width 0.03-0.97 cm) were grown under 0, P50 and Ca100 and observations on yields and other attributes were recorded.

In general, application of P and Ca, increased of pods, pegs, pod and haulm yield, total biomass, increased both length and width of the pod and seed due to proper nutrition of the same in all sizes of groundnut genotypes. However, it was not true with all the genotypes as there were few genotypes, which did not respond to these elements. The response of P and Ca, however, was more pronounced in the groundnut with bigger pod and seed size than the one with smaller pod and seed due to more surface area available for nutrient absorption by pods in the soil. The study further reveals that large seeded groundnuts showed different behavior of

nutrition than the small seeded. The size of pod and seed inside it and the surface area of the pod were the key factor for pod and seed nutrition.

The pod yield of various genotypes ranged from 2.1-14.5 g pod/plant. High yielding genotypes were of medium and large pod and seed size and the low yielding genotypes were of small pod and seed size. The large pod and seed size genotypes did not show their full potential probably due to not getting proper nutrition and showed their yield at par with medium sized pod and seed.

The groundnut genotypes having slight to moderate reticulation showed highest pod and seed yield, however, the poor yielder showed no reticulation. The shelling percentage of small size groundnut genotypes did not increase with the application of P and Ca, the medium size seed showed slight increases in shelling percentage. However, the large seeded genotypes showed significant increase in shelling percent due to P and Ca application.

The small sized genotypes showed lesser P content in their kernel and shell as compared to medium and large sized genotypes, on the other hand the large sized genotypes, which require more P showed high concentration of P in their kernel and shell.

The application of Ca increased the concentration of Ca in kernel and shell of groundnut genotypes with more pronounced effect in large seeded genotypes. The high yielding genotypes showed more uptake of Ca by kernel and shell. The Zn concentration of groundnut genotypes was more in medium size genotypes and least in large sized genotypes indicating that the Zn requirement of large sized genotypes was not met properly.

It was therefore, concluded that pod morphology particularly size and reticulation played important role in the pod nutrition of groundnut. Further the P and Ca are important nutrients for proper pod filling in large-seeded groundnut genotypes and their application is essential for maintaining the proper seed and pod size for the production of export quality produce.

2 Studies on various Calcium sources in groundnut

A field experiment was conducted to evaluate the various sources of Ca and other amendments [(CaCl2, Gypsum, Lime, Ties (Murram), H2SO4 (0.5% along with irrigation), FYM, Organic matter, Calcium ammonium nitrate)] for Ca nutrition of groundnut, taking GG 20 groundnut variety, and to find out the cheap sources of Ca. The results revealed that maximum pod yield of 1699 kg/ha was obtained with the application of Calcium chloride as against 1168 kg/ha in control. The responses of gypsum, CAN, lime and ties were at par and out of these, ties and lime were the cheaper sources.

These Ca sources also increased shelling out-turn and 100-seed weight. The Calcium chloride treatment showed maximum shelling (72.8%) and 100-seed weight (51.4 g) as against 71.5% and 49.2 g, respectively, in control plot.

3 Screening for P and Ca-efficient groundnut genotypes

Field experiment was conducted to identify P and Ca-efficient groundnut genotypes.

One hundred and three genotypes were grown in field under unfertilized and fertilized conditions (control, 50 kg ha/P and 100 kg ha/Ca treatments) and based on the relative performance of growth, dry matter accumulation, yields and nutrient uptake, the nutrient efficient and inefficient groundnut genotypes were identified.

The P-efficient genotypes generally showed high P concentration in leaves at early growth stages, and high kernel P content and high P uptake by plant at harvest than in P-inefficient genotypes. The genotypic differences were observed in Ca concentrations and uptake by plants of the various genotypes under observation. But, there was no clear-cut relation between high yield and high Ca uptake by plants. However, kernels of the Caefficient genotypes showed higher Ca concentration than others which serve the main criteria for selection of Ca-efficient genotypes.

The concentration of P under unfertilized (without P) and fertilized (with 50 kg/ha P) conditions ranged from 0.12-0.31% and 0.13-0.45%, in the leaves (at 60 DAE) and 0.30-0.56% and 0.32-0.7%, respectively, in seed (at harvest). However, the average P concentration of control and P-fertilized groundnut was 0.25 and 0.28%, respectively, in leaves at 60 DAE and 0.52 and 0.62%, respectively, in kernel at harvest.

Based upon the overall performance (yield and nutrient uptake) following nutrient efficient and inefficient genotypes were identified:

The nutrient efficient and inefficient genotypes were:

- P-efficient: GG 5, GG 20, NRCG 3498, 7085-1, 6919, 1308, ICGV 86590, SP 250A
- Ca-efficient: GG 5, GG7, SP 250A, NRCG 3498, and B 95 ICGHNG 88448, and NRCG Acc. 7085-1, 6155
- P-inefficient: VRI 3, CSMG 84-1, B 95, PBS 20012, 18057
- Ca-inefficient: BAU 13, TG 26, NRCG 7472 and 162

As the search for the nutrient efficient genotypes is a priority study looking to the fertilizer scarcity, this trial with 100 genotypes was also laid out at Mainpuri, Vriddhachalam, Coimbatore and Raichur.

The data revealed that at Mainpuri the genotypes M 13, SG 84, and FeESG 8 responded maximum to P. The other promising lines to P were TNAU 256, SP 250A, ICGV 86590, Chitra and CSMG 84-1. The Ca efficient lines were CSMG 84-1, CSMG 884, M 522,CO(2), GG 2 and ICGV 86590. At Raicur the crop suffered from PBND and showed poor yield. However, the genotypes GG 7, FeESG 10, RS 1 and R 2001-2, R 2001-3 (local cultures) were both P and Ca efficient. At Coimbatore, the genotypes GG 20, ICGV 86590, FeESG 8 and FeESG 10 were both P and Ca efficient.

4 Studies on the various levels of Mo and B on groundnut

Micro-plot studies using various B and Mo levels for commonly grown cultivars GG 2, JL

24, ICGS 76 and GG 20 showed that all these varieties responded to upto 0.6 ppm of B during first two years, but if the B application was continuous, only 0.2-0.4 ppm of B was sufficient to meet the requirement. Similarly during first year of treatment the groundnut cultivars responded to 0.4-0.6 ppm of Mo. The Variety JL 24 showed minimum requirement whereas ICGS 76 required maximum amount of both of these elements.

5 Maintenance and multiplication of nutrient-efficient and inefficient lines

Twenty-five nutrient-efficient groundnut genotypes were grown for maintaining the seed stocks of these genotypes. Two of the Fe-efficient groundnut genotypes namely FeESG-8 and FeESG 10-1 were multiplied for acquiring sufficient seed for testing them in AICRP-G system. These genotypes are being tested in the rice-based cropping system of Goa, Karnataka and Orissa for their potential in these region and further release.

6 Screening germplasm for high nutrient density

One hundred and seventy-four core collection of germplasm lines were subjected to fertilizer response and micronutrient density in their kernels. Some of the genotypes having high micronutrient density in their kernels were identified as:

High Fe : NRCG 12291, 12148, 11088 12880, 11236 (500-1000 ppm)

High Mn : NRCG 11126, 12291, 3533, 10820, 12321 (above 40 ppm)

High Zn : NRCG, 11868, 3648, 12321, 1086, 11925 (above 50 ppm)

High Cu : NRCG 12746, 9966, 10820, 11088, 11276 (above 14 ppm)

PROJECT 05: STUDIES ON GROUNDNUT BASED CROPPING SYSTEM

(DEVI DAYAL, I. K. GIRDHAR, P. C. NAUTIYAL AND K. K. PAL)

1 Cropping systems

1.1 Long-term experiment on nutrient dynamics in groundnut based cropping systems

Information is available on cumulative as well as residual fertility build up in the long run for whole cropping systems. A long term experiment with five popular groundnut based cropping systems *viz.*, mono cropping of groundnut, two intercropping systems (with pearl millet and pigeon pea) and two sequential cropping systems (groundnut-wheat and groundnut-wheat-green gram) was initiated during kharif 1998 under different combinations of organic and inorganic fertilizer regimes to study the nutrient dynamics and crop sustainability. After seven years of completion, the following changes in yield of kharif groundnut and soil properties were observed.

- Among the cropping systems, pod yield of kharif groundnut was the maximum (1365 kg/ha) in groundnut-wheat-green gram cropping system
- Organic Carbon Content in the soil was the maximum in G+PP intercropping system
- The activities of PSM and the fluorescent pseudomonads were higher in groundnut- wheat sequence whereas the activities of these microorganisms were the least in sole groundnut

The residual effect of FYM applied @ 5t/ha during kharif along with 50% of the recommended dose of fertilizer (RDF) on grain yield of wheat was evident but was more pronounced on summer green gram and it increased grain yield of green gram by 11.3% over 100% RDF. Fertilizer dose applied to wheat significantly influenced the grain and straw yields of wheat. The highest grain yield of 3289 kg/ha was recorded when combination of inorganic (50% RDF) and organic (FYM 5 t/ha) was applied. Significant reduction in grain yield (9%) was observed when fertilizer dose was reduced to 50% of RDF compared with that recorded under RDF.

Grain yield of green gram was not influenced significantly due to different fertility treatments of wheat. However, when fertilizer dose to green gram was reduced to 50%, significant reduction (11.6%) over 100% RDF was noticed. The maximum grain yield of 1105 kg/ha was recorded under the treatment of groundnut (50% RDF+ FYM) wheat (100% RDF) green gram (100%RDF).

Available nitrogen (NH_4 N and NO_3 N) in the soil after harvest of wheat and green gram indicated that soil had higher nitrogen (43.575 ppm) in G-W-G cropping system than that in G-W cropping system (available N 34.405 ppm). The OC content of soil (0-30 cm depth) was also

significantly higher in G-W-G system than in G-W system. It is mainly because in G-W-G system, crop residue of green gram (599-978 kg/ha) was incorporated into the soil after picking of pods that helped in increased available nutrient in the soil.

1.2 Phosphorus management in groundnut+pigeon pea intercropping system

Three sources of P namely monophosphate, diphosphate and triphosphate were evaluated under three levels of P (50, 100 and 150% RDF) in groundnut+ pigeon pea intercropping system. All the P was applied as basal application at the time of sowing. The first year result indicated following:

- Sole groundnut yielded 39.9% less under triphosphate than under monophosphate.
- Sole pigeon pea yield was significantly higher under triphosphate than under monophosphate
- Groundnut yield under intercrop did not vary significantly among the three sources of P
- P content in groundnut was slightly less under triphosphate than under mono phosphate

Response of intercrop groundnut to monophosphate and triphosphate was quadratic whereas it was linear for diphosphate. The highest response was observed to monophohphate followed by triphosphate. Intercrop pigeon pea responded linearly to all the three sources and it was the highest for triphosphate followed by monophosphate (Fig. (1) and (2)).

2 Dry seeding in rainfed groundnut

Groundnut cv. GG 2 was sown 15 days before onset of monsoon and at the time of monsoon. The seeds were treated with different chemicals ($CaCl_2$-1%, Thiourea-1%, Salicylic acid-0.25%, and Ethrel-0.25%) and shade dried for 6 hours before sowing . Data on seedling emergence at different interval, DM of plant and yield and yield attributing characters were recorded. The results showed the following:

- Seed treated with CaCl2 (1%) and Ethrel (0.25%) gave significantly more plant density recorded at 15 and 30 DAS than under control
- Plant under above two treatments had more dry matter recorded at 30 DAS (7.70-8.85 g/plant) than under control (6.85 g/pl)
- Yield was significantly higher under these two treatments (1211-1281 kg/ha) than the control (1022 kg/ha)
- Irrespective of chemical treatment, dry seeding recorded 23.8% higher pod yield compared with that recorded under onset of monsoon sowing

3 Water management in irrigated groundnut

3.1 Yield-water relationship in groundnut under limited water supply in summer season

Field experiment was conducted to quantify soil-water-plant relationship for maximizing

water use efficiency under limited water supply in summer 2004. Study was conducted on 5 cultivars *viz.*, GG 2, GG 4, GG 6, TAG 24 and TG 26 using the single sprinkler line source design by keeping single sprinkler line in the centre of experimental block. Sprinklers were spaced at 6.1 m apart to achieve overlapping moisture pattern along the line and gradient water supply across the line. Water gradients were applied in 4 stages, (1), up to 30 days after crop emergence (DAE) (2) 30-60 DAE (3) 60-90 DAE and (4), throughout crop season. The uniform irrigation was applied at 50% depletion of available soil moisture from the soil profile 0-50 cm.

The most sensitive crop stage to water deficit was worked out. The values of B for emergence to flowering stage were close to unit value, which indicated that this stage was less sensitive to water deficit. Among the stages, pod formation to pod development stage was more sensitive to water deficit as the value of B was the highest (1.36-1.49) followed by flowering to pod formation stage (1.29-1.46). Among the genotypes, GG 6 was the most sensitive (1.31) and the TAG 24 the least (1.20). The highest yield with Et max. was recorded for GG 2 followed by TAG 24.

As moisture deficit increased from Field Capacity to deficit state, soil temperature recorded at 1400 hours (0-5 cm and 5-15 cm depth) increases linearly from no deficit (38.9° C) to severe deficit (45.9° C). This led to increase in leaf temperature from 44.3° C to 48.7° C). However, genotypic differences in leaf temperature were observed.

The available nutrient (N, Ca, Mg) in the soil under different soil moisture gradients was also measured. The available N decreased consistently with increase in moisture deficit. However, no such trend was observed in Ca and Mg. This suggests that different nutrient management strategies have to be followed for deficit irrigation.

Fig. 1 Response of intercrop groundnut to different P sources

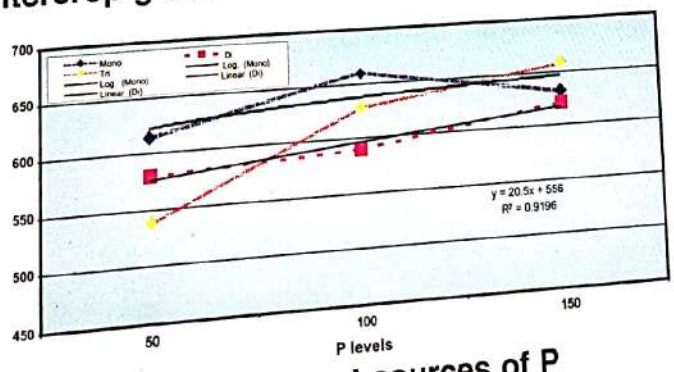
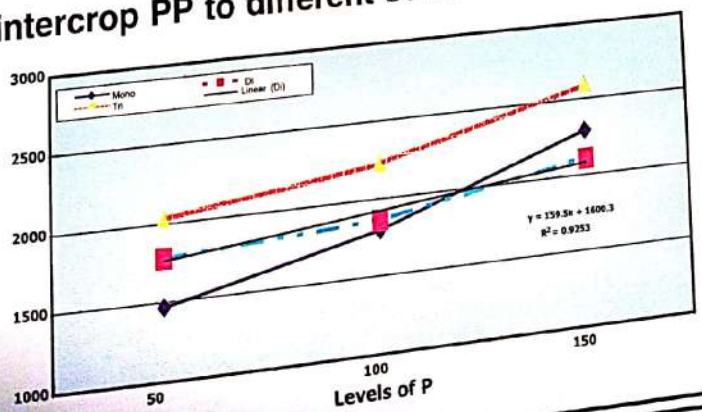


Fig. 2 Responce of intercrop PP to different sources of P



PROJECT 06 :MANAGEMENT OF EXISTING AND EMERGING PROBLEMS OF SOIL AND WATER SALINITY FOR GROUNDNUT PRODUCTION

(I.K. GIRDHAR, DEVI DAYAL, P.C. NAUTIYAL AND K.K. PAL)

USE OF SALINE WATER IN GROUNDNUT-WHEAT CROPPING SYSTEM IN BLACK CLAY SOILS

Availability of good quality water for irrigation in arid, semi-arid and coastal regions of the country is limiting factor and farmers have no option but to use saline water for irrigating crops. Hence, groundnut-wheat cropping system was evaluated using saline water irrigation in saline black soil. Field experiment was conducted at NRCG Farm for three years starting from 2002. The data for the year 2002-03 and 2003-04 has been already presented in the previous Annual Reports. As usual, the above said experiment was repeated in the year 2004-05. In this season also four salinity levels of irrigation water (0.5, 2, 4 and 6 dS/m) and five cultivars of groundnut (Gangapuri, GG 2, ICGS 44, JL 24 and MH 2) were tested in a split plot design. Besides the contribution of rainfall, four numbers of irrigations with saline water were applied at sensitive stages of the crop during September and October 2004. It was found that plant height, pod yield, haulm yield, 100-seed weight and shelling percentage was significantly affected by saline water of 2 dS/m and above over the control. Germination and days to 50% flowering was delayed by 3 to 4 days by the high salinity of the water. Soil salinity build up varied from 2.0 to 5.1 dS/m as a result of saline water irrigation (0.5 to 6 dS/m) during the crop cycle. This increased soil salinity as a result of saline water irrigation decreased the osmotic potential from -0.72 bars to -1.84 bars, which are reflected in decrease in water uptake by the roots and subsequently reduction in plant transpiration, which further decreased the yield.

PROJECT 07: DEVELOPMENT OF SUSTAINABLE PRODUCTION TECHNOLOGIES FOR PROMOTION OF GROUNDNUT CULTIVATION IN NON-TRADITIONAL AREAS OF EASTERN AND NORTH-EASTERN INDIA

[A.L. SINGH AND K.K. PAL (NRCG) AND D.P. PATEL, G.C. MUNDA, M. DUTTA, N.P. SINGH, K.A. PATHAK, A. K. VISHWAKARMA, L.C. DE AND MOUSUMI RAYCHOUDHURY (ICAR RES. COMPLEX FOR NEH REGION)]

1 Experimentations in North-Eastern Hill regions

To provide suitable cultivation technologies, following collaborative experiments were conducted at various centres of ICAR Research complex in North-East Hills. The results of these experiments are summarized below:

1.1 Evaluation of recently released cultivars and nutrient efficient lines

The field experiments were conducted under rainfed condition where 36 groundnut genotypes comprising of recently released cultivars and nutrient efficient lines were evaluated for their yield, and tolerance of Al- and Fe-toxicities and Ca and P deficiencies. Pod yields of the cultivars ranged from 750-3170 kg/ha against 940 kg/ha of the check (JL 24) in Meghalaya and 410-1270 kg/ha in Tura, 522-2087 kg/ha against 671 kg/ha of the check (JL 24) in Tripura, and 353-2034 kg/ha in Mizorum.

The study reveals that at Barapani, all the cultivars performed better than JL 24 except VRI 4 and DRG 12 in terms of pod yield. Highest pod yield (q/ha) was observed in BAU 13 (31.7), which was found at par with CSMG 84-1 (30.8), ICGS 76 (29.3), GG 13 (27.8) and TKG 19A (26.1). At Tripura, the cultivars M 13, TG 26, ICGS 76, ICGV 86590 and DRG 12 were high yielder and showed yield at par (Table 1), and ICGV 86590 and CSMG 84-1 were high yielder in Tura. At Basar in Arunachal pradesh the high yielding genotypes were NRCG 1308 (1796), 7599 (1853) and GG 7 which showed more yield than JL 24 (1450 kg/ha).

At Mizorum, where the soil is highly eroded and acidic, the cultivars TKG 19A, S 84, JL 24, JL 220, GSMG 84-1, ICGV 86590, FeESG 10-1, and FeESG 10-3 showed more than 1500 kg/ha pod yield and more than 1000 kg/ha seed yield during first year. However during second year all these genotypes along with GG 20, TG 26, ICGS 76, TKG 19 A, ICGV 88448, NRCG 1308, 7206, 7471 and M13, showed more than 2000 kg/ha yield. The high yielding groundnut genotypes were also tolerant of Al-toxicity, resistant to ELS, LLS and rust diseases and hence can be grown in NEH region.

Table 1. Evaluation of groundnut varieties at Tripura

Groundnut	Pod (q/ha)	Haulm (q/ha)	Shelling (%)
SG 84	24.4	25.6	75
VRI3	10.90	17.4	78
M 13	22.8	28.3	76
JSP 19	24.5	34.8	72
TAG 24	10.9	14.4	71
TG 17	23.6	23.6	63
CSMG 84-1	23.9	23.9	82
FeESG 8	13.4	13.4	72
FeESG 10-1	8.5	8.5	75
FeESG 10-3	9.4	9.4	71
NRCG 162	14.2	14.2	76
NRCG 1308	15.4	15.4	78
NRCG 2588	14.7	14.7	75
NRCG 3498	10.8	10.8	76
NRCG 4659	17.9	17.9	68
NRCG 5513	15.8	15.8	80
NRCG 6131	20.9	20.9	51
NRCG 6155	21.0	21.0	85
NRCG 6450	16.6	16.6	78
NRCG 6820	17.5	17.5	68
NRCG 7206	14.2	14.2	75
NRCG 7599	21.3	21.3	69
PKVG 8	13.0	13.0	75
JL24	15.1	15.1	84
Mean	16.7	16.7	74
CD (5%)	6.8	6.8	-

1.2 Screening and evaluation of germplasm lines

The latest set of 100 germplasm lines of groundnut from 2004 onward were grown in acid soils having nearly pH 5.0, under fertilized (50 kg/ha P + 2500 kg/ha lime) and unfertilized (control) conditions and assessed for pod yield and their tolerance of Al and Fe toxicities, Ca and P deficiencies at the hot spots identified for screening for soil acidity and Al-toxicity foot hill upland of ICAR Res. Complex, Imphal (Manipur) and Barapani and 'Tilla' lands at Lembucherra (Tripura). The tolerant genotypes identified were NRCG 5513, 6820, 4659 3498, 11891 and 11860.

Higher root length, pod number and yields and their higher relative values in unfertilized plots over fertilized one, coupled with high P and Ca content in seed, and high Ca/Al and P/

ratio were found to be associated with Al-toxicity tolerance in groundnut in acid soils of NEH region.

Further, the performance of 100 genotypes was evaluated during *rabi* season under polythene mulch as well as under control conditions at Barapani where the grounnut genotypes NRCG 7325, 7244, 6820 3892, 162, 7599 and ICGV 96333 performed well under cold season. These were further tested during the present rabi season at Barapani.

1.3 Integrated nutrient management in groundnut

The Field experiments were conducted to compare the effects of organic and inorganic nutrients (P, Ca, K, Mo and B) and biofertilizers, PSM and PGPR (PPB) on groundnut production in acid soils.

In Tripura application of PGPR enhanced the pod yield to 1667 kg/ha as against 1369 kg/ha in control. Application of P50 and K50 along with PGPR caused 1964 kg/ha yield which was highest and 43% more than the control. At Barapani also the PGPR 4 was found beneficial and increased yield with groundnut var. ICGS 76 (Table 2).

Table 2 Effect of PGPR on groundnut productivity at Tripura (kg/ha)

Treatments	Pod	Haulm
To control	1369	2380
T1 10 t FYM/ha	1488	3571
T2 P50	1012	2976
T3 P50+10 t FYM/ha	1488	2381
T4 P50+K50	893	2230
T5 PGPR	1667	2520
T6 10 t FYM/ha+ PGPR	1667	2630
T7 P50+PGPR	1488	2435
T8 P50+10 t FYM/ha	1548	2625
T9 P50+K50+ PGPR	1964	2730
CD (5%)	250	-

1.4 Experiment on organic farming

Various organic farming approaches were tested in Tripura, Meghalaya and Manipur taking ICGS 76 groundnut cultivars in Tripura and Meghalaya and TG 22 in Manipur. The result revealed that organic fertilizers showed its superiority over inorganic one and FYM (at 10 t/ha) alone was the best for highly eroded soils of NEH region with as high as 2220 kg/ha pod yield against 896 kg/ha pod yield at Tripura (Table 3).

In Tripura, application of NPK (30:50:40 kg/ha)+Lime (2.5 t/ha), NPK (30:50:40 kg/ha)+ Lime(2.5 t/ha)+ PGPR+PSM+Bradyrhizobium, and cowdung (10 t/ha) produced 1572, 1825 and 2220 kg/ha pod yield, respectively as against 896 kg in control. The promising organic

sources in decending order were cowdung (10t/ha) Compost, mustard oil cake (1 t/ha), and Gliricidia green leaf (Table 3).

In a residual trial application of cattle manure (5 t/ha) produced 13.5-52% more pod yield over control. The green leaf of Gliricidia (5 t/ha) in combination with NPK produced 44 to 50% more pod and haulm yield. On the other hand Subabul leaf (5 t/ha) produced maximum 30.3% increase in yield.

Table 3. Effect of various organics on groundnut (Variety ICGS 76)

Treatments	Pod yield (q/ha)	Haulm yield (q/ha)
T0 control	8.96	22.07
T1 N30P50K40+ Lime (2.5t/ha)	15.72	36.69
T2 PSM (Bacillus polymixa)+Rhizobium (TAL100)+PGPR4 (without fertilizer)	9.6	36.80
T3 Cowdung (10 t /ha)	22.2	39.20
T4 Mustard oil cake (10 t /ha)	15.8	25.9
T5 Compost (10 t/ha)	16.20	24.5
T6 Gliricidia green leaf (10 t/ha)	14.5	20.2
T7 Subabul green leaf (10 t/ha)	12.2	18.5
T8 PSM+Rhizobium+ PGPR4+N30P50K40	18.25	24.2
T9 Farmers practice (20kg P+37.5 kg K)	11.7	30.20
SE (±)	2.5	5.25
CD (5 %)	4.8	9.30

In Manipur, application of Mustard cake (@1 t/ha) increased 51% pod yield over control, but when it was combined with Bradyrrhizobium it increased 102% pod yield over control. However, application of NPK (30:50:40 kg/ha) fertilizers showed 46% increase in pod yield over control. FYM @ 10 t/ha along with Rhizobium increased the pod yield over NPK and NPK +Lime. Maximum pod yield of 24.3 q/ha was obtained with 5 t/ha FYM+0.5 t/ha Mustard cake + Rhizobium.

In Barapani also application of FYM (10 t/ha) was superior and showed 2766 kg/ha pod yield as against 1533 kg/ha in control and 2783 kg/ha with application of 30:50:40 kg/ha NPK + 2.5 t/ha lime. Interestingly the application of PSM+Bradyrhizobium + PGPR + Biocontrol agents could produce 2483 kg/ha pod yield. It was noted that application of rabbit slurry, castercake, neem cake, and farmer practice of Bun method farming were at par and promising organic farming approaches.

1.5 Nutrient Management in bold-seeded groundnut

In NE region, as water is not a limiting facto, groundnut shows its full potential and has a lot of potential area for confectionary groundnut. However, there are reports that when planted in highly leached acid soils there is no proper formation of kernel. Thus, an experiment was conducted to study the nutrient management in large-seeded ICGS 76 groundnut with various

combinations of nutrients at Barapani (Table 4). Two years of experimentation showed that in general the bold seed groundnut showed high yield and interestingly all the treatments showed significant increase in pod yield over control (T1). Highest pod yield was recorded with T8 (3244 and 3302 kg/ha) which was found significantly superior to T3, T5 and T4 but at par with T7, T6 and T2.

1.6 Experiment on long term fertility trials

Looking to the depletion of nutrient from the soil through uptake by crop leaching and the regular practice of shifting cultivation in NEH regions an experiment on the assessment of the nutrient status of the soil need to be investigated through long term fertility experiments to have a long lasting fertilizer recommendation by taking recently released groundnut variety. Accordingly a trial was started at Tripura with various treatments. The experiment will be repeated for three to four year and conclusion will be drawn.

Table 4. Nutrition of bold-seeded groundnut (ICGS 76) with various nutrients

Sl. No.	Treatments	Yield (kg/ha)	
		2002	2003
1	T1 Control	2427	2052
2	T2 N20 (kg/ha) + P50 (kg/ha)	3073	3052
3	T3N20 (kg/ha) + K100 (kg/ha)	2969	2822
4	T4 N20 (kg/ha) + Lime (2.5 t/ha)	2740	2500
5	T5 N20 (kg/ha) + P50 (kg/ha) + Lime (2.5 t/ha)	2917	3167
6	T6 N20 (kg/ha)+ P50 (kg/ha) + K100 (kg/ha) + Lime (2.5 t/ha)	3146	3193
7	T7 T6+ Boric acid (13 kg/ha)	3177	3167
8	T8 T6 + FYM (10 t /ha)	3302	3244
	C. D. (5%)	283	340

1.7 Experiment on the date of planting and cropping system

Looking to the different cropping season an experimentation on the date of planting were initiated to find out the suitable cropping season of groundnut in NEH regions for fitting it in the traditionally followed cropping systems. The experiment was conducted at Barapani and Mizorum. At Barapani among the 6 dates of sowing at 15th and 30th May, 20th June 10th and 30th July and 20th August, the yield was maximum when the crop was sown on 10th July for groundnut varieties ICGS 76 and TKG 19A with yield of 3180 and 2720 kg/ha. In Mizorum among the 5 dates of sowing at 4th 15th, and 30th June 15th and 30th July, the highest yield of ICGV 86590 was when the crop was sown on 15th June with yield of 2660 kg/ha.

2 Basic studies on Al-toxicity at NRCG

2.1 Screening of groundnut genotypes

Fifty-five groundnut genotypes were screened for their tolerance of Al-toxicity where most of the groundnut genotypes tolerated 1000 µM of Al (as $AlCl_3$) till 25-30 days after sowing

(DAS), but later on Al-toxicity symptoms on roots and subsequently on plant growth were noticed causing reduction in growth and yields. Based on these parameters and relative performance of the genotypes under normal and Al-stress conditions, the genotypes ICG 11882, GG 3, NRCG 3498 and 6919 showed comparatively more tolerance than others.

2.2 Isolation and testing of soil microbes responsible for P release and high nitrogen fixing Bradyrhizobium in acid soils

Bradyrhizobium and PSM cultures were isolated from the acidic soils collected from Tura, Manipur and Barapani in NEH Region. However these materials will be shared with scientist working on acid soils. From these two phosphates solublising bacteria (one fluorescen and another non-fluorescent Pseudomonas) showed good solubilisation of Tricalciun phosphate.

PROJECT 08: GERMPLASM MANAGEMENT OF CULTIVATED GROUNDNUT (A.HYPOGAEA L.) AND IT'S WILD RELATIVES

(K. RAJGOPAL, S.K. BERA, V. NANDAGOPAL, S. DESAI AND V.V. SUMANTH KUMAR)

SUB PROJECT 01 : COLLECTION, EVALUATION, DOCUMENTATION AND DISTRIBUTION OF CULTIVATED GROUNDNUT AND RELATED ARACHIS SPECIES

1 Acquisition of germplasm

The working collection is enriched at the Centre by assembling 2346 accessions from various sources. The ICRISAT, which is the major donor, has provided 2238 cultivated groundnut accessions and 60 wild *Arachis* species under the repatriation programme. Rest of the accessions, which included released cultivars, registered material and land races were assembled from six different sources.

2 Supply of germplasm

A total of 1899 accessions were supplied to 28 indenters; a total of 662 accessions were supplied within the centre, 956 accessions to AICRP centres and rest to six other organizations. The accessions supplied included land races, released cultivars, wild *Arachis* species and other promising accessions.

3 Multiplication of germplasm

3.1 For long-term conservation

Being one of the National Active Germplasm Sites (NAGS), a set of working collectio has to be deposited in the National Gene Bank at NBPGR, New Delhi for long-ter conservation. Multiplication of 320 accessions representing Virginia bunch (HYB): 119, Virgir runner (HYR): 67, Spanish (VUL): 92, and Valencia (FST): 11 types and unknown 31 v undertaken. The yield recovery was poor in many of the accessions due to erratic rain fall. C 130 accessions could be deposited in NGB.

3.2 Under repatriation programme

Under the groundnut germplasm repatriation programme in collaboration with the ICI Patancheru, a set of 442 accessions (VUL: 101, FST: 30, HYB: 113 and HYR: 110, UI was multiplied. The sowing of crop was delayed due to late receipt of seed material. M the seed quantity received in some of the accessions was less. These factors resulte yield recovery. Sufficient quantity of seeds of 60 accessions only could be sent to NG

4 Characterization of groundnut germplasm

A set of five hundred accessions (HYB: 25 and HYR: 475) was characterized for various descriptor states for the second year. The collection was scored for 18 qualitative and 31 quantitative traits at different phenophases including observations on four randomly selected plants from each accession. The traits included were on crop (7), flower (3), stem (2), leaf (7), plant (7), pod (13), seed (3) and yield (6). Although qualitative traits showed variation for majority of the traits, the variation did not cover the entire spectrum of descriptor states. As the collection belonged to hypogaea types, majority of the accessions had salmon and rose testa and a few accessions also had white and purple colour testa. The descriptors for pod traits did not show higher notes. The variability for important agronomic traits is given in Table 1. Higher value (>20.0%) of CV was observed for NSB, NMP, NIMP, PPMT and PYP indicating more variation in the collection for these traits.

Table 1. Variation in 500 germplasm accessions for important agronomic traits

Traits	Accessions				Controls			
	Minimum	Maximum	Average	CV	Minimum	Maximum	Average	CV
DFF	21.0	25.0	24.0	4.0	21.0	25.0	23.5	4.4
DTM	104.0	138.0	130.0	2.4	122.0	135.0	129.9	2.3
PLS	38.7	97.0	65.0	17.5	46.3	93.3	69.3	17.8
LMA	23.5	60.0	46.8	11.8	32.8	43.8	36.7	8.0
LPB	34.3	70.0	60.5	11.6	39.8	62.3	50.6	13.8
NPB	2.8	4.0	4.0	1.9	3.8	11.5	4.2	30.2
NSB	1.3	24.8	7.0	58.1	9.0	23.8	15.9	22.0
NMP	1.5	22.8	5.8	54.2	5.8	24.8	11.9	37.3
NIMP	0.0	10.5	0.5	257.7	0.3	5.3	2.2	47.5
HPW	42.6	147.5	101.2	14.4	82.4	128.8	104.9	10.7
SHE	43.5	78.3	59.5	8.1	59.4	73.7	67.0	5.9
SMK	69.2	98.2	96.0	5.6	66.7	97.0	90.2	6.0
HSW	17.0	69.4	42.4	16.7	26.4	64.4	49.0	15.5
PPMT	12.5	125.1	59.2	34.4	37.6	120.8	84.5	27.5
PYP	1.3	17.4	6.8	40.7	3.7	26.8	11.8	37.8

[DFF:Days to 50% flowering, DTM:Days to maturity, PLS:Plant spread(cm), LMA:Length of main axis (cm), LPB:Length of primary branches, NPB:No of Primary branches, NSB:No. of Secondary braches, NMP:No of mature pods, NIMP:No of immature pods, HPW:100-pod mass (g), SHE:Shelling outturn, SMK:Sound mature seeds (%), HSW:100-seed mass (g), PPMT:Pod mass(g)/m^2, PYP:Pod yield (g)/plant]

Table 2. List of accessions having better agronomic traits over respective controls

Traits	NRCGs
Shelling outturn >76 %	13689,4187,5801,13697,5820,3258,13828
100 seed mass >60 g	5875,10190,10199,12048
Pod mass(g)/m²>115	3122,3123,3124,2063,13753,13752
Pod yield (g)/plant >15	4372,5849,5984,6000,13734,13738,12756

4.1 Released cultivars

Twenty-two released varieties (VUL: 13, FST: 01, HYB: 05 and HYR: 03) of four botanical groups were sown in a Randomized Block Design for characterization. The varieties were characterized for 20 qualitative and 29 quantitative traits. The observations on four randomly selected plants were recorded for plant traits. The varieties Kopergaon 3 and OG 52-1 had red testa and BAU 19 had dark red testa. Rest of the varieties had either rose or salmon colour testa. Among the varieties, BSR 1 had smooth pods. Some of these traits can be used as distinguishing features of the improved varieties.

4.2 Confirmation of traits under DUS testing

Ninety-four released varieties of groundnut (VUL: 47, FST: 03, HYB: 22 and HYR: 22) of all the four botanical groups were sown in a R.B.D. in three replications. The varieties were characterized for 18 qualitative and 18 quantitative characters. The confirmation of test guidelines was done. Some of the traits could not be confirmed due to the poor expression of traits. The analysis of data of selected traits is given in Table 3. The maximum yield was recovered by GG 11, GG 13, LGN 2 and M 145 ranging from 95 g to 101 g/m² compared to other varieties.

Table 3. Variation in quantitative traits among 94 released varieties

Traits	Min.	Max.	Mean	MSS	CD
LLL	29.90	60.40	47.61	82.208**	0.49
LLW	14.63	24.63	19.50	17.377**	0.26
L/W	1.93	2.83	2.45	0.085**	0.03
OSP	9.17	63.70	24.11	250.804**	2.09
TSP	36.30	90.83	75.89	250.809**	2.09
PDL	19.33	34.33	25.19	29.308**	0.50
PDW	9.33	14.67	11.30	3.201**	0.20
SDL	9.17	16.00	11.81	7.422**	0.20
SDW	5.67	8.27	6.74	0.858**	0.20
HPW	43.43	150.23	70.45	1025.752**	2.20
SHE	41.63	76.90	59.79	114.247**	1.80
SMK	59.87	89.03	77.01	105.872*	2.30
HSW	22.07	53.53	32.40	100.521**	0.60
PPMT	4.93	101.13	45.02	1407.830**	2.20

[LLL=Leaflet length(mm), LLW=Leaflet width(mm), L/W=Length/width ratio, OSP= Percentage of 1 seeded pods, TSP=Percentage of 2 seeded pods,PDL=Pod length (mm), PDW=Pod width(mm), SDL=Seed length (mm), SDW=Seed width (mm), HPW=100 pod mass(g)weight, SHE=Shelling percent, SMK=Percent of sound mature seeds, HSW=100 seed mass(g), PPMT= Pod yield(g)/m^2]

4.3 Evaluation of core collection for $\Delta^{13}C$ and $\Delta^{18}D$

A set of 200 accessions (VUL: 73, FST: 47, HYB: 32 and HYR: 15) from core collection developed at the Centre was sown in the last week of July in two replications. The leaf and stem samples were sent to U.A.S., Bangalore for analysis. The observations on randomly selected five plants were recorded for dry haulm weight, shelling percentage, hundred seed mass and sound mature kernel. As the condition of the crop was poor at the time of harvest, the data could not be interpreted properly. The data on $\Delta^{13}C$ and $\Delta^{18}D$ is yet to be received from UAS, Bangalore.

4.4 Mini-core collection from ICRISAT

A set of 184 accessions (VUL: 64, FST: 38, HYB: 42 and HYR: 40) received from ICRISAT representing mini core collection was sown in an Augmented Randomized Block Design with respective checks *viz.,,* GG 2, JL 24, Gangapuri, MH 2, GAUG 10, M 13, GG 20 and Kadiri 3. The set was sown to study the extent of variability in the collection. The accessions were characterized for 18 qualitative and 31 quantitative traits, including observations on morphological traits on four randomly selected plants. The collection showed considerable variation for no. of secondary branches, number of immature and mature pods, pod length, 100 pod weight, 100 seed weight and pod yield. The list of traits and the variation is given in Table 4.

4.5 Variability museum

About 45 germplasm lines having the variability in the leaf colour, leaflet shape and size, standard petal colour, stem and peg pigmentation, pod size, constriction, beak and reticulation etc was maintained as a variability museum for demonstration purpose.

5 Maintenance of Wild *Arachis* Species

Ninety-six accessions representing five sections: *Procumbentes* (06), *Erectoides* (04), *Arachis* (49), *Heteranthae* (02) and *Rhizomatosae* (35) accessions were maintained. Out of 60 new wild *Arachis* accessions received from the ICRISAT, 15 new accessions were sown but only seven could survive. Periodical harvesting of seed forming wild species was undertaken to enhance the seed quantity. The shelling percentage, hundred seed mass and percent of sound mature kernel were also recorded in the accessions having sufficient seeds quantity. The collection available in the field gene bank is as under:

Section	Accessions	Species
Arachis	49	18
Erectoides	04	03
Heteranthae	02	02
Procumbentes	06	03
Rhizomatosae	35	01
Total	**96**	**27**

6 Charcterization of Bambara Groundnut (*Vigna subterranea* L.)

Ten accessions of bambara groundnut were characterized for 15 quantitative traits and eight qualitative traits. The collection was scored for eight qualitative traits and 15 quantitative traits. The variation was not distinct for most of the qualitative traits except for seed colour. The "Uniswa Red" variety had distinct flower colour and pigmentation compared to other accessions. Much variation was observed for seed colour and length of petiole, 100 seed weight and plant stand. The 100 seed weight ranged from 20.8 to 66.0 g. In general the pod yield was poor. Some of the important quantitative traits have been given in Table 5.

Table 5 Variation in some important quantitative traits in Bambara groundnut accessions

Traits	Min	Max	Mean	CV
DTG	8.0	11.0	10.1	14.3
DIF	44.0	50.0	47.6	5.5
DFF	50.0	55.0	53.5	3.4
DTM	110.0	120.0	114.7	3.3
LLL	5.0	7.0	5.9	10.3
LLW	1.6	2.9	2.3	14.8
LWR	2.2	3.4	2.6	13.0
PTL	8.0	18.2	12.0	26.5
PNR	7.3	11.4	8.7	14.6
SHE	71.2	88.3	81.9	6.5
HSW	20.8	66.0	37.7	35.1
PWP	5.0	24.0	14.2	40.2
LMA	10.8	21.0	16.6	18.9
PLS	14.2	43.0	25.4	34.0

[DTG:Days to germination, DIF: Days to initial flowering, DFF:Days to 50 % flowering, DTM:Days to maturity, LLL=Leaflet length(mm), LLW=Leaflet width(mm), L/W=Length/width ratio, PTL:Petiole length(cm), SHE:Shelling outturn, HSW:100-seed mass (g), PWP: No. of plant with pod, LMA: Length of main axis(cm), PLS: Plant spread (cm)]

7 Conservation

The seeds of accessions grown in kharif season were properly processed for conservation in medium term storage.

8 Present status of germplasm

The working collection is being maintained at the Centre in the medium term storage at 4°C and 30% R.H. In addition a field gene bank has been developed with perennial rhizomatous wild Arachis species and seed bearing accessions. One set of available germplasm from both cultivated and wild species has been deposited at National Genebank for long-term conservation. The present status of accessions available is as follows.

Place of storage	Status	No. of accession
NRCG, Junagadh	Working collection	8934
-do-	Wild *Arachis* species	96
NBPGR, New Delhi	Base collection	6511

Sub project 02: Screening of germplasm for biotic stresses

(K. Rajgopal and V. Nandagopal)

Forty-five genotypes available in variability museum were screened for Groundnut Leaf Miner (GLM) during kharif 2004. The percent damage ranged from 3 to 67. The genotypes NRCG's 10628, 12698 and 10818 are found to be resistant.

Out of 259 genotypes screened (repatriation material) for GLM in epiphytotic conditions during kharif, 2004, following ICG lines viz.,, 12367, 12620,12621, 9981, 7846, 15119, 11721, 2462, 3037, 4032, 5403, 9889, 2701, 2748 and 4248 are found to be resistant recording less than 1% damage incidence.

Sub project 03 : Development of Germplasm Resources Information System (GRIS)

(K. Rajgopal and K. Sumanth Kumar)

The information generated on 775 accessions characterized in kharif 1998 and 525 accessions in kharif 1999 published in the form of two catalogues has been reoriented using Mysql database server. Various types of searches have been developed based on NRCG number, ICG number, habit, country and variety. The data can be retrieved within the intranet.

Table 4. Variation in mini core collection for some of the agronomic traits

Trait	Population				Checks													
					HYB				HYR				VUL				FST			
	Min.	Max.	Mean	CV%	Min.	Max	Mean	CV%	Min.	Max	Mean	CV%	Min.	Max	Mean	CV%	Min.	Max	Mean	CV%
LMA	13.0	68.8	46.4	16.8	37.8	61.5	47.1	17.9	31.8	46.3	37.8	14.3	35.8	52.0	42.9	15.2	7.8	53.3	33.5	59.7
LPB	15.3	82.3	53.9	16.0	47.3	75	59.1	17.0	40.8	56.3	47.8	13.2	39.8	55.8	47.2	11.2	11.0	58.0	38.3	53.5
NSB	0.0	24.8	10.0	71.8	12.8	20.8	17.5	19.5	8.8	19.3	13.2	31.4	1.8	7.8	5.2	26.6	0.3	3.3	1.7	66.5
NIMP	0.3	7.5	2.1	53.7	2.5	3.5	2.8	14.0	1.3	4.0	2.2	42.9	1.3	3.5	2.3	42.0	0.0	2.0	0.9	85.1
NMP	1.0	18.8	8.7	41.9	10.3	20.0	15.2	22.9	4.3	18.0	11.2	54.1	7.0	17.0	11.6	28.2	0.0	11.3	5.7	76.9
PDL	15.3	41.0	24.8	20.4	16.2	32.5	23.1	25.4	26.2	32.0	29.1	8.2	20.0	25.5	22.5	8.5	18.5	27.0	22.9	13.3
PDW	7.5	15.2	11.2	15.2	10.2	13.0	11.6	8.6	11.2	14.0	12.7	8.1	9.3	11.5	10.4	7.1	10.5	12.0	11.3	5.3
SDL	7.2	21.5	12.3	19.6	10.4	15.5	13.2	15.4	12.5	17.0	14.7	10.5	9.2	13.0	11.2	10.6	10.5	11.5	11.0	2.9
SDW	5.5	9.5	7.5	12.6	7.6	8.5	8.1	3.8	7.0	8.2	7.6	5.3	6.5	8.5	7.3	9.4	6.0	7.5	6.9	9.6
HPW	25.2	215.6	87.6	30.7	68.8	123.2	89.5	25.1	78.7	134.1	107.9	19.0	63.1	88.0	80.5	6.2	61.8	96.0	86.2	15.4
SHE	40.0	76.2	62.6	11.2	64.9	75.8	70.9	6.6	56.5	68.3	62.3	6.9	50.0	70.1	64.8	11.5	47.2	63.5	57.4	13.6
SMK	70.8	98.6	92.1	6.0	65.3	96.7	87.3	12.7	84.4	97.3	92.5	6.5	90.2	98.3	94.8	2.3	80.0	97.5	90.2	6.6
HSW	21.6	78.4	37.1	28.7	36.4	52.5	42.9	17.2	41.0	56.4	50.6	11.3	32.4	39.6	35.8	7.5	21.0	29.8	26.4	12.4
PPMT	2.9	172.8	66.7	53.7	99.5	181.9	128.0	28.0	7.2	146.7	102.4	50.7	49.6	134.1	85.7	31.8	8.0	49.1	30.7	57.7
PYP	1.3	20.8	6.2	43.3	6.5	16.1	10.6	39.2	0.5	15.6	9.2	58.1	4.7	10.2	7.2	12.6	3.6	6.4	5.5	20.7

LMA:Length of main axis (cm), LPB:Length of primary branches, NSB:No. of Secondary braches, NIMP:No of immature pods, NMP:No of mature pods, PDL=Pod length (mm), PDW=Pod width(mm), SDL= Seed length (mm), SDW=Seed width (mm), HPW= 100 pod mass(g)weight, SHE=Shelling percent, SMK=Percent of sound mature seeds, HSW=100 seed mass(g), PPMT=Pod yield(g)/m^2, PYP:Pod yield (g) / plant.

PROJECT 09: BIOTECHNOLOGICAL APPROACHES TO THE CHARACTERISATION AND GENETIC ENHANCEMENT OF GROUNDNUT

RADHAKRISHNAN, LUKE RATNAKUMAR, CHUNILAL, S. K. BERA, T. V. PRASAD, HARIPRASANNA, AND VINOD KUMAR

1 Interspecific Hybridization for gene introgression

1.1 Direct and back cross

Wild *Arachis* accessions are the major sources for resistance against important groundnut diseases. Interspecific hybridization is currently limiting to exploit the gene sources from the compatible species and cultivar, J11 was hybridized as ovule parent with five wild species (table 1) as pollen parent from for introgression of foliar disease resistance. However success has been achieved only in one cross combination between J11 x *A. stenosperma*.

Similarly cultivar GG-2 was backcrossed with existing sixteen different triploid F_1 and hexaploid F_2 interspecific hybrids for development of back cross population (table 2). BC_1F_1 populations will be sown during next rainy season for further use in ongoing interspecific breeding programme.

Besides, cultivar GG-20, a high yielding variety but susceptible to *Sclerotium rolfsii* was hybridized with a resistant interspecific genotype, CS-19 in reciprocal. The F_1 progeny along with reciprocal will be sown during next rainy season for identification of molecular marker for resistance against stem rot disease.

Table 1 Number of crosses attempted during rainy season and hybrids isolated

Sr.No.	Name of Cross	No. of Pollination	No. of Cross pod
1	J11 x *A. pusilla*	742	324
2	J11 x *A. batizocoi*	409	268
3	J11 x *A.cruziana*	454	293
4	J11 x *A .stenosperma*	359	211
5	J11 x A. *glabrata*	508	262
6	GG 2 x (J11 x *A. duranensis F4*)	597	244
7	GG 2 x (J11 x *A. duranensis F4*)	463	370
8	GG 2 x (J11 x *A. duranensis F4*	602	351
9	GG 2 x (J11 x *A. duranensis F4*)	549	225

9	GG 2 x (J11 x *A. duranensis F4*)	436	167
10	GG 2 x (J11 x *A. duranensis F4*)	258	123
11	GG 2 x (J11 x *A. duranensis F4*)	138	47
12	GG 2 x (J11 x *A. cardenasii F4*)	29	10
13	GG 2 x (J11 x *A. cardenasii F4*)	56	37
14	GG2 x (J11 x *A. oteroi* F1)	170	66
15	GG2 x (J11 x *A. cardenasii* F1)	198	56
16	GG2 x (J11 x *A. kretschmeri* F1)	133	42
17	GG2 x (J11 x *A. duranensis* F2)	196	53
18	GG2 x (J11 x *A. correntina* F1)	54	15
19	GG2 x (J11 x *A. helodes* F1)	109	10
20	GG2 x (J11 x *A. diogoi* F1)	150	11
21	CS 19 x GG-20	424	171
22	GG 20 x CS-19	410	141

1.2 Generation advancement

One hundred and seventy one progenies comprising from F_4 to F_7 generations developed from different 22 inter-specific and eight intra-specific crosses have been advanced to the next generation based on agronomic traits and disease reactions during rainy season (table 3). Similarly, 15 M_3 populations of cultivar GG-2 developed through chemical mutagenesis were advanced in bulk during rabi/summer season. Four F_3 populations were advanced to F_3 generation to confirm their inheritance pattern.

Table 2 Advancement of inter and intra-specific progenies

Sr.No.	Cross	Generation	No. of sel. sown	No. of sel. made
Inter-specific				
1	J11 x *A. kretschmeri*	F3	11	21
2	J11 x *A. duranensis*	F4	18	23
3	J11 x J11 x *A. diogoi*	F4	1	2
4	J11 x (J11 x *A. cardenasii*)	BC1 F2	1	Bulked
5	J11 x (J11 x *A. duranensis*)	BC1 F2	1	Bulked
6	J11 x (J11 x *A. kretschmeri*)	BC1 F2	1	Bulked
7	J11 x (J11 x *A. correntina*)	BC1 F2	1	Bulked
8	J11 x (J11 x *A. oteroi*)	BC1 F2	1	Bulked
9	J11 x (J11 x *A. helodes*)	BC1F2	1	Bulked

10	VRI 4 x *A. cardenasii*	BCF4	1	Bulked	
11	VRI 4 x *A. Correntina* 1	Bulked	6XF3		
12	VRI 3 x *A. correntina*	BCF4	1	Bulked	
13	VRI 3 x *A. correntina*	BCF4	1	Bulked	
14	J11 x *A. duranensis*	F2	24	24	
15	6X x *A. cardenasii*	F3	2	2	
16	J11 x *A. duranensis*	F2	5	5	
17	J11 x *A. correntina*	F2	8	8	
18	J11 x *A. helodes*	F2	9	9	
19	J11 x *A. diogoi*	F2	29	29	
20	J11 x *A. kretschmeri*	F2	7	7	
21	J11 x *A. oteroi*	F2	1	1	
22	J11 x *A. kretschmeri*	F7	3	3	
		Total	**128**	**144**	
Intra-specific					
1	CT 7-1 x SB XI	F7	3	3	
2	J11 x Golden yellow		F7	7	5
3	DRx PV	F7	10	8	
4	PT x DR	F7	3	3	
5	J 11 x Black testa	F7	9	3	
6	GY x Puckered	F7	1	1	
7	Puckered x Crinkle	F7	3	2	
8	White testa x PV	F7	3	2	
		Total	**39**	**27**	

1.3 Evaluation of advanced cultures

Three hundred and one advanced interspecifc breeding lines developed for foliar disease resistances were being evaluated along with seven checks (GG-2, GG-20, JI-24, ICGS-44, Chico, TKG 19A and TAG-24) in augmented design during rainy season. Genotypes have been scored for pod yield/plant, shelling percent, 100 kernel weight along with early leaf spot, late leaf spot, rust, collar rot and stem rot diseases.

1.3.1 Genotypes with high pod yield:

Sixty eight genotypes showed promise by recording higher pod yield per plant than best

check (GG-20) pod yield (6.8g). However, thirty six out of sixty eight genotypes recorded higher pod yield per plant than check over last three years. The final yield evaluation of these 36 genotypes will be made under replicated field trial during next rainy season.

Table 3 Genotypes recorded higher pod yield/plant than check over three seasons

Genotype	Mean pod yield/pl. over three seasons (g)	Genotype	Mean pod yield/pl. over three seasons (g)
CS-191	17	CS-82	14
CS-1	16	CS-98	14
CS-211	16	CS-6	14
CS-2	15	CS-36	14
CS-87	15	CS-175	14
CS-184	15	CS-170	14
CS-206	15	CS-53	14
CS-178	15	CS-148	14
CS-163	15	CS-221	14
CS-198	15	CS-232	14
CS-158	15	CS-49	14
CS-229	14	CS-235	14
CS-147	14	CS-83	14
CS-135	14	CS-200	14
CS-93	14	CS-15	14
CS-180	14	CS-199	14
CS-151	14	CS-45	14
v114	14	CS-155	14
GG-20 (check)	12.0		
SE	1.5		

1.3.2 Genotypes with resistance/tolerant to foliar diseases and stem rot pathogen

Eighteen lines, 45 lines, 113 lines and 69 lines recorded significantly less scoring than check against ELS, LLS, Rust and Stem rot respectively under artificial inoculation condition. While, five genotypes viz. CS 77, 86, 132, 160 and 168 recorded multiple disease resistance against ELS, LLS, rust, collar rot and stem rot diseases table 4). CS-77, 86 and 168 among them consistently showed resistance against said four important diseases over last two seasons under field condition (table 5).

Table 4 Multiple diseases resistance genotypes

Genotype	ELS	LLS	Rust	Collar rot	Stem rot
CS-77	0.00	1.83	2.17	0.00	0.00
CS-86	0.00	0.00	0.00	0.00	0.00
CS-132	3.00	2.00	2.00	0.00	0.00
CS-160	3.33	2.17	1.50	1.79	17.86
CS-168	3.00	2.67	1.50	3.85	18.93
GG 20	6.5	6.5	6.16	Not recorded	23.65
GG 2	7.0	7.0	5.4	Not recorded	25.21

Table 5 Mean scoring against four diseases over two season

Genotype	ELS	LLS	Rust	Stem rot
CS-77	2.8	2.8	1.8	19.0
CS-86	3.2	3.4	2.0	15.6
CS 168	3.6	2.3	1.2	11.6

1.4 Yield Evaluation of selected foliar disease resistant genotypes

Eighteen interspecific multiple disease resistant lines have been evaluated in replicated field trial during rainy season. Two advanced lines, CS-158 and DRPV-18 among 18 genotypes evaluated registered significantly higher pod yield of 1017kg and 1102kg, respectively than check yield (910kg) and will be confirmed during next rainy season.

Similarly, five advanced inter specific foliar disease resistant cultures viz, code 42, 28a, 30, 8 and 28 out yielded previously than check over two seasons and fifty kg of pods each of five cultures have been produced during rainy season for AICRPG testing.

Table 6 Pod yield and shelling % of 18 selected interspecific cultures

Genotype	Pod yield (Kg/plot)	Shelling %
CS-6	589.2	59.8
CS-37	750.8	61.0
CS-38	615.3	58.2
CS-98	681.1	59.0
CS-145	688.9	53.2
CS-148	630.8	57.9
CS-153	910.6	54.0
CS-158	**1017.2**	55.8

CS-170	752.2	59.7
CS-199	744.2	62.0
CS-219	759.7	55.5
CS-228	846.1	53.9
CS-229	523.6	55.7
CS-251	723.6	58.0
DR x PV-16	854.7	60.6
DR x PV-17	930.0	54.7
DR x PV-18	**1102.2**	57.0
GG-20 (CH)	**912.2**	**60.4**
Mean	779.6	58.0
SE	154.0	2.7

Plot size=12m²

1.5 Screening of wild species against stem rot pathogen

There are very few resistance sources against *Sclerotium rolfsii* among the cultivated groundnut. Twenty five wild *Arachis* accessions were screened against *Sclerotium rolfsii* to identify the resistance source among wild *Arachis* accessions. The experiment was carried out in earthen pots, replicated thrice under artificial inoculation condition during rainy season. Nine accessions showed 50-100% survivability and 1.2 to 6.4% pod infection and would be confirmed during next rainy season.

Table 7 Promising accession against stem rot pathogen

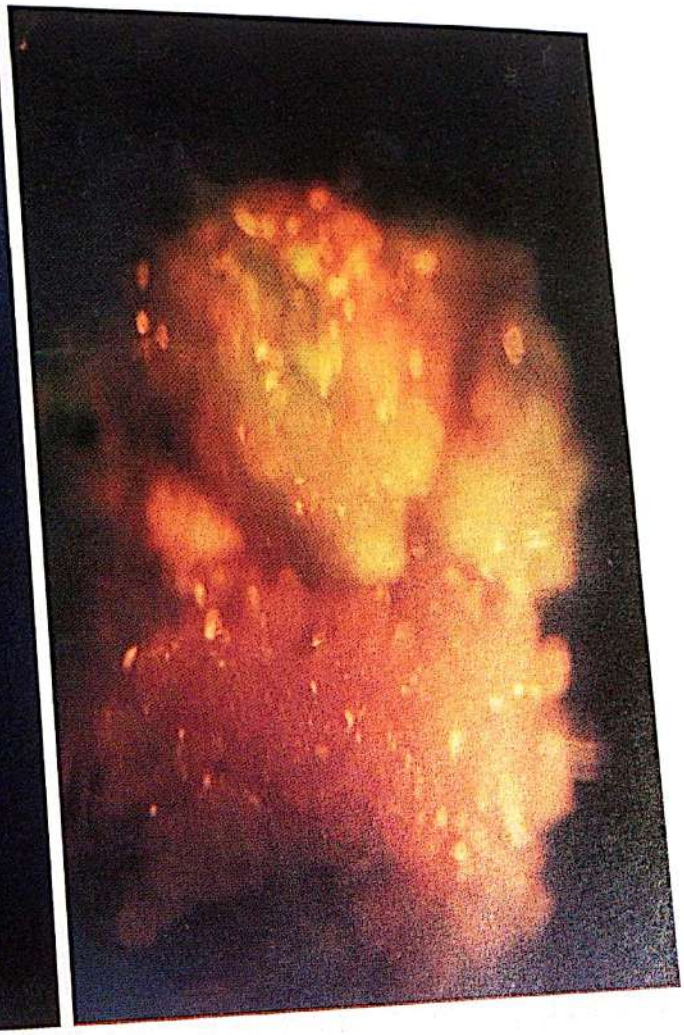
Accession	Species	Survival (%)	Pod infection (%)
12035	*A. appressipila*	100.0	1.8
11789	*A. monticola*	100.0	2.1
12047	*A. pusilla*	100.0	1.4
11800	*A. monticola*	94.1	2.6
11805	*A. duranensis*	91.7	3.5
12031	*A. batizogaea*	64.3	6.4
12030	*A. batizocoi*	60.0	0.0
12032	*A. rigonii*	57.1	2.9
11786	*A. appressipila*	50.0	1.2

1.6 Incorporation of fresh seed dormancy in Spanish bunch groundnut

In situ germination is a major problem in Spanish bunch groundnut. To incorporate fresh seed dormancy in spanish back ground hybridization was made between two mutants viz. purple testa and deep red testa. About 40 days fresh seed dormancy was initially observed among F_4 segregating progenies. Three progeny rows were identified with 40 days fresh seed dormancy during rainy season and have been advanced for further fixation during rabi/ summer season. Progeny with purple testa colour bears fresh seed dormancy while, rest two selections with rose and variegated testa colours, respectively do not bear fresh seed dormancy indicating fresh seed dormancy may be associated with purple testa colour.

1.7 Anther culture for production of Double Haploid

Callus has been inducted from anther cultured in MS medium supplemented with growth hormones. Fifty to 90% callus induction was observed in GG2, TMV 2, TAG 24, JL 24, J 11, GG 2, *A. glabrata, A. rigonii, A. pusilla, a. monticola,* J11 x *A kempff-mercadoi,* J11 x *A. duranensis,* J11 x *A. kretschmeri* and J11 x *A. helodes*) However, maximum callusing (90%) was achieved in GG2. Shoot differentiation from anther derived calli was observed in GG2, JL24, TAG24 and J11. Planlets have been developed successfully in cultivar, GG2 with 20-30% repeatability and are presently growing in rooting media.



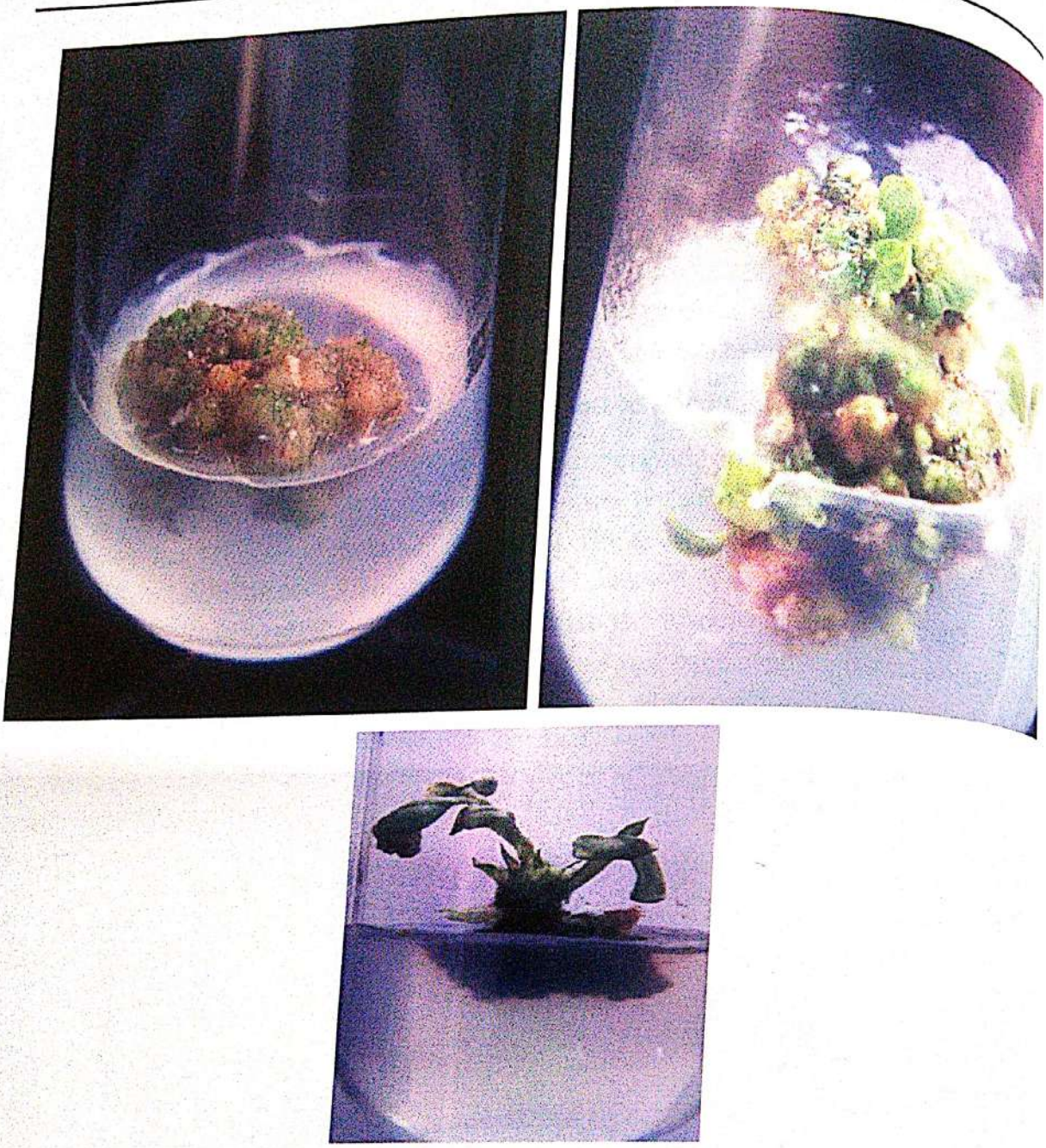


Fig.-1 Callus induction, callus differentiation and shoot formation from anthers of cultivar GG 2

F) Resistance against stem rot pathogen introgessed

Resistance to *Sclerotium rolfsii* has been successfully introgressed from wild background to cultivated background The stem rot resistant genotype, CS-19 is a back cross derivative developed between TMV-2 as female and *A. chacoense* as male parent and also tolerant to early leaf spot, late leaf spot and rust. It is also moderately resistant to PBND, collar rot and Alternaria blight. The CS-19 a multiple disease resistant germplasm has been developed first time at the Center and registered (NGR No.04096). It is a semi spreading Virginia groundnut; matures in 120-125 days with an average pod yield of 2 to 3 tons/ha with 73% shelling out turn and 46.8% harvest Index. Pods are predominantly two seeded and contains 48% oil and 26% protein.

Fig. -2 CS-19 a multiple resistant genotype

1.1.1.1 *Mutant for new plant type developed*

A new mutant with elongated flowering axis (EFA) has been isolated from the cross between two mutants of different testa colour. The EFA mutant bears single elongated flowering axis in each node of both main stem and lateral branches. The elongated flowering axis bears only flower and peg in each node without bearing any leaf. The mutant produced three times more flowers and pegs synchronously than normal plant type.

Fig. -3 Field and close up views of Extended Rachis mutant

2 AFLP Studies on Cultivated groundnut

The following genotypes from the cultivated groundnut, which were earlier reported as disease resistant were selected for the detection of DNA polymorphism and subsequent correlation with the agronomically desirable characters to find our the markers for those if any.

Table 8 List of genotypes used in the study

Sr.No.	NRCG No.	CULTURE	HBT
1	11586	PI 476166	VUL
2	4859	PI 393531	FST
3	11879	PI 476183	FST
4	1177	NCAC 17090	FST
5	5186	PI 298115	HYB
6	13149	203/66 WCG 190	FST
7	4734	NCAC 17718	HYB
8	4853		FST
9	4857		HYR
10	12205	Ah 6	HYR
11	288	Chitala white	HYR
12	8013	EC 35399	FST
13	250	WCG 184	HYR
14	4849	PI 215696	FST
15	11580	PI 476164	FST
16	11581	PI 476195	FST
17	4998	EC 76446 (292)	FST
18	6517	PI 341879	FST
19	7598	PI 259747	FST
20	6524	PI 393641	FST

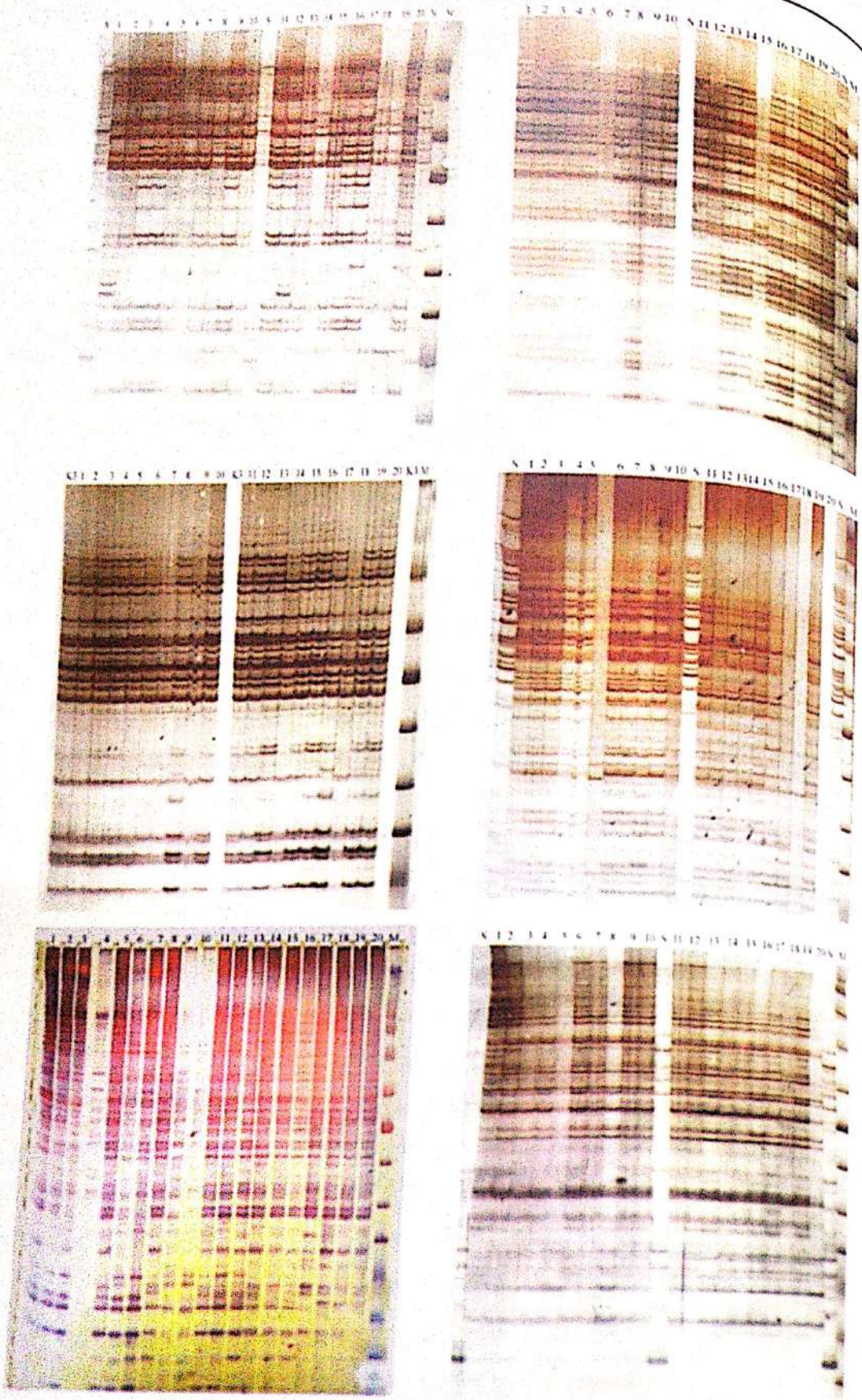
The genomic DNA was amplified using the AFLP protocol standardised and 33 selective primers. All the primers produced bands and a few unique bands were observed in some genotypes (see figures). The detailed analyses of the gels are underway.

Table 9 Banding pattern of AFLP produced in different genotypes by 33 selective AFLP primers

	PRIMER PAIR	TOTAL BANDS
1.	E-AAC/M-CAA	510
2.	E-AAC/M-CAC	680
3.	E-AAC/M-CAT	400

4.	E-AAC/M-CTA	320
5.	E-AAC/M-CTC	540
6.	E-AAG/M-CAA	480
7.	E-AAG/M-CAC	495
8.	E-AAG/M-CAG	527
9.	E-AAG/M-CAT	816
10.	E-AAG/M-CTC	464
11.	E-AAG/M-CTG	340
12.	E-AAG/M-CTT	460
13.	E-ACA/M-CAA	340
14.	E-ACA/M-CAC	504
15.	E-ACA/M-CAT	312
16.	E-ACA/M-CTA	479
17.	E-ACA/M-CTC	418
18.	E-ACA/M-CTT	320
19.	E-ACT/M-CAA	378
20.	E-ACT/M-CAC	284
21.	E-ACT/M-CAG	520
22.	E-ACT/M-CAT	328
23.	E-ACT/M-CTC	374
24.	E-ACT/M-CTG	589
25.	E-ACT/M-CTT	344
26.	E-ACC/M-CAA	620
27.	E-ACC/M-CAC	299
28.	E-ACC/M-CAG	540
29.	E-ACC/M-CAT	620
30.	E-ACC/M-CTA	673
31.	E-ACC/M-CTC	620
32.	E-ACC/M-CTG	257
33.	E-ACG/M-CAG	470
TOTAL	15,321	
Average	464	

Analyses for associating these bands with the disease foliar resistance of these accessions are yet to be done.



AFLP gels showing DNA polymorphism in foliar disease resistant genotypes

3 Preliminary Screening of released cultivars for salt tolerance *in vitro*

In order to have a preliminary screening of the available cultivars of groundnut to their tolerance to salinity, 123 cultivars were grown *in vitro* in three levels of sodium chloride in culture medium.

Multiple shoots were regenerated from de embryonated cotyledons of the seeds f these genotypes and cultured in modified MS medium supplemented with 1, 1.5 or 2.5 % of sodium chloride. Number of healthy shoots growing in these cultures was recorded. Each value was mean of 10 observations and the experiment was replicated thrice. In medium containing 1.5% sodium chloride, the percentage of shoots survived ranged from 66 to 87.4 and in medium containing 2% sodium chloride it ranged from 24.6 to 74.2 whereas a drastic reduction in survival was observed in medium containing 2.5% sodium chloride (0-9.4). Of the 123 cultivars tested, ICGS76, MA16, S-206, and TG27 registered more than 9% survival in 2.5% sodium chloride, the cultivars M-522, MA-16, GG-20 and ICGS-76 registered more than 60% survival in 2% sodium chloride whereas GG-2(1), MA-16, ICGS-76, VRI-4, TMV-2, DSG-1, JL-24, TG-26, M-335, KADIRI-6 and GG-20 showed more than 80% survival in 1% sodium chloride. This result can be compared with the earlier screening done under field conditions for validation and based on that this technique can be used for rapid screening of groundnut for salinity tolerance.

PROJECT 10: ASSESSMENT AND ENHANCEMENT OF QUALITY IN GROUNDNUT AND ITS VALUE ADDED PRODUCTS

(J.B.MISRA, K.K.PAL, R.DEY AND DEVIDAYAL)

SUB PROJECT 01: ASSESSMENT OF QUALITY IN GERMPLASM COLLECTION, BREEDING MATERIAL AND PRODUCE OF OTHER EXPERIMENTS

(J.B. MISRA)

1 Chemical composition of groundnut cultivars

Kernel samples of fifty-six groundnut cultivars (34 Spanish, 12 Virginia Bunch and 10 Virginia Runner) grown during *Kharif* 2004 were analyzed for the contents of oil, protein, reducing sugars, sucrose, free amino acids and total phenols. Stability index (O/Lratio) was also determined.

The kernel oil content was in the range of 43.9 to 54.1% with a mean value 49.3%. Among the spanish types the range was 54.1% (Tirupati-3) to 45.8% (S 206), among Virgina bunch types 48.7% (B95) to 51.4% (R8808) and among Virginia runner types 43.9% (M335) to 53.0% (Somnath). Seven cultivars *viz.*, GG 2, Girnar1, ICG (FDRS) 10, J 11, TG 3, Tirupati 3 and Somnath were identified as high oil (>52.0%) cultivars. Over the years (2001 to 2004), cultivar TMV 12 was found to be the most stable for kernel oil content (cv 0.4%) while the cultivar Chitra showed maximum variation (cv 11.8%).

The ranges of stablitiy indices (oleic acid to linoleic acid ratio or O/L ratio) of spanish, virginia bunch and virginia runner types were 1.6-2.4, 1.1-2.6, and 1.4-2.2, respectively. The O/L ratio was found to be greater than 2.0 in as many as 27 cultivars. The maximum value (2.6) was for the cultivar GG 20. This cultivar has been showing a high O/L ratio year after year.

Irrespective of habit groups, the maximum protein content was found in the kernels Tirupati 4 (30.1%) while the minimum was in Chitra (20.1%).

The ranges of values for contents of phenolics, reducing sugars, free amino acids, and sucrose contents were 0.2-0.5%, 0.1-0.2%, 0.1-0.4%, and 7.5-14.7%, respectively. The results of analysis are shown in Table 1a, b, c, d and e.

2 Services rendered

Analytical services were rendered to scientists of NRCG and other institutions by analyzing their experimental samples. Oil, protein and O/L ratio was analyzed in 1725, 360, and 85 samples respectively (Table 2).

3 Determination of nutritive value of some popular groundnut value added products

Nutritive value of some popular groundnut products was worked on the basis foodstuff compositions in the preparations concerned. The standard values for the nutrients present in each foodstuff (as published in the compilation 'Nutritive Value of Indian Foods'– a publication of NIN, Hyderabad), were used for this purpose. The preparations included salted groundnuts, groundnut chikki, groundnut barfi, spicy g'nuts, nut-chocolate, peanut butter, and groundnut milk (Table 3).

4 Determination of nutritive value and organoleptic qualities of *chapati* prepared from wheat fortified with groundnut

Chapaties were prepared from wheat-groundnut flour prepared by grinding a mixture of wheat grains and groundnut in five different proportions *viz.*, 100:0, 95:5, 90:10, 85:15, and 80:20 by weight. The energy, protein, fat, mineral, and fibre contents of chapati increased with increasing proportion of groundnut while carbohydrate content decreased. The mixing of groundnut not only improved the protein content of flour but also the EAAI of protein. The chapati prepared from a flour of 90:10 mixture of wheat and groundnut, was adjudged to be the best from the organoleptic point of view (Table 4).

5 Evaluation of groundnut cultivars for preparation of peanut-butter

Kernels of seven cultivars *viz.*, ICGV 86325, Somnath, DRG 12, GG 6, JL 24, ICGV 37, and BAU 3 were processed for preparing butter. The colour of butter was autumn leaf from ICGV 86325 and BAU 13, greyish orange from Somnath and DRG12, apricot yellow from GG 6, reddish golden from JL24 and ICGV37. On the basis of combined texural and proximate composition, cultivar Somnath was adjudged to be the best for peanut butter preparation (Table 5).

6 Roasting of groundnut in microwave oven

Twenty kernels each of eight cultivars GG 20, GG 7, ICGS 37, TG 26, Somnath, J 11, JL 24 and ICGS 1 were roasted in microwave oven for 60 and 75 seconds. Kernels of all the cultivars, except TG 26 and ICGS 1, tasted 'done' even at 60 seconds and were easily de-skinned completely. After 75 seconds of roasting, however, even the kernels of TG 26 and ICGS 1 tasted 'done'. The kernels of ICGS 37 and ICGS 1 did not show any discolouration (browning) even when roasted for 75 seconds whereas cultivars J 11. JL 24 and GG 20 showed some discolouration after 60 seconds of roasting and a little more after 75 seconds of roasting. Kernels of cultivars Somnath, GG7 and TG 26 showed discolouration only after 75 seconds of raosting. However, maximum discolouration was seen in the kernels of GG 20 after 75 seconds of roasting. Thus cultivars differed in their response to time of roasting by microwave vis-a-vis doneness and discoloration (Table 6).

Sub project 02: Bio-transformation of groundnut byproducts into useful products

(R. DEY, K.K. PAL AND J.B. MISRA)

1 Utilization of groundnut cake as a substrate for microbial production of proteases

De-oiled groundnut cake was subjected to solid substrate fermentation (SSF) by *Aspergillus awamori* MTCC 548, and *Penicillium roqueforti* MTCC 933. The protease production started after

24 hours by *Penicillium* and after 48h by *Aspergillus*. The activity of protease elaborated was measured at six different pH poits the range of 5.0 to 10.0. In general, both the organisms produced the maximum proteases after 120-144h of inoculation. *Aspergillus* produced 17.7, 14.0, 10.2, 10.2, 9.6 and 11.42 IU of proteases g^{-1} de-oiled groundnut cake at pH points 5.0, 6.0, 7.0, 8.0, 9.0 and 10.0, respectively. *Penicillium* produced 10.8, 21.4, 13.2, 12.8, 43.4, and 18.9 IU of proteases/g cake at pH points 5.0, 6.0, 7.0, 8.0, 9.0 and 10.0, respectively after 144h of inoculation. *Aspergillus* elaborated maximum proteases activity after 144h of inoculation at pH 5.0, 7.0 and 10.0 while *Penicillium* elaborated the same after 120h of incubation at pH 5.0 and 7.0 and after 144h of incubation at pH 9.0. *Penicillium* was found to be four times as efficient as *Aspergillus* in producing alkaline proteases. The results indicated that both the microbes could successfully produce the three types of proteases *viz.*, acid, neutral and alkaline, by utilizing groundnut cake as their substrate.

2 Isolation and identification of potential microbes for proteolytic, lipolytic and amylolytic enzymes

Microbes showing proteolytic, lipolytic and amylolytic properties were isolated from soil by enrichment technique and screened for their enzyme producing potential by petri-dish assays. Ten bacterial and five fungal isolates showing proteolytic activity were selected on the basis of their producing a larger hydrolysis zone (on skimmed milk agar) than that produced by Bacillus subtilis MTCC1789 (standard). Further evaluation of proteolytic bacterial cultures indicated that Bacillus sp. P5, a new isolate, was more efficient than Bacillus subtilis MTCC 1789, in producing acidic, neutral and alkaline proteases from de-oiled groundnut cake in slurry fermentation. At pH points 5.0, 7.0, and 9.0, Bacillus sp. P5 produced 26.2, 28.5, and 62.8 IU of protease g^{-1} cake, respectively after 120h of incubation while the corresponding values for Bacillus subtilis MTCC1789 were 2.52, 6.58 and 11.91 IU protease g^{-1} cake

Sub project 03: Studies on organic farming for maximizing groundnut productivity

(DEVIDAYAL, K.K. PAL AND J.B. MISRA)

1 Studies on contributions of various components of organic farming on yield and quality of groundnut

The experiment was conducted for fourth time in the year 2004 (in continuation to the *kharif* seasons of 2001, 2002 and 2003) for generating information on the contrasting effects of organic cultivation and conventional cultivation (with use of chemical fertilizers and other agrochemicals) of groundnut on pod-yield and kernel-quality and also on the soil health. Three most important components of organic farming *viz.*, farm yard manure (FYM), bio-fertilizer (BF) and bio-pesticides were incorporated in the trial along with components like application of the recommended doses of chemical fertilizers (RDF) and also without application of any type of fertilizer or pesticide (control). The biopesticide component comprised basal application of castor cake (500 kg/ha) and Trichoderma (62 kg/ha) and spray of neem oil (2%) during crop growth. Groundnut cultivar GG 2 was used in the study.

Observations taken 45 days after sowing indicated that the plant receiving bio-fertilizers and bio pesticides were taller and having longer roots compared to those which received FYM, RDF or the control. The differences in the incidences of foliar diseases (ELS, LLS and Rust) were narrow. However, the lowest incidence of collar rot and stem rot was observed in plots receiving bio-pesticides while the plots receiving only FYM had the highest incidence.

Application of FYM in conjunction with RDF gave the maximum pod yield (1547 kg/ha), which was closely followed by RDF (1530 kg/ha) and combined application of FYM, bio fertilizer, biopesticide, gypsum and rock phosphate (1504 kg/ha). Application of FYM alone gave significantly lower yield than that given by RDF.

The organic carbon and nitrogen contents of soil were higher under organic treatments (OC= 0.396-0.407% and N= 38.7-40.2 ppm) than the untreated control (OC= 0.310% and N= 35.9 ppm).

Microbial population in the soil recorded 45 days after sowing indicated that organic treatments, especially organic manure + bio fertilizer+ biopesticide supported a higher activity of fluorescent pseudomonas (0.71 cfu/g x 10^6) and pseudomonas (4.25 cfu/g x 10^8) than the RDF and control.

Table 1a. Chemical composition of groundnut cultivars

Sr. No.	Habit group and name of	Constituent (%)						O/L ratio
		Oil	Protein	Phenols	Amino Acids	Sucrose	Reducing sugars	
Spanish								
1	AK 12-24	50.3	21.4	0.26	0.36	8.61	0.08	2.4
2	CO1	49.0	21.7	0.26	0.39	12.84	0.12	2.3
3	DH 8	48.8	26.1	0.31	0.32	13.08	0.12	1.9
4	DRG 12	47.9	27.7	0.39	0.34	9.28	0.12	1.7
5	GG 2	52.7	23.8	0.51	0.35	9.31	0.13	2.2
6	GG 3	47.7	23.4	0.54	0.38	12.23	0.11	2.0
7	GG 5	50.0	26.0	0.35	0.27	12.27	0.08	1.9
8	GG 7	50.4	27.3	0.53	0.24	12.17	0.10	1.8
9	Girnar 1	54.0	22.4	0.52	0.23	9.57	0.10	2.4
10	ICG(FDRS)10	52.6	22.7	0.31	0.17	9.06	0.12	2.3
11	ICG(FDRS)4	51.1	26.6	0.38	0.35	13.56	0.11	1.9
12	ICGS 1	51.0	26.1	0.38	0.34	10.11	0.17	2.0
13	ICGS 37	51.5	26.3	0.38	0.35	13.08	0.17	2.0
14	ICGS 44	51.5	24.7	0.40	0.34	13.93	0.15	2.1
15	ICGV86590	51.1	25.4	0.41	0.33	7.72	0.15	2.0
16	J 11	52.4	24.4	0.28	0.35	9.09	0.13	2.1

17	Jawan	49.4	22.6	0.28	0.30	9.55	0.07	2.2
18	Jyoti	49.1	21.2	0.27	0.29	8.42	0.11	2.3
19	K 134	48.0	27.8	0.29	0.28	8.84	0.06	1.7
20	Kadiri 4	51.4	23.0	0.33	0.31	7.54	0.09	2.2
21	Kisan	50.1	24.4	0.31	0.34	8.96	0.08	2.0
22	S 206	45.8	24.6	0.27	0.39	12.85	0.09	1.9
23	SG 84	47.0	21.7	0.28	0.30	11.10	0.11	2.2
24	Spanish Imp.	48.1	25.2	0.23	0.33	8.92	0.14	1.9
25	TG 17	49.9	26.1	0.23	0.35	9.01	0.16	1.9
26	TG 26	49.9	25.8	0.24	0.28	11.44	0.11	1.9
27	TG 3	53.3	24.1	0.22	0.29	7.80	0.11	2.2
28	Tirupati 3	54.1	24.7	0.24	0.18	8.26	0.09	2.2
29	Tirupati 4	48.3	30.1	0.24	0.19	11.40	0.10	1.6
30	TMV 12	48.8	24.0	0.24	0.21	10.19	0.10	2.0
31	JL 24	47.6	26.7	0.21	0.16	8.64	0.10	1.8
32	TMV2	46.9	27.5	0.19	0.17	7.66	0.10	1.7
33	TRP 2	50.8	22.1	0.27	0.27	10.31	0.08	2.3
34	VRI 3	50.6	24.4	0.23	0.29	13.58	0.08	2.1
	Minimum	45.8	21.2	0.2	0.2	7.5	0.1	1.6
	Maximum	54.1	30.1	0.5	0.4	13.9	0.2	2.4
	Mean	50.0	24.8	0.3	0.3	10.3	0.1	2.0
	SD	2.1	2.1	0.1	0.1	2.0	0.0	0.2
	CV%	4.1	8.6	30.8	22.6	19.4	24.8	10.2

Table 1a (contd.). Chemical composition of groundnut cultivars

Sr. No.	Habit group and name of	Constituent (%)						O/L ratio
		Oil	Protein	Phenols	Amino Acids	Sucrose	Reducing sugars	
Virginia bunch								
35	B95	48.7	24.7	0.37	0.25	11.03	0.09	1.9
36	DRG 17	49.0	26.3	0.28	0.22	12.98	0.11	1.4
37	GG 20	45.9	24.0	0.32	0.21	12.05	0.21	2.6
38	ICGV86325	49.6	20.6	0.26	0.22	10.48	0.20	1.2
39	K 2	46.9	22.0	0.33	0.23	11.51	0.20	1.9
40	K 3	48.7	24.0	0.26	0.21	12.59	0.15	1.2
41	LGN 2	47.6	28.1	0.26	0.24	11.96	0.20	1.1
42	M145	47.7	23.7	0.24	0.27	11.77	0.06	1.7
43	M222	47.6	21.0	0.32	0.42	12.42	0.15	1.6

44	R6808	51.4	24.1	0.30	0.33	10.75	0.11	1.2
45	R9251	49.3	25.8	0.28	0.33	10.03	0.14	1.1
46	RG 2	50.4	23.0	0.33	0.34	11.42	0.22	1.1
	Minimum	45.9	20.6	0.2	0.2	10.0	0.1	2.6
	Maximum	51.4	28.1	0.4	0.4	13.0	0.2	1.1
	Mean	48.6	23.9	0.3	0.3	11.6	0.2	2.6
	SD	1.5	2.16	0.04	0.07	0.89	0.05	1.6
	CV%	3.2	9.03	13.1	24.9	7.7	33.5	0.44
	Virginia runner							30.3
47	ALR3	48.97	21.82	0.28	0.42	9.71	0.12	
48	Chandra	46.46	20.90	0.39	0.30	11.92	0.14	2.17
49	Chitra	47.15	20.13	0.33	0.08	14.25	0.11	2.05
50	DSG1	45.69	25.35	0.37	0.10	14.70	0.19	1.94
51	GAUG10	46.79	21.82	0.45	0.09	12.90	0.17	1.91
52	Kaushal	47.43	21.05	0.37	0.12	12.20	0.17	1.96
53	M197	49.34	22.12	0.39	0.09	11.59	0.16	2.00
54	M335	43.89	25.81	0.34	0.08	13.31	0.13	1.36
55	S230	48.83	22.59	0.40	0.10	13.39	0.16	2.02
56	Somnath	52.96	21.51	0.25	0.08	11.37	0.07	1.61
	Minimum	43.9	20.1	0.2	0.1	9.7	0.1	1.68
	Maximum	53.0	25.8	0.5	0.4	14.7	0.2	1.4
	Mean	47.7	22.3	0.4	0.1	12.5	0.1	2.2
	SD	2.5	1.9	0.1	0.1	1.5	0.0	1.9
	CV%	5.2	8.3	17.0	79.1	11.8	24.3	0.2
								13.1

Table 1b. Range of values, SD and CV for various constituents

	Oil (%)	Protein (%)	O/L ratio	Phenols (%)	Amino Acids (%)	Sucrose (%)	Reducing sugars (%)
Minimum	43.9	20.1	1.1	0.2	0.1	7.5	0.1
Maximum	54.1	30.1	2.6	0.5	0.4	14.7	0.2
Mean	49.3	24.2	1.9	0.3	0.3	11.0	0.1
SD	2.2	2.3	0.3	0.1	0.1	1.9	0.0
CV%	4.5	9.3	17.8	26.2	35.9	17.6	31.2

Table 1c. Stability of groundnut genotypes for oil their content over the years of cultivation

Genotype	Oil content (%)					
	Kharif 2001	Kharif 2002	Kharif 2003	Kharif 2004	Mean	CV (%)
Most stable						
TMV 12	49.1	49.3	49.0	48.8	49.0	0.4
Tirupati 4	47.1	47.6	49.0	48.3	48.0	1.7
AK 12-24	49.7	49.6	48.0	50.3	49.4	2.0
K134	49.2	47.3	49.5	48.0	48.5	2.1
Jyoti	46.9	48.7	50.0	49.1	48.7	2.6
Most unstable						
DSG 1	47.6	44.9	53.5	45.7	47.9	8.1
TG 26	43.5	45.3	52.0	49.9	47.7	8.3
GG 20	51.1	46.0	54.5	45.9	49.3	8.5
GG 5	44.5	46.3	54.0	50.0	48.7	8.6
Chitra	48.0	40.8	54.5	47.1	47.6	11.8

Table 1d. Studies on stability of oil content of groundnut genotypes (49) over the years of cultivation

Season	Oil content (%)		
	Range	Mean	CV(%)
Kharif 2001	43.5 - 51.8	48.2	4.2
Kharif 2002	40.8 - 50.6	46.9	4.8
Kharif 2003	48.0 - 54.5	51.4	3.6
Kharif 2004	45.7 - 54.1	49.3	4.2

Table 1e. Distribution of groundnut genotypes in various ranges of CV for the oil content over four years (2001-2004)

Range of coefficient of variation over four years (2001-2004)	Number of genotypes
0 to 2.0%	3
2.01 to 4.0%	10
4.01 to 6.0%	21
6.01 to 8.0%	9
> 8.0%	6

Table 2. Analytical services rendered to other scientists/sections

Analysate	Name of the section	Number of samples
1. Oil	Genetic Resources	363
	Plant Breeding	288
	Agronomy	013
	Plant Physiology	389
	Soil Science	011
	Microbiology	110
	Cytogenetics	027
	Entomology	126
	AICRIP(G)	398
2. Protein	Soil Science, JAU, JND	360
3. Stability Index	Soil Science, JAU, JND	85

Table 3. Nutritive value of some value added products of groundnut

Product	Composition per 100g					
	Energy (K cal)	Carbohydrate (g)	Protein (g)	Fats (g)	Mineral (g)	Fibre (g)
1. Salted groundnuts	567.0	26.1	25.3	40.1	2.8	3.1
2. Groundnut chikki	595.9	18.8	18.1	31.5	1.9	2.2
3. Groundnut barfi	511.9	14.5	14.0	25.1	1.4	1.7
4. Spicy groundnuts	554.9	28.8	24.3	34.7	2.4	3.3
5. Nut-chocolate	452.1	35.2	11.3	29.6	2.7	0.4
6. Peanut butter	577.8	28.9	24.3	40.5	3.5	2.9
7. Groundnut milk	98.0	5.0	4.0	7.0	0.0	1.0

Table 4. Organoleptic and nutritive value of chapatis perpared from wheat fortified with groundnut

Ratio (W:G)	Composition per 100g product						EAAI*	Score for taste$
	Energy (K cal)	Carbo-hydrate (g)	Protein (g)	Fat (g)	Minerals (g)	Fibre (g)		
100:0	346	71.2	11.8	1.5	1.5	1.2	0.642	5.7
95:5	357	68.9	12.5	3.4	1.5	1.3	0.648	6.0
90:10	368	66.7	13.2	5.4	1.6	1.4	0.653	8.2
85:15	379	64.4	13.8	7.3	1.6	1.5	0.659	6.7
80:20	390	62.2	14.5	9.2	1.7	1.6	0.664	5.2

*EAAI= Essential amino acid index

$Average of subjective evaluation by six panelists on 1-10 scale

Table 5. Quality attributes of peanut butter prepared from some Indian groundnut cultivars

Cultivar	Colour	Maximum adhesive force (dyne)		Moisture (%)	Oil (%)	Protein (%)	Unsaturated fatty acids		O/L ratio
		Penetration	Withdrawal				Oleic (%)	Linoleic (%)	
ICGV 86325	Autumn leaf	82.0	52.4	0.56	45.6	19.5	10.6	8.1	1.3
Somnath	Greyish orange	73.2	44.8	0.56	49.0	21.1	6.2	3.1	2.0
DRG12	Greyish orange	94.3	56.6	0.54	49.4	19.7	4.6	3.4	1.4
GG6	Apricot yellow	63.3	38.9	0.68	51.1	23.2	4.1	3.1	1.3
JL24	Reddish golden	90.8	81.2	0.74	50.4	24.2	10.0	7.9	1.3
ICGV37	Reddish golden	66.9	45.6	0.58	50.1	21.6	16.0	11.7	1.4
BAU13	Autumn leaf	108.4	81.7	0.74	49.4	22.4	12.5	3.7	3.4
Maximum		108.4	81.7	0.74	51.1	24.2	16.0	11.7	3.4
Minimum		63.3	38.9	0.54	45.6	19.5	4.1	3.1	1.3
Mean		82.7	57.3	0.63	49.3	21.7	9.1	5.9	1.6

Table 6. Evaluation of some groundnut cultivars for their microwave roasting attributes

Cultivar	Duration of microwave (1.25 KW, 2450 MHz) roasting							
	60 seconds				75 seconds			
	Taste	Blanchability	Dis-colouration	Loss of weight (%)	Taste (%)	Blanchability	Dis-colouration (%)	Loss of weight (%)
GG 20	Done	Complete	15	2.98	Complete	Complete	60	3.09
GG 7	Done	Complete	None	0.82	Complete	Complete	10	1.03
ICGS 37	Done	Complete	None	0.58	Complete	Complete	None	1.16
TG 26	Incomplete	Small specks	None	1.77	Complete	Small specks	25	1.70
Somnath	Done	Complete	None	0.55	Complete	Complete	20	1.92
J 11	Done	Complete	15	1.38	Complete	Complete	20	1.81
JL 24	Done	Complete	25	1.82	Complete	Complete	30	1.78
ICGS 1	Incomplete	Small specks	None	0.83	Complete	Small specks	None	0.50
Mean				1.34				1.62

PROJECT 11: PREVENTION AND MANAGEMENT OF MYCOTOXIN CONTAMINATION IN GROUNDNUT

(VINOD KUMAR AND M. P. GHEWANDE)

1 Demonstration of on-farm trial on integrated management of aflatoxin at NRCG

An on-farm trial for demonstration of integrated aflatoxin management package vis-à-vis Farmer's Practice (FP) was laid out at NRCG for the farmers during *kharif* 2004 with the following treatment details for integrated management package (IP):

1. Seed treatment : Bavistin @ 2g/kg seed.
2. Furrow application : *Trichoderma*-100g + 50kg Castor cake/ha
3. First spray at 40-45 DAS : Neem Seed Kernel Extract (5%)
4. Second spray at 60-70 DAS : Carbendazim (Bavistin) (0.05%)+ Mancozeb(0.2%)
5. Variety : GG 20

The Plot size was kept 750 m^2 for both IP and FP. Observations were taken on soil population of *A. flavus* at the time of sowing and before harvesting, seed infection, seed colonization and aflatoxin content in the kernels. The detailed observation is given in Table 1.

Table 1. Evaluation of integrated aflatoxin management package during *kharif* 2004 at NRCG, Junagadh

Observation		Improved Practices*	Farmers Practice*
A. flavus population (*cfu*/g soil)	At the time of sowing	2.67×10^3	2.75×10^3
	Before harvest	1.17×10^3	2.33×10^3
Seed infection (%)	6	31	
Seed colonization (%)	6	29	
Aflatoxin content (ppb)	16.4	30.7	
Pod yield g /25 plants	635.96	614.04	

*Average of three replications

As evident from the data there was a drastic reduction in soil population of *A. flavus*, seed infection, colonization and aflatoxin content in improved management practices (IP) as compared to farmers practice (FP). There was a reduction in pre-harvest aflatoxin content by 46.5% in IP as compared to the control (FP).

2 Revival of cultures of *A. flavus*

Out of 350 isolates, about 150 isolates of *A. flavus* isolated under the externally funded

project (ROPS 17) at NRCG was revived and is being maintained in lyophilized condition for their molecular characterization.

3 Evaluation of *Trichoderma* spp. for biocontrol efficacy against *A. flavus* under laboratory conditions

Antagonistic activity of 17 isolates of *Trichoderma* belonging to eight species was studied under *in vitro* conditions (bangle method) against *Aspergillus flavus*. Out of these isolates, two isolates *viz.*, T 071 and T 29 showed more than 50% inhibition of growth. The maximum inhibition (51.33%) of growth of *A. flavus* was by the isolates T 071 (*T. viride*) and T 29 (*T. coningii*), followed by T 219 (42%) and T 226 (42%) belonging to *T. viride*. The growth and sporulation studies of different isolates of *Trichoderma* revealed that out of seventeen isolates, three viz, T 28, T 93 and T 134 were very good sporulating while the isolates T 72, T 29, T 126, T 219, T 292, T354 and T 362 showed good sporulation. The colony diameter after 3 days of inoculation was maximum (4.93 cm) in isolates T 00 and T 29 followed by T 219 (4.87 cm) and T 257 (4.80 cm). Based on these results it is concluded that the isolates T 071 and T 29 have antagonistic potential against *A. flavus* and could be used as biocontrol agents in reducing aflatoxin contamination in groundnut.

PROJECT 13: BREEDING FOR LARGE SEEDED AND CONFECTIONERY TYPE GROUNDNUT

(HARIPRASANNA, K., RADHAKRISHNAN, T., CHUNI LAL, J.B. MISRA AND VINOD KUMAR)

During the period under report efforts were carried out to acquire new large seeded and confectionery type groundnut cultures and to evaluate the advanced breeding lines developed at the NRCG for yield superiority and quality attributes. Fresh crosses were effected with the objective of increasing the seed size, and segregating generations of various crosses were advanced to next respective generation and selections were made. A brief report of activities undertaken is as follows:

1 Hybridization

During *kharif* 2004, 30 crosses were attempted in a diallel mating design involving six parents, two each of large, medium and small seed size. Crosses involved all possible combinations among these parents. A total of 1569 probable hybrid pods were harvested with a success rate of 23%.

2 Selection and generation advancement

Three crosses made for the purpose of increasing seed size (PBS 29069 x ICGV 86564) as well as incorporating earliness (ICGV 86564 x ICGV 91114, ICGV 91114 x ICGV 86564) were sown and 27 true hybrids were identified. Pods were harvested separately for further advancement. Fourteen crosses in the F_2 were sown and segregating progenies were harvested in bulk after eliminating the non-segregating lines. Phenotypic selections were operated for large pod size in F_3 to F_6 generations and 85 selections were made for advancing to next respective generation. Segregating materials in F_5 and F_6 generations (from 15 crosses) were supplied to 12 AICRP-G centers for location specific selection.

Segregating materials sown and selections made during *kharif* 2004

Gen.	No.of crosses	Seln. sown	Seln. made
F_3	4	4	7
F_4	12	32	30
F_5	23	66	47
F_6	1	2	1
Total			85

3 Multiplication and maintenance

Three advance breeding lines were multiplied and 36 lines were maintained. Five new advanced breeding lines (PBS Nos. 19013, 19014, 19015, 19016 and 19017) were developed from the segregating generation during the season. These will be multiplied, maintained and evaluated in replicated trials subsequently.

4 Station trials

Two different yield evaluation trials, a preliminary and an advanced trial were conducted under this project. The advanced breeding lines developed with different breeding objectives were evaluated under these trials. In all the trials observations on morphological traits, hundred-seed mass (HSM), sound mature kernels (SMK), shelling percent (SP), pod yield (PY) and kernel yield (KY) were recorded and analyzed statistically. The results of these trials are given trial-wise as under:

4.1 Preliminary yield trial of advanced breeding lines

Under this a total of 39 advanced breeding lines were evaluated along with three checks (GG 20, M 13 and TKG 19A) in a replicated trial. Five-plant sampling at harvest was carried out and the relevant observations were recorded. Plant stand, plot yield etc. were also recorded. The entries involved 17 cultures obtained from ICRISAT and seven from BARC. Eight cultures, which recorded yield at par with the check varieties are promoted to large seeded trial in the ensuing *kharif* season. The ICRISAT cultures will be evaluated for one more year in the preliminary trial. The HSM ranged between 30.88 and 59.96 g. The best check, TKG 19A recorded only 51.61 g seed size and six entries had higher seed size than the check.

4.2 Large seeded yield evaluation trial

A total of 23 cultures along with three checks (GG 20, M 13 and TKG 19A) were evaluated in a RCBD. Eighteen cultures were in 2nd year and six were in 3rd year of evaluation. Apart from yield related traits data were also recorded for SCMR, SLA, flowering initiation, 50% flowering, and days to maturity at the time of harvest. Significant variation was found for all the traits studied. The pod yield ranged from 683 to 2764 kg/ha and kernel yield from 444 to 1330 kg/ha. Two entries (PBS 29034 and ICGV 99101) recorded significantly higher pod yield over the best check, GG 20, while two other entries (PBS 23031 and ICGV 00428) had numerically higher pod yield. Apart from these, PBS 29080, 22008 and 21063 exhibited numerical superiority over TKG 19A, the second best check. For kernel yield PBS 29034, ICGV 99101, PBS 23031 and ICGV 00428 exhibited numerical superiority over GG 20. The mean HSM ranged from 25.4 to 57 g and only PBS 29077 had significantly higher seed size than the best check (TKG 19A). The HSM on the basis of sound mature kernels (SMK) ranged from 44.3 to 77.8 g. Three cultures (PBS 29058, 29077 and 29078) had significantly higher HSM than TKG 19A. The proportion of SMK varied between 14 and 51.6% and very high variation was recorded for this trait due to difference in maturity. The mean performance of some selected lines is given in Table 1.

The mean duration for flower initiation ranged between 21.7 to 27.3 days. The days to maturity showed 10 day difference between the earliest and late culture. The culture PBS 19011, which matured in 119 days had the lowest pod yield. The highest yielding culture PBS 29034 had SCMR value above the experimental mean and SLA significantly less than the best check. Both these traits are associated with water-use efficiency and the culture can be adjudged as

efficient in water-use. None of the test entries had higher shelling outturn than the best check, GG 20. Similarly none of the entries had significantly higher harvest index than the check varieties.

Eighteen entries completed two years of evaluation. The variation due to year and G x E interaction was significant indicating the differential response of genotypes over year. The combined analysis showed that PBS 23031 had numerical superiority for both pod and kernel yield over GG 20, and ICGV 99101 for pod yield. PBS 29077 recorded significantly higher HSM (56.6 g) compared to all the checks (Table 2). Out of six entries, which completed three years of evaluation, ICGV 99101 recorded nearly 21% higher pod yield and 10% higher kernel yield over GG 20. The culture had slightly higher HSM (51.3 g) than TKG 19A (50.6 g). This culture will be proposed for testing under AICRP-G trials after seed increase. The highest HSM was recorded for PBS 29058 (58.9 g) (Table 3). The pod and kernel yields in this advance breeding line were higher than TKG 19A but less than GG 20.

4.3 Stability analysis of entries

The entries evaluated for three years were subjected to stability analysis following Eberhart and Russell's Model (1966). The analysis indicated that the mean squares due to environments and environment (linear) were significant thus signifying unit changes in environmental index for each unit change in the environmental conditions. Significant pooled deviation suggested that performance (pod yield) of different genotypes fluctuated significantly from their linear path of response to environments. For pod yield only three entries exhibited regression coefficient (*bi*) near to unity indicating general adaptation, and only GG 20 had high mean, near unity *bi* and moderately low mean square deviation (Table 3). The promising culture ICGV 99101 had high *bi* and mean square deviation, thereby depicting the highly sensitive nature of the genotype. Thus, this genotype can perform well under high input and better management conditions. The results were similar for kernel yield, pod yield per plant and seed size.

5 Quality evaluation

5.1 Physical traits

The produce of the entries evaluated under Large seeded yield evaluation trial in *kharif* 2003 was subjected to quality analysis. The HSM ranged from 27.6 to 56.3 g (PBS 29077). The proportion of SMK varied between 15.9 to 88% with an average of 39.8%. Very high variation was observed (43%) for this trait. Majority of the cultures had elongated-oval to oval seed shape with tapering to intermediate shape of the end (Table 4). Seed size was highly varying with PBS 29077, PBS 29058, PBS 19007, PBS 29072, PBS 29075, ICGV 00428 and ICGV 99101 having moderate uniformity. Entries like PBS 21063, PBS 23031 and PBS 29010 had highly varying seed size with least uniformity. Except four (PBS 19011, 21063, 29075, ICGV 99101) all other entries had pink or light brown testa colour which is acceptable.

5.2 Chemical traits

The oil and protein contents were analyzed in collaboration with Biochemistry section. The oil content in the entries ranged from 42.7% (PBS 29062) to 50.3% (PBS 29021 and 30061) with a mean of 47.3%. The protein content varied from 16.7 to 25.5% with 11 entries exhibiting above experimental average (20.9%) protein content. Thirteen entries had more oil content than the experimental average. Genotypes with high protein content were PBS 29062, PBS 29030, PBS 22008 and PBS 19007 (Table 4).

6 New cultures acquired

Seventeen confectionery quality groundnut germplasm was acquired from ICRISAT during the period. The cultures are CG 7, ICGV 89214, ICGV 90173, ICGV 90196, ICGV 90208, ICGV 90210, ICGV 90212, ICGV 90308, ICGV 90312, ICGV 90325, ICGV 91089, ICGV 91099, ICGV 97040, ICGV 97047, ICGV 97049, ICGV 97051 and ICGV 97061. Large seeded advanced breeding lines from BARC having hundred seed mass of 70 g or above (TG 28, TG 31, TG 33, TG 39, TG 40, TPG 42, TG 45) were also assembled for evaluation. One of the interspecific derivatives, CS 148, was also collected from Cytogenetics section for evaluation and subsequent incorporation in crossing programme.

Table 1. Mean performance of selected advanced breeding lines

Sr.No.	PBS No/name	DTM	PY (kg/ha)	KY (kg/ha)	HSM (g)	SMK (%)	SP (%)	HI (%)
1	PBS 29034	128.7	2764.0	1330.4	40.4	15.6	48.4	39.0
2	ICGV 99101	129.0	2153.5	1321.3	46.7	39.9	61.4	34.7
3	PBS 23031	124.7	1843.5	1227.4	43.6	28.2	66.6	33.4
4	ICGV 00428	128.3	1817.6	1140.3	47.2	20.8	62.7	35.6
5	PBS 21063	126.0	1552.7	977.1	38.8	41.1	63.1	32.5
6	PBS 29080	129.3	1545.3	1011.5	51.9	36.3	65.4	31.0
7	PBS 22008	128.7	1542.0	698.1	25.4	14.7	45.3	36.0
8	PBS 29077	125.3	1357.1	900.3	57.0	38.6	66.5	36.
9	GG 20	124.3	1614.9	1101.5	41.0	33.4	67.9	35.4
10	TKG 19 A	126.3	1533.7	1043.6	47.1	40.7	67.5	36.9
11	M 13	127.3	1414.8	856.5	39.4	14.0	60.9	31.4
	CD (0.05)	4.5	378.5	250.3	8.6	19.9	5.6	8.0

Table 2. Mean performance of selected advanced breeding lines over 2 years

Sr.No.	PBS No/name	PY (kg/ha)	KY (kg/ha)	HSM (g)	SMK (%)	SP (%)	HI (%)
1	PBS 23031	1927.9	1315.2	42.5	23.6	68.1	31.2
2	ICGV 99101	1860.8	1164.1	45.2	35.8	62.8	32.5
3	PBS 29077	1631.6	1128.1	56.6	44.8	68.7	32.7
4	GG 20	1827.6	1266.0	43.9	46.6	69.1	38.1

5	M 13	1555.1	1010.2	42.2	21.1	64.5	29.2
6	TKG 19 A	1671.7	1090.8	46.6	30.9	65.3	35.3
	CD (0.05)	521.2	364.0	9.2	22.8	5.3	9.1
	Prob.Year	0.015	0.008	0.104	0.052	0.047	0.368
	Prob.Genotype	0.000	0.000	0.000	0.000	0.000	0.001
	Prob. G x Y	0.039	0.070	0.340	0.004	0.174	NS

Table 3. Mean performance of selected entries over 3 years and stability parameters

Sr. No.	PBS No/name	PY (kg/ha)	KY (kg/ha)	SP (%)	HSM (g)	bi for pod yield	Mean sq. dev.
1	ICGV 99101	2435.6	1579.8	64.3	51.3	1.87	949255.30
2	PBS 29058	1867.1	1300.2	68.9	58.9	1.29	46940.65
3	GG 20	2009.4	1431.6	70.8	45.4	0.93	-42498.78
4	M 13	1825.2	1214.5	65.8	43.8	1.18	-33682.83
5	TKG 19 A	1647.2	1106.9	67.2	50.6	0.06	-6901.44
	CD (0.05)	619.5	463.7	4.7	9.0		
	Prob. Year	0.001	0.001	0.001	0.000		
	Prob. Genotype	0.001	0.015	0.000	0.000		
	Prob. G x Y	0.004	0.017	0.252	0.168		

Table 4. Quality parameters of entries evaluated during *kharif* 2003

Sl. No.	Genotype	HSM (g)	SHK	SSU	Oil (%)	Protein (%)
1	PBS 19007	44.2	8	6	46.2	23.4
2	PBS 19011	44.8	4	4	44.7	21.9
3	PBS 21063	43.0	6	2	46.2	21.8
4	PBS 22008	27.6	8	4	49.0	24.0
5	PBS 23031	41.4	9	2	47.7	19.8
6	PBS 24041	44.8	9	4	47.8	18.7
7	PBS 29010	47.5	8	2	49.5	16.7
8	PBS 29020	40.5	8	2	47.2	20.1
9	PBS 29021	45.4	6	4	50.3	20.5
10	PBS 29026	39.8	8	5	49.3	17.2
11	PBS 29030	41.3	8	2	48.8	24.6
12	PBS 29056	37.3	8	2	44.7	21.4
13	PBS 29058	54.1	8	8	49.2	19.9
14	PBS 29060	49.7	8	2	48.8	23.4
15	PBS 29062	41.7	8	2	42.7	25.5

16	PBS 29064	39.8	6	4	46.2	21.2
17	PBS 29072	38.7	9	6	47.5	18.7
18	PBS 29075	44.0	8	6	46.8	17.1
19	PBS 29077	56.3	8	8	46.8	20.0
20	PBS 30061	36.8	6	4	50.3	20.6
21	PBS 30062	43.4	7	2	49.5	22.0
22	ICGV 00428	42.2	9	6	45.0	18.1
23	ICGV 99101	43.7	9	6	45.0	21.9
24	GG 20	46.7	9	6	48.8	21.5
25	M 13	45.0	9	9	46.3	20.6
26	TKG 19 A	46.1	9	8	45.0	23.3
	CD (0.05)	10.5	-	-	2.2	1.1

[SHK: shape of kernel- 10 to 1 scale (elongated....round)]

[SSU: seed size uniformity- 10 to 1 scale (highly uniform....highly varying)]

EXTERNALLY FUNDED PROJECT FARMERS PARTICIPATORY VARIETAL SELECTION OF GRAIN LEGUMES IN RAINFED ASIA

(M.S.BASU AND G.GOVINDARAJ)

1 Koraput

1.1 Farmers' Participatory Varietal Selection (FPVS) trials

Forty FPVS trials were conducted in two villages Sundhipongar and Malikhudi, using six varieties, namely ICGV 91114,ICGV 86104,ICGV 86590,TAG 24 K 134 and Smruti. Among these varieties, ICGV 86590 yielded 3080 kg/ha of pods followed by Smruti of 2832 kg/ha. The farmers opined that they prefer these varieties due to their boldness and resistance to pest and diseases. The pod and haulm yield of different varieties are givenin Table 1.

Table 1. FPVS trials at S.Pongar and Malikhudi at koraput during *Rabi* 2004

S.No	Varieties	Pod yield (kg/ha)	Haulm yield(Kg/ha)
1.	ICGV 91114	2656	3922
2.	ICGV 86104	2307	3422
3.	ICGV 86590	3080	5966
4.	TAG 24	2391	3623
5.	K 134	2830	3320
6.	Smruti	2832	4093

1.2 Intercropping trials

Five Groundnut+Sunflower (4:1) intercropping trials were conducted using ICGV 86590 groundnut and MSFH-17 Sunflower. An average yield of 1434 kg/ha of groundnut was obtained along 250kg of sunflower. Farmers were interested to grow sunflower as an intercrop since its oil acts as one of the component in their consumption basket and moreover dependency on Niger oil by them will be minimized.

1.3 On station Back-up trial

Eight varieties, ICGV 91114, ICGV 86104, ICGV 86590, TAG 24, K-134, ICGS 76, Dh 86 and Smruti were used in back up trials at KVK,Semiliguda, Orissa and the results revealed that ICGS 76 performed better than the other varieties. Dh-86 was susceptible to late leaf spot resulting in lower pod yield (Table 2).

Table 2. Results of on station backup trial at KVK, Semiliguda during Rabi/summer 2004

S.No.	Varieties	Pod yield (kg/ha)	Haulm yield(kg/ha)
1.	ICGV 91114	3450	5000
2.	ICGV 86104	2820	4750
3.	ICGV 86590	3020	5370
4.	TAG 24	2560	4000
5.	K-134	2750	4920
6.	ICGS 76	3820	6360
7.	Dh 86	3100	2820
8.	Smruti	3720	5400

1.4 Seed production programme

Two varieties, Smruti (0.032 ha) and ICGS 76 (0.064 ha) were multiplied in KVK farm Semiliguda, Koraput and three quintals thus obtained were distributed to the farmers under KVK's FLD programme. In farmers field at Sundhipongar village, ICGS 76 and ICGV 86590 were multiplied in two ha and the produce obtained were used for sowing during rainy season 2004.

1.5 Nutritional impact study

The nutritional impact study results indicated that in the Sundhi pongar village around 13.6% of the total energy intake (1814.4 Kcal per capita) was contributed through groundnut consumption in the participants where as 8.9% in the non-participant. In Daleiguda village, around 13% of the total energy intake (2001.2 Kcal per capita) was contributed through groundnut consumption among the participants and 4.4% among the non-participants.

Similarly, in Mali-Doli amma village the energy addition due to groundnut consumption among the participants was 11.6% of the total energy intake (2302.1 Kcal per capita) and among the non-participants 5.1% of the total energy intake (1803.7 Kcal per capita). This explicits that the introduction of groundnut in the project site not only helped the participants to achieve nutritional security but also to the non-participants through consumption of groundnut earned through kind wages.

In Daleiguda village the protein addition per capita per day due to consumption of groundnut was 11.1 g and 7.4 g among the participants and non-participants respectively. In Daleiguda the protein addition among the participants was 11.7 g and 2.8 g among the participants and non-participants respectively. Similarly, in Mali Doli amma 11.9 g among participants and 4.1 g among non-participants. From this it can be construed that to some extent energy and protein has been supplemented in the diets of participants and non-participants due to introduction of groundnut in the adopted tribal villages at Koraput.

2 Dhenkanal

2.1 FPVS trial

Fifty on-farm trials (each of 0.01 ha area) using five varieties *viz.*, ICGV 91114, ICGS 76, TAG 24, Dh 86 and Smruti were conducted in river bed/tank areas of Gunadei village at Dhenkanal. The soil type of the plots was light textured sandy loam. Seeds were treated with Carbendazim @ 1.5 g/kg of seeds and were sown behind country plough. Gypsum as basal dose was applied @ 250 kg/ha at the time of final land preparation. The highest pod yield was recorded in ICGS 76 of 1782 kg/ha followed by smruti and Dh86 recorded on a par yield of 1449 kg/ha. The TAG 24 yielded 1278 kg/ha and ICGV 91114 yielded 1212 kg/ha. Besides ICGS 76 the farmers also preferred TAG 24 due to more number of pods i.e. 23 pods per plant as compared to 15-18 pods in other varieties. The pods and haulm yield of FPVS trials are presented in Fig.1.

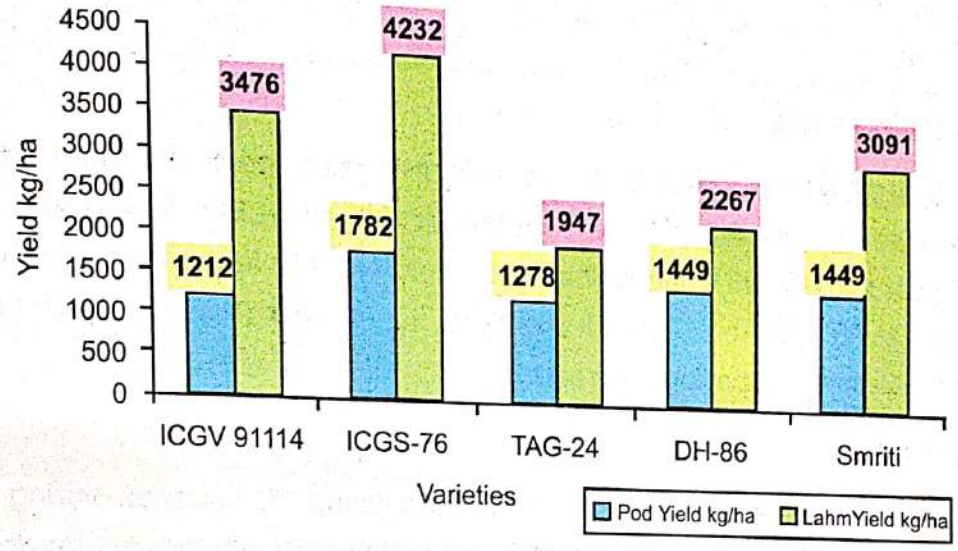


Fig.1. FPVS trials during kharif 2004 at Gunadei

2.2 Integrated Crop Management (ICM) trials

Twenty-eight ICM trials in 6.0 ha were conducted at Gengutia village in 30 farmers' field (each with 0.2 ha of land) of Dhenkanal district. Five groundnut cultivars namely ICGV 9114, ICGS 76, Dh 86 and Smuruti were evaluated under ICM package. The soil type of the plot was red lateritic. Seeds were treated with Carbendazim @ 1.5 g/kg of seeds. Sowing was done behind the country plough. Recommended fertilizers dose of 40:20:20 kg of N, P2O5 and K2O per ha was applied as basal application in soil. Gypsum @ 250 kg/ha was applied at the time of peak flowering followed by hoeing. For controlling insect pests and diseases one

Spray with Chloripyriphos at 60 days after sowing (DAS) and another with Dithane M 45 at 75 DAS were done.

The highest pod yield was obtained in Dh-86 of 1566 kg/ha followed by Smruti (1500 kg/ha), ICGV 91114 (1566 kg/ha), TAG 24 (1203 kg/ha) and ICGS 76 of 1200 kg/ha, respectively. Though Dh86 was the highest yielder, farmers preferred TAG24 due to more number of pods

per plant. Since most of the farmers have sown their crop in uplands which remained fallow for three to five years in addition to early recession of monsoon the crop was affected and there by yield drastically. However, these farmers were interested to grow groundnut in well-drained soils adjacent to Brahmini river during rabi/summer season. The yield performance of ICM trials were presented in Table 3.

Table 3. Results of ICM trials at Gengutia, Dhenkanal

S.No.	Varieties	Pod yield (kg/ha)	Haulm yield (kg/ha)	No.of plants/m²	No.of pods/plant
1.	ICGS 76	1200	2950	24	11
2.	Dh 86	1566	2440	32	14
3.	ICGS 91114	1304	3897	31	12
4.	Smruti	1500	3245	31	13
5.	TAG 24	1204	2020	24	22

2.3 Inter cropping trials

Twenty-eight intercropping trials (groundnut+pigeon pea in 6:2 ratio) in 6 ha area were conducted at Badagilla village. Three varieties, ICGS 44, ICGV 86590 and DRG 12 were intercropped with ICPL 87051.The highest pod yield of 2133 kg/ha was obtained in ICGS 44 followed by ICGV 86590 (1513 kg/ha) and DRG 12 (1424 kg/ha). The pigeon pea was not harvested at the time of preparing this report.

2.4 Back-up trial

Back up trials were conducted at KVK farm using 10 varieties during kharif season 2004. Among 10 varieties none were found to be statistically significant over the local variety Smruti. However, the varieties ICGS 76, ICGV 86590 and Fe(ESG)10 for pod yield were on par with the local variety. Similarly there was no significant difference in haulm yield but ICGS 76 and ICGV 86590 were found to be at par with Smruti. Stastically the harvest index was non-significant but some varieties like TAG 24, TG 41 and TG 26 recorded higher harvest index.

2.5 Seed production programme

In the new project site Dhenkanal, around 151 q consisting of six varieties *i.e.* TAG 24, Dh- 86, ICGS 76, ICGV 86590, DRG 12 and Smruti were produced from 12.6 ha land in three villages Gunadei, Barda and Badigilla and these produce were utilized by the farmers during this Rabi/summer 2005 sowing.However a portion of the produce around 2 q were sold to the farmers of the neighboring district Kendrapara for the current Rabi/summer 2005 sowing. Around 4 q groundnut pods were sold by Badigilla farmers (IFAD adopted) to the farmers of Gajamara and Sadeibarani (IFAD non-adopted). This explicits there was horizontal spread of the improved varieties supplied through IFAD programme.

FARM SECTION

During the period under report various activities including development work attended by the Farm Section are described herewith:

An area of about 22.5 ha in Kharif and 9.4 ha in summer was covered under experiments and land utilization programme. This included experimental trials, agro forestry and general crops. All the pumps, starters and sprayers were got repaired as and when required for smooth functioning of irrigation. Required Farm Yard Manure was procured and incorporated in the fields to maintain soil fertility. Procurement and distribution of agricultural inputs was done both in Kharif and Rabi seasons. Deepening, soil transportation and finishing of pond was got done through Gujarat State Land Development Corporation. An amount of Rs. 3,13,763 was generated by disposing farm products during the financial year.

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Technical bulletins

Basu, M. S. and Devi Dayal. 2004. Crop diversification through intercropping of groundnut, Technology bulletin, National Research centre for Groundnut, Junagadh, pp 32

Reddy, B. N., Devi Dayal, Gawand, P. B., Ramesh, A. and Pratibha, G. 2004. Oilseed cultivars for moisture and nutrient stress. Technology bulletin, DOR, Hyderabad, pp 1-37

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Meetings / Training

Dr.T.V.Prasad

Attended interactive Meeting on "Bio-pesticides in Horticultural Crops" held at Institute of Agricultural Technology (IAT), Bangalore from 14-15th February, 2005

Attended 'Pride of India Expo' held during the 92nd Session of the Indian Science Congress, Ahmedabad, Jan. 3-7, 2005

Dr. Vinod Kumar

Interactive Meeting on "Bio-pesticides in Horticultural Crops" at Institute of Agricultural Technology (IAT), Bangalore, from February 14th to 15th, 2005

Dr. P.C. Nautiyal

"Winter School on "Photosynthesis and Productivity", Organized by the Plant Physiology Division, IARI, New Delhi, from December 2 to 22, 2004.

Dr. Hariprasanna, K.

'Microsatellites for Genetic Diversity Assessment and Cultivar Identification', Jan. 28 to Feb. 5, 2005, NRC for DNA Fingerprinting, NBPGR, New Delhi.

Dr. Devi Dayal

Annual *Kharif* Groundnut Workshop (11-13 April, 2004) at TNAU, Coimbatore

Meeting on FLDs on April 26, 2004 organized by Agril Commissioner, Govt. India at Krishi Bhavan, New Delhi.

Farmers meeting on groundnut production technology organized by Fresh O Veg, Krishak Club, Indore, M. P. on May 30, 2004.

Field survey of villages of Amreli and Junagadh district regarding assessment of drought situation July 24-25, 2004.

National seminar on Organic Farming, Maharana Pratap University of Agriculture and technology, Udaipur, July 30-31, 2004.

Meeting on Minikit on Aug. 12, 2004 organized by Agril Commissioner, Govt. India at Krishi Bhavan, New Delhi.

Mid-Term Review Workshop of ROPS-12 (NATP) (28-29 Sept, 2004) at DOR, Hyderabad.

Annual Rabi/Summer Research Workers Group Meeting (8-9 Oct., 2004) at NRCG, Junagadh.

Meeting on increasing WUE in field crops at Karnal, Nov. 20, 2004, ICAR Regional Committee, Karnal, Haryana.

National Symp. Enhancing productivity of groundnut for sustainable food and nutritional security, Oct. 11-13, 2004, NRCG, Junagadh, Gujarat.

National Symp. on Resource Conservation and Agricultural Productivity. PAU, Ludhiana, November 22-25, 2004.

Farmers meeting on increasing groundnut production organized by Deptt. Agriculture, Gujara state, at Halwad, Surendranagar district on Dec. 15, 2004.

International Conference on Soil, water and environmental quality-issues and strategies, Ne Delhi, January 28- Feb. 1, 2005.

STAFF LIST OF NRCG AS ON 31st March 2005

1	DR.M.S.BASU	DIRECTOR
2	DR. I.K. GIRDHAR	PRI. SCIENTIST
3	DR.M.P.GHEWANDE	PRI.SCIENTIST
4	DR.J.B.MISRA	PRI.SCIENTIST
5	DR.P.C.NAUTIYAL	SR.SCIENTIST
6	DR.DEVI DAYAL	SR.SCIENTIST
7.	DR.A.L.SINGH	SR.SCIENTIST
8.	DR.T.RADHAKRISHNAN	SR.SCIENTIST
9.	DR.V.NANDAGOPAL	SR.SCIENTIST
10.	DR.K.RAJGOPAL	SR.SCIENTIST
11.	DR.A.L.RATHNA KUMAR	SR.SCIENTIST
12.	DR.RINKU DEY	SCIENTIST (SS)
13.	DR.S.K.BERA	SCIENTIST (SS)
14.	DR.CHUNI LAL	SCIENTIST (SS)
15.	DR.K.K.PAL	SCIENTIST (SS)
16.	SH.G.D.SATISHKUMAR	SCIENTIST
17.	SH.G. GOVIDARAJ	SCIENTIST
18.	DR.HARIPRASANNA K	SCIENTIST
19.	DR.T.V.PRASAD	SCIENTIST
20.	SH.V.V.SUMANTH KUMAR	SCIENTIST
21.	DR.VINOD KUMAR	SCIENTIST
22.	DR.R.S.TOMAR	FARM SUPTD. T-6
23.	SH.M.M.DAS	TECH.OFFICER, T-6
24.	MS.S.M.CHAUHAN	TECH.OFFICER, T-6
25.	SH.V.K.SOJITRA	TECH.OFFICER, T-6
26.	SH.V.G.KORADIA	TECH.OFFICER, T-6
27.	SH.D.M.BHATT	TECH.OFFICER, T-6
28.	SH.H.B.LALWANI	TECH.OFFICER, T-6
29.	SMT. VEENA GIRDHAR	TECH.OFFICER, T-6
30.	DR.D.L.PARMAR	TECH.OFFICER, T-6
31.	SH.C.P.SINGH	TECH.OFFICER, T-6
32.	SH.N.R.GHETIA	TECH.OFFICER, T-6
33.	SH.P.V.ZALA	TECH.OFFICER, T-6
34.	SH.H.M.HINGRAJEA	TECH.OFFICER, T-5

35.	SH.P.R.NAIK	TECH.OFFICER, T-5
36.	SH.P.K.BHALODIA	TECH.OFFICER, T-5
37.	MRS.V.S.CHAUDHARY	TECH.OFFICER, T-5
38.	SH.B.M.CHIKANI	TECH. OFFICER,T-5
39.	SH.RANVIR SINGH	TECH. OFFICER,T-5
40.	SH.VIRENDRA SINGH	TECH.OFFICER, T-5
41.	SH.H.K.GOR	TECH.OFFICER, T-5
42.	DR.J.R.DOBARIA	TECH.OFFICER T-5
43.	DR.S.D.SAVALIA	TECH.OFFICER, T-5
44.	SH.M.V.GEDIA	TECH.OFFICER T-5
45.	SH.D.R.BHATT	TECH.OFFICER T-5
46.	SH.A.D.MAKWANA	T.A.T-4
47.	SH.R.D.PADAVI	T.A.T-4
48.	SH.H.V.PATEL	T.A.T-4
49.	SH.V.K.JAIN	T.A.T-4
50.	SH.SURAJ PAL	T.A.T-4
51.	SH.G.J.SOLANKI	T.A.T-4
52.	SH.PRABHU DAYAL	T.A.T-4
53.	SH.SUGAD SINGH	T.A.T-3
54.	SH.C.B.PATEL	T.A.T-3
55.	SH.PITABAS DAS	T.A.T-2
56.	SH.A.M.VAKHARIA	ART.-PHOTO. T-3
57.	SH.P.B.GARCHAR	ELECTRICIAN T-2
58.	SH.K.H.KORADIA	DRIVER T-3
59.	SH.G.G.BHALANI	DRIVER T-2
60.	SH.N.M.SAFI	DRIVER T-2
61.	SH.J.G.KALARIA	TRACTOR DRIVER T-3
62.	SH.B.M.SOLANKI	TRACTOR DRIVER T-2
63.	SH.S.K.GHOSH	ADMN.OFFICER
64.	SH.A.P.SHARMA	FAO
65.	SH. J. RAMANI	AAO
66.	MS.ROSAMMA JOSEPH	Stenographer
67.	SH.Y.S.KARIA	JR.STENO.
68.	SH.L.V.TILWANI	JR.STENO.
69.	SH.J.B.BHATT	ASSTT.
70.	SH.R.T.THAKAR	ASSTT.

71.	MS.K.A.VASANI	ASSTT.
72.	MS.S.VENUGOPALAN	SR.CLERK
73.	MS.M.N.VAGHASIA	SR.CLERK
74.	SH.R.D.NAGWADIA	JR.CLERK
75.	SH.C.G.MAKWANA	JR.CLERK
76.	SH.H.S.MISTRY	JR.CLERK
77.	SH.N.M.PANDYA	SSG 4
78.	SH.D.M.SACHANIA	SSG 4
79.	SH.C.N.JETHWA	SSG 3
80.	SH.B.K.BARIA	SSG 3
81.	SH.R.B.CHAWDA	SSG 3
82.	SH.M.B.SHEIKH	SSG 2
83.	SH.J.G.AGRAWAT	SSG 2
84.	SH.R.V.PUROHIT	SSG 2
85.	SH.V.N.KODIATAR	SSG 2
86.	SH.K.T.KAPADIA	SSG 2
87.	SH.G.S.MORI	SSG 1
88.	SH.P.M.SOLANKI	SSG 1
89.	SH.R.P.SONDARWA	SSG 1
90.	SH.A.D.MAKWANA	SSG 1
91.	SH.V.M.CHAWDA	SSG 1
92.	MS.D.C.SACHANIA	SSG 1
93.	SH.N.G.VADHER	SSG 1
94.	SH.B.J.DABHI	SSG 1
95.	SH.P.N.SOLANKI	SSG 1

2. Staff Strength

Total staff in NRCG, and the Number of SC/ST and OBC employees as on 31.3.2003-2004.

Category of staff	Sanctioned	Filled	SC	ST	OBC
Scientific	40	20	03	-	04
Technical	39	41	06	4	03
Admn.	13	13	02	-	01
Supporting	19	19	04	01	06
Total	111	103	15	05	14

3. Departmental Promotion committee

The DPC/Assessment Committee Meeting was held at the NRCG on 21-22/8/2004

Sl.No.	Name of personnel	Existing post	Promoted post
1	Sh.P.V.Zala	Tech.Officer,T-5	Tech.Officer T-6
2	Sh.Prabhu Dayal	T.A.T-II-3	T-4
3	Sh.G.J.Solanki	T.A.T-I-3	T-4
4	Sh.Sugad Singh	T.A.T-I-3	T-3
5	Sh.K.H.Koradia	T.A.T-I-3	T-3
6	Sh.J.G.Kalariya	T.A.T-I-3	T-3
7	Sh.A.M.Vakhariya	T-2	T-3
8	Sh.Pitabas Das	T-1	T-2

- Assurance Career Promotion Committee (ACP) held on 7.12.2004 for considering the cases of Financial Upgradation of two Admn.Staff.
- Research Advisory Committee Meeting was held during 14-15/10/2004.
- Institute Management Committee Meeting was held on 4.1.2005.

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