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ANNUAL REPORT 2008-09

भाकृअनुप
ICAR

मूँगफली अनुसंधान निदेशालय

पो. बो. नं. 5, जूनागढ़ – 362 001, गुजरात, भारत

Directorate of Groundnut Research

P.B. No. 5, Junagadh-362001, Gujarat, India

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Directorate of Groundnut Research
(Indian Council of Agricultural Research)
P.B. No. 5, Ivnagar Road, Junagadh, Gujarat, India

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Prologue

The year 2008-09 had rather been a year of lassitude for NRCG. The incumbent director Dr. V. Muralidharan, who took over as the new director in November 2007 opted for his repatriation to TNAU, Coimbatore. He was eventually relieved on 31st May 2008. Dr. I.K. Girdhar, the next senior-most scientist, conveyed his unwillingness to ICAR for taking over the reigns, for some personal reasons, and serve NRCG as the officiating director. As a sequel, the ICAR decided to appoint me as the officiating director of NRCG with effect from 1st June 2008 till a regular director took over. At that time, the NRCG was embroiled in several court cases and other in-house simmering problems. As such, I was not in a position to help much because as an officiating director I could not take major policy decisions. Hence, decisions on many issues were simply deferred to be taken by the would-be regular director. Thus many crucial decisions were delayed. Although, the XIth five-year plan period began from 1st April, 2007, the EFC recommendations were not approved and this was the second financial year running without an approved XIth plan budget.

The situation, however, did not last long. On the basis of my selection through ASRB, I was appointed as the regular director by the ICAR on 11th January 2009 for the next five years. And soon came the approval of the XIth five-year plan budget and along with it the communication that NRCG is to be elevated to the level of a Directorate. Thus the NRCG was rechristened as the Directorate of Groundnut Research (DGR) w.e.f. 24.02.2009. Thus, for about first nine months of the financial year (from April to December 2008) there prevailed an atmosphere of uncertainty and lack of full enthusiasm. Soon after my appointment as the regular director in January 2009 followed by approval of budget for XIth Plan in February '09, a feeling of stability was restored and this unit started catching up the lost momentum.

The immediate daunting task ahead for me was to fully utilize the plan and non-plan funds before 31st March 2009, i.e. by the close of the fiscal year. And this was indeed achieved with the co-operation and zeal of the scientists and other administrative staff.

Several remedial steps were needed. Stores section was to be made more responsive and prompt. The administrative set up needed to be transformed into a modern service support system by shedding as much load of the red tape as possible. The farm land, of which a large part was covered with plethora of bushes required to be cleared for taking up land development work. The resource generation and seed production activities needed to be revived from their nadir. The security set up needed toning up. The much needed maintenance of official and residential buildings was to be attended to and their ambience improved.

The most important task was to inculcate a new work-culture by restoring the sagging morale that had gripped the personnel, the next was to get the vacant positions of the scientific category filled as early as possible for it would not be possible to deliver the goods in time with about half the scientists on position against the sanctioned post of 39 compounded with a third of ministerial positions lying vacant. And finally the research projects needed to be reoriented to be in conformity with latest developments in farm sciences.

In the milieu, the publication of annual reports and newsletters also suffered. To my utter chagrin, the annual reports for the years 2006-07 and 2007-08 were also pending. An initiative was therefore taken to clear the backlog and this annual report for the year 2008-09 is now ready to see the light of day.

The contributions of the DGR scientists for inclusion in this report are gratefully acknowledged. The painstaking efforts of Dr. Rinku Dey, Senior Scientist (Microbiology) in compiling, editing and overseeing the over all process of publication of this report deserves sincere appreciation. The contributions of Dr. Radhakrishnan, T., Principal Scientist, in designing the cover page and that of Sh. C.P. Singh, Tech Officer (T6) and Sh. V.K. Jain, Technical Officer (T5) in providing the Hindi version of the executive summary are thankfully acknowledged.

(J.B. Misra)
Director

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सारांश

- खरीफ मौसम के लिए मूंगफली की एक वर्जीनिया प्रजाति, "गिरनार 2" उत्तर-पश्चिमी प्रक्षेत्र (उत्तरी रजस्थान, पंजाब एवं उत्तर प्रदेश के लिए विमोचित की गई।
- बेहतर शस्यीय परिस्थितियों में विभिन्न जैविक एवं अजैविक दबावों के प्रति प्रतिरोधकता/सहिष्णुता को सन्निहित करने के लिए खरीफ 2008 में 20 संकर बनाने का प्रयास किया गया।
- इस वर्ष के दौरान कुल 85 अग्रिम प्रजननिक लाइनें विकसित की गई।
- ए वी टी (AVT) में प्रदर्शन के आधार पर एक अग्रिम प्रजननिक कल्चर PBS 12160 को अग्रिम प्रजातीय परीक्षण के लिए प्रोन्नत किया गया।
- एक ही संकर से चयनित कुल 40 व्युत्पन्नों में फली की उपज 2263 से 3438 कि.ग्रा./है. तक पाई गई तथा दानों की उपज 1419 से 2329 कि. ग्रा./है. पाई गई। जब कि तुलनात्मक दृष्टि से पैत्रिक लाइनों की फली की अधिकतम उपज 1448 कि.ग्रा./है. तथा दानों की 609 कि.ग्रा./है. थी। दो के अलावा इन सभी व्युत्पन्नों में एस सी एम आर (SCMR) सार्थक रूप से उच्च पाया गया।
- खरीफ 2007 में बनाए गए विभिन्न संकरों की F_1 पीढ़ी को खरीफ 2008 में लगाया गया तथा सही संकरों की पहचान की गई।
- शस्यीय परिस्थितियों में विभिन्न जैविक एवं अजैविक दबावों के प्रति प्रतिरोधकता/सहिष्णुता को सन्निहित करने के लिए विगत वर्ष में बनाए गए विभिन्न पीढ़ियों (F_3 से F_5) से 209 एकल पौधों का चयन किया गया।
- खरीफ 2008 में विकसित की गई 371 अग्रिम प्रजननिक लाइनों को अनुरक्षित किया गया।
- दो प्रजातियों, गिरनार 1 एवं गिरनार 2, के न्युक्लियस बीज का उत्पादन किया गया और गिरनार 2 के बीज को बहुगुणन की कडी में लाने के लिए इसके 6.7 कुन्टल न्युक्लियस बीज की आपूर्ति एस एफ सी आइ (SFCI) को गई।
- विभिन्न प्रजननिक कार्यक्रमों के लिए बनाए गए 23 संकरों के पृथकीकृत पदार्थ को स्थान विशिष्ट के चयन एवं प्रजातियों के विकास के लिए मूंगफली पर अखिल भारतीय समन्वयित अनुसंधान परियोजना के पांच केन्द्रों पर भेजा गया।
- मोनोक्रोटोफॉस (0.04%) के छिड़काव के उपरान्त वी. लेकैनी (*Verticillium lecanii*) के व्यवसायिक फॉर्मुलेशन को 2 ग्रा./लीटर की दर से छिड़काव करने से जैसिड एवं थ्रिप्स की संख्या न्यूनतम पाई गई।
- जैसिड की संख्या कम करने में इमिडाक्लोप्रिड (0.0035%) द्वारा बीजोपचार + बुआई के 30 एवं 45 दिन बाद इमिडाक्लोप्रिड (0.008%) का छिड़काव सार्थक रूप से बेहतर पाया गया।
- खरीफ 2008 के मौसम में अग्रिम प्रजननिक लाइनों NRCG CS nos. 101, 108, 241, एवं 290 को जैसिड के प्रति मध्यम दर्जे का प्रतिरोधक पाया गया।
- मूंगफली की प्रजातियों GG 5, GG 7 एवं R 9251 को जैसिड के विरुद्ध तथा GG 2, GG 3, GG 7, Kadiri 4, Kadiri 5, R 9251 एवं TAG 24 को थ्रिप्स के विरुद्ध मध्यम दर्जेका प्रतिरोधक पाया गया।
- मूंगफली की GG 3, Jyoti, R 8808 एवं TAG 24 A प्रजातियों में कैरीडॉन सेरेटस (ब्रुचिड) के अण्डों की औसतन संख्या 116.3 की तुलना में CO 2 प्रजाति में अण्डों की संख्या सिर्फ 40 पाई गई।
- आपेक्षिक आर्द्रता (79.6%) एवं तापक्रम (27.6°सेन्टीग्रेड) पर कैरीडॉन सेरेटस (ब्रुचिड) के अण्डों, लारवों, प्यूपों एवं वयस्कों की अवधि क्रमश: 4.3, 30.2,17.6 एवं 19.8 दिन पाई गई।

- चूसने वाले कीटों के नियन्त्रण के लिए प्रयोग किए गए कीटनाशकों में फिप्रोनिल से 1 मि. ली./कि.ग्रा. बीज की दर से बीजोपचार करना, जैसिड की संख्या कम करने में सार्थक रूप से बेहतर पाया गया जबकि थायोमेथोक्जाम को 1 मि.ली./कि.ग्रा. बीज की दर से प्रयोग करना थ्रिप्स की संख्या को कम करने में बेहतर पाया गया।
- बुआई के 30 एवं 45 दिन बाद इमिडाक्लोप्रिड (0.008%) का छिड़काव जैसिड एवं थ्रिप्स को कम करने में प्रभावी पाया गया।
- चूसने वाले नाशीकीटों जैसे कि जैसिड एवं थ्रिप्स की अधिकतम संख्या अक्टूबर में तथा एफिड एवं पर्णसुरंगियों की अधिकतम संख्या दिसम्बर में दर्ज की गई। हेलिकोवर्पा एवं स्पोडाप्टेरा की संख्या वर्षा ऋतु में कम पाई गई।
- दो जननद्रव्यों यथा NRCG CS 73 एवं 85 ने अगेती एवं पछेती पर्णधब्बा तथा रस्ट के प्रति प्रतिरोधकता दर्शाई।
- जननद्रव्यों NRCG CS 329 एवं 346 ने अगेती एवं पछेती पर्णधब्बा, रस्ट तथा तनासड़न के प्रति बहुआयामी प्रतिरोधकता दर्शाई।
- रायचुर जैसे संवेदनशील स्थान पर खेतों में दो जननद्रव्यों यथा NRCG CS-296 एवं CS-263 को प्रतिरोधक प्रतिक्रिया (संवेदनशील चेक KRG 1 में अधिकतम प्रभाव 41.86% की तुलना में 5% से भी कम) के लिए दर्ज किया गया।
- मृदा में समृद्ध ट्राईकोडर्मा के अनुप्रयोग तथा पर्णधब्बा के प्रथम बार दिखने पर वी. लेकैनी (*V. lecanii*) के छनित कल्चर को 50% तनुता पर पर्णीय छिड़काव के बाद 15 दिनों के अन्तराल पर दो और छिड़काव करने पर पछेती पर्णधब्बा रोग की तीव्रता को सार्थक रूप से कम दर्ज किया गया।
- एकीकृत रोग प्रबन्धन के एक प्रयोग में टेबुकोनाजोल (Tebuconazole) को जब बीजोपचार (1.5 ग्रा./कि.ग्रा.) तथा पर्णीय छिड़काव (1 मि.ली./ली.) के रूप में अनुप्रयोग किया गया तो तना-सड़न, अगेती व पछेती पर्णधब्बा एवं रस्ट का प्रभाव न्यूनतम पाया गया।
- नये फफूंदीनाशकों में टेबुकोनाजोल (Tebuconazole) द्वारा बीजोपचार (2 ग्रा./कि.ग्रा.) करने से तना सड़न (3.85%) तथा फली सड़न (13.3%) के रोगों का न्यूनतम प्रभाव पाया गया तथा अधिकतम उपज दर्ज की गयी।
- ऐसा देखा गया कि मूंगफली, सोयाबीन, अरहर, मूंग तथा उर्द के फसल के अवशिष्ट *Sclerotium rolfsii* के कवकजाल की वृद्धि एवं स्क्लेरोटियल (sclerotial) के अंकुरण को उत्प्रेरित करते हैं तथा तना सड़न के प्रभाव को बढ़ाते हैं।
- *Sclerotium rolfsii* के आइसोलेटों में बाह्य आकारिकी एवं रोगमूलक विभिन्नता के अध्ययन के साथ वानस्पतिक सुसंगता एवं भिन्नता विश्लेषण के आधार पर चार आईसोलेटों यथा NRCG-CSR 6, 7, 18 एवं 57 की पहचान की गयी जिन्हें कि सिक प्लॉट (sick plot) के विकास हेतु उपयोग किया जा सकता है।
- अप्रैल एवं मई 2009 में कच्छ एवं सौराष्ट्र क्षेत्रों के किसानों के खेतों में ग्रीष्मकालीन मूंगफली की फसल में आलटरनेरिआ लीफ ब्लाइट (*Alternaria* leaf blight) का फूट पड़ना दर्ज किया गया। गुजरात के जूनागढ़ एवं राजकोट जिलों में मूंगफली के खेतों में सभी प्रजातियों एवं वृद्धि की सभी अवस्थाओं में इस रोग की तीव्रता 0-67% तक पाई गई।
- सूखा-सहिष्णुता से सम्बन्धित गुणों की पहचान के लिए बीजों तथा पौधों के ओज का अध्ययन किया गया और आशाजनक लाइनों की पहचान की गई जिन्हें कि मूंगफली की प्रजातियों के विकास में उपयोग किया जा सकता है।
- मूंगफली के 30 स्पैनिश प्रजातियों में प्रकाश संश्लेषण तथा इसका कार्यकीय, बाह्य आकारकीय, उत्पादकता गुणों एवं फली उत्पादन के साथ सम्बद्धता का अध्ययन किया गया। कम एवं अधिक प्रकाश संश्लेषण दर वाली प्रजातियों की पहचान की गयी तथा इनका उपयोग प्रकाश संश्लेषण तथा उत्पादकता से सम्बन्धित स्रोत-सिंक (source-sink) के सम्बन्ध को स्पष्ट करने में किया गया।

- सामान्य सिंचाई एवं जल की कमी की परिस्थिति के अंतर्गत जननद्रव्यों एवं प्रजातियों की मूल संरचना का अध्ययन किया गया तथा सूखा-सहिष्णुता से संबद्ध गुणों की पहचान की गयी।
- पी जी पी आर (PGPR), पी एस एम (PSM) एवं मूंगफली राइजोबिया के कंसोर्शिया का परीक्षण किया गया और पी एस एम तथा राइजोबिया के एक कंसोर्शियम को मूंगफली की प्रजाति GG 2 की उपज बढ़ाने में आशाजनक पाया गया।
- फॉस्फेट विलायक सूक्ष्मजीवों (पी एस एम) के कंसोर्शियम के निवेशन के परिणाम स्वरूप मूंगफली की प्रजाति गिरनार-2 की उपज में 9.6% की वृद्धि पायी गई।
- ए एम फफूंदी, ग्लोमस फैसिकुलेटम (*Glomus fasciculatum*) तथा ग्लोमस मॉसी (*Glomus mosseae*) के निवेशन के परिणाम स्वरूप मूंगफली की प्रजाति GG 2 के फली उत्पादन में 23% की बढ़ोत्तरी पाई गई।
- 'टेल्कम पाउडर पर आधारित कल्चर' को बीजों के जीवाणुवीकरण हेतु उपयोग करने से सिद्ध हुआ कि यह लाभकारी जीवाणुओं के कंसोर्शियम के लिए एक अच्छी डिलीवरी प्रणाली होगी।
- एक तरल फॉर्मुलेशन (परिवर्तित King's B broth) ने स्युडोमोनास मीकुलिकोला (*Pseudomonas maeculicola*) $S_1(6)$ के भण्डारण अवधि को बढ़ाने में काफी सहारा दिया।
- फॉस्फोरस, बोरॉन एवं जिंक तत्व फलियों में समुचित भराव को सुनिश्चित करने के लिए महत्वपूर्ण पाये गये हैं। इसलिए बीजों के उचित आकार और मूंगफली के बड़े बीजों की गुणवत्ता को बनाए रखने के लिए इनका अनुप्रयोग आवश्यक है।
- खेत में जांचे गए 110 जननद्रव्यों में से निम्नलिखित की पहचान पोटाश एवं गन्धक-दक्ष के रूप में की गयी।
  - पोटाश दक्ष: Chitra, GG 13, CSMG 84-1, GPBD 4, LGN 2, Tirupati 3 एवं ALR 2
  - गंधक दक्ष: CSMG 84-1, Tirupati 3, GG 7, GG 13, ALR 1, SP 250A एवं ICGV 86590.
- मूंगफली की प्रजातियों ने तांबे के अनुप्रयोग पर सकारात्मक अनुक्रिया दिखाई।
- लौह एवं जस्ता की उच्च मात्रा युक्त कुछ प्रजातियों की पहचान की गयी।
- पूर्वोत्तर पर्वतीय क्षेत्रों में खेतों पर प्रदर्शन के आधार पर GG 2, GG 20, GG 13, TG 37A, ICGS 76 एवं CSMG 84-1 की पहचान उच्च उत्पादकता वाली प्रजातियों के रूप में की गयी।
- पूर्वोत्तर पर्वतीय क्षेत्रों में मूंगफली के साथ मक्का, धान, तिल या मूंग का अंतर्शस्यन अनुकूल पाया गया।
- मूंगफली की बड़े बीज वाली प्रजायों में से TPG 41, CSMG 84-1, ICGS 76, एवं NRCG CS 208 ने पूर्वोत्तर पर्वतीय क्षेत्रों में अच्छा प्रदर्शन किया और इस क्षेत्र में बड़े बीज वाली मूंगफली के लिए फॉस्फोरस, कैल्शियम, बोरॉन तथा कार्बनिक खाद को क्रांतिक घटकों में पाया गया।
- कार्बनिक स्रोतों में पिग स्लरी, वर्मी कम्पोस्ट, कुक्कुट खाद तथा ग्लिरिसिडिया (Gliricidia) तथा सुबबूल की हरी पत्तियों को सर्वाधिक आशाजनक पाया गया।
- मूंगफली–गेहूं–मूंग फसल प्रणाली के साथ एक टन गोबर की खाद +RDF 50% का अनुप्रयोग मृदा के कार्बनिक कार्बन और प्रणाली की कुल अधिकतम उत्पादकता (मूंगफली के तुल्य उपज) के साथ मूंगफली और गेहूं दोनों फसलों के लिए सर्वाधिक टिकाउ पाया गया।

- साइट्रिक एसिड अनुप्रयोग से मूंगफली का उत्पादन बढ़ता है तथा गोबर की खाद या सिंगल सुपर फॉस्फेट के साथ उपयोग करने पर उत्पादन और भी बढ़ता है। एक टन गोबर की खाद/है. के साथ दो किग्रा. साइट्रिक एसिड के अनुप्रयोग से मूंगफली का अधिकतम उत्पादन दर्ज किया गया।

- दो किग्रा. साइट्रिक एसिड + एक टन गोबर की खाद/है. के अनुप्रयोग के साथ मृदा में मुक्त-जीवी नत्रजन स्थिरी कारकों की संख्या अधिकतम पाई गई। विश्लेषण से स्पष्ट हुआ कि साइट्रिक एसिड को जब गोबर की खाद के साथ अनुप्रयोग करते हैं तो मुक्तजीवी नत्रजन स्थिरी कारकों की संख्या बढ़ती है तथा सिंगल सुपर फॉस्फेट के साथ अनुप्रयोग करने पर यह संख्या घटती है।

- NBPGR के हैदराबाद स्थित क्षेत्रीय स्टेशन से *Arachis* संवर्ग की बीज बनाने वाली प्रजातियों की 47 तथा Rhizomatosae की तीन प्रविष्टियां प्राप्त की गयीं तथा खेत के जीन-बैंक में स्थापित की गयीं।

- कुल 351 प्रविष्टियों, जिनमें ICRISAT की 184 तथा एन आर सी जी के कोर कलेक्शन की 167 शामिल हैं और जो कि विभिन्न बाह्य शारीरिक गुणों की विभिन्नता का प्रतिनिधित्व करती है, का खरीफ में बहुगुणन किया गया। फसलोन्नत कार्यक्रम में उपयोग के लिए मूंगफली के जंगली संबंधियों सहित जननद्रव्य की 1762 प्रविष्टियों को मांगकर्ताओं को भेजा गया।

- मात्रात्मक एवं गुणात्मक गुणों की अनुवांशिकता, भिन्नता के जननिक गुणांकों, अस्थिरता के गुणक तथा औसत प्रदर्शन के आधार पर संकेत मिले हैं कि निम्नलिखित प्रविष्टियों को मूंगफली में विशिष्ट गुणों के विकास के लिए पैत्रिकों के रूप में प्रयोग किया जा सकता है:

  ⇒ अगेतीपन के लिए: NRCG 14407

  ⇒ गठीले पौधों के लिए: NRCG 14425

  ⇒ जड़ों के अधिक जैव-द्रव्य के लिए: NRCG 14356

  ⇒ अधिक द्वितीयक शाखाओं के लिए: NRCGs 14377, 14470

  ⇒ उच्च उत्पादकता के लिए: NRCGs 14365, 14368,14433

- स्पैनिश बंच मिनी-कोर कलेक्शन में ताजे बीजों में सुसुप्तावस्था के लिए मूल्यांकन ने संकेत दिये कि 4 प्रविष्टियां NRCG 14329, NRCG 14349, NRCG 14350, NRCG 14409 लम्बी अवधि (60 दिनों) की सुसुप्तावस्था रखती है जबकि अन्य चार NRCGs 14326, 14336, 14368, 14380 में यह सुसुप्तावस्था अवधि 40 दिन की पायी गयी।

- आंध्रप्रदेश के कादिरी जैसे संवेदनशील केंद्र पर छंटनी की गई सात प्रविष्टियों (PI 268573, SPANISH 2B, MTUTU C, SCHWARZ 21, LE 36, SPZ PURPLE, NCAc 515) में मूंगफली के PSND का 5% से भी कम संक्रमण दर्ज किया गया।

- एम टी एल डी (*mtlD*), एनेग्जिन (annexin) तथा डिफेन्सिन (defensin) जीनों का उपयोग करके जननिक रूपान्तरण का कार्य प्रारंभ किया गया।

- जल-उपयोग-दक्षता एवं फफूंदीजनित रोग सहनशीलता के लिए RIL की जननद्रव्यता का कार्य प्रगति पर है।

- विभिन्न अन्तरशस्यीय प्रणालियों में से मूंगफली-बाजरा अन्तरशस्यीय प्रणाली में एसपर्जिलस फ्लैक्स की संख्या खरीफ 2007 एवं ग्रीष्म 2008, दोनों मौसमों में सार्थक रूप से कम पाई गई।
- लम्बी अवधि के फसल चक्र के परिणामों से स्पष्ट हुआ है कि लहसुन या प्याज की फसलों के बाद ली गई मूंगफली की फसल एफ्लटॉक्सिन के संदूषण एवं एसपर्जिलस फ्लैवस की संख्या को सार्थक रूप से कम होती है।
- ट्राइकोडर्मा स्पिशीस के आइसोलेटों से समृद्ध कार्बनिक वाहकों के प्रयोग पर अध्ययन से स्पष्ट हुआ है कि NRCG T12 आइसोलेट से समृद्ध नीम या अरण्डी की खली ने एफ्लाटॉक्सिन के संदूषण एवं एसपर्जिलस फ्लैक्स की संख्या को सार्थक रूप से कम किया है।
- मूंगफली के पौधों को उल्टा कर पंक्ति में हवा से सुखाने के बाद जल-शुष्कक के साथ पॉलीथीन बैग में भण्डारित की गईं सूखी फलियों एवं दानों में कैरीडॉन सेर्रेटस (बुचिड) का प्रकोप, एसपर्जिलस फ्लैवस का उपनिवेशन एवं बीजों में संदूषण तथा B1 एफ्लाटॉक्सिन का स्तर निश्चित रूप से कम पाया गया।
- फसलोपरान्त भण्डारण के अध्ययन से स्पष्ट हुआ है कि मूंगफली के दानों में कैरीडॉन सेर्रेटस (बुचिड) के प्रकोप तथा एसपर्जिलस फ्लैवस का बीजों में उपनिवेशन तथा एफ्लाटॉक्सिन संदूषण में सकारात्मक सम्बद्धता होती है।
- ढेर में से एफ्लाटॉक्सिन संदूषित दानों को हटाने के लिए मानवीय तथा इलेक्ट्रॉनिक पृथकीकरण के संयुक्त तरीके को बहुत ही प्रभावी पाया गया है।
- तेलरहित मूंगफली की खली में कुछ प्रोटियोलिटिक फफूंदी के प्रोटिएज (protease) उत्पादन सामर्थ्य का मूल्यांकन किया गया। सॉलिड सब्सट्रेट फर्मेन्टेशन (SSF) के दरम्यान *Aspergillus nidulans* MTCC 831 नामक फफूंदी ने अधिकतम प्रोटिएज उत्पादन दर्शाया।
- जिस अनुकूलतम तापक्रम तथा pH पर *Aspergillus nidulans* के उदासीन प्रोटिएज (280.26 IU/mg) ने अधिकतम अनुक्रिया दर्शाई, वह क्रमश: 50 डिग्री सेन्टीग्रेड तथा 7.0 पाया गया। प्रोटिएज लगभग 78 KD आकार का प्रोटीन है। बाजार में उपलब्ध डिटर्जेन्टों के साथ उपयोग करने पर डिटर्जेन्टों की धोने की क्षमता बढ गई जिससे प्रोटिएज के साथ डिटर्जेन्टों की सुसंगतता का संकेत मिला।
- उच्च उत्पादकता सामर्थ्य की पृष्ठभूमि में बड़े बीज के गुणों को सन्निहित करने के लिए नए संकर बनाए गए। विभिन्न पृथकीकृत पीढ़ियों को क्रमश: अगली पीढ़ियों में बढाया गया तथा बड़े बीजाकार/फली उत्पादन के लिए बाह्य आकारिकी पर आधारित चयन किए गए। बड़ी फलियों/बड़े बीजाकार/या फली उत्पादन वाली ग्यारह अग्रिम प्रजननिक लाइनों (सात स्पैनिश, एक वर्जीनिया) को विकसित किया गया।
- विकसित की गई अग्रिम प्रजननिक लाइनों तथा NRCG एवं ICRISAT दोनों के 77 जननद्रव्यों का प्राथमिक मूल्यांकन परीक्षण किया गया। इसी प्रकार अन्य 26 अग्रिम प्रजननिक लाइनों को एक साल (खरीफ 2008) तथा 12 अग्रिम प्रजननिक लाइनों को दो साल (खरीफ 2007 एवं 2008) के लिए बड़े बीजाकार वाली मूंगफली की उपज मूल्यांकन परीक्षण में चेक के साथ मूल्यांकन किया गया।
- दो वर्षों (खरीफ 2007 एवं 2008) में ICGV 97051 में अधिकतम फलियों (1661 किग्रा./है.) तथा दानों (1084 किग्रा./है.) का उत्पादन दर्ज किया गया हालां कि सांख्यकीय दृष्टि से यह आंकड़े चेक की प्रजाति GG 2 (1570 किग्रा. फलियां तथा 1137 किग्रा. दानें /है) के लगभग बराबर ही पाए गए।
- ग्रीष्म 2008 में भी 29 जननद्रव्यों का मूल्यांकन किया गया।

- उत्पादन तथा प्रमुख रोगों के प्रति प्रतिक्रिया के आधार पर चयनित की गई 11 प्रजननिक लाइनों में से NRCG CS 360 में फलियों का अधिकतम उत्पादन (134 ग्रा./10 पौधों) अवलोकित किया गया उसके बाद NRCG CS 376, NRCG CS 366 एवं NRCG CS 359 में अधिक उत्पादन पाया गया।
- उच्च उत्पादकता एवं सम्बन्धित गुणों के लिए पित्र GG 2 एवं उन्नत प्रजाति GG 20 की अपेक्षा उत्परिवर्ती NRCG CS 379, NRCG CS 394, NRCG CS 407 एवं NRCG CS 401 सार्थक रूप से आशाजनक पाए गए।
- संवेदनशील स्थान पर सुग्राही चेक KRG 1 में अधिकतम स्कोर 7 के विरुद्ध NRCG CS 108, NRCG CS 109, एवं NRCG CS 206 में यह स्कोर 3 दर्ज किया गया। NRCG CS 215, NRCG CS 241, NRCG CS 244 , NRCG CS 245 एवं NRCG CS 260 में PBND के 5% से भी कम प्रभाव को दर्ज करके इन्हें प्रतिरोधक पाया गया। तना-सड़न के प्राकृतिक प्रभाव का औसत 2.1% (NRCG CS 221 एवं NRCG CS 108 में) रहा।
- जंगली एरैचिस प्रविशिष्टियों NRCG 11811 (*A. stenophylla*), 11831 (*A. glabrata*) एवं 12035 (*A. appresipilla*) में कम एस एल ए (SLA) तथा अधिक एस सी एम आर (SCMR) दर्ज किया गया तथा इन्हें जल के सीमित दबाव के प्रति सहिष्णु पाया गया।
- जंगली एरैचिस प्रविशिष्टियों 11846, 11821 एवं 11817 में सोडियम तथा कैल्शियम लेने का अनुपात कम होने के कारण इन्हें सोडियम क्लोराइड से उत्पन्न लवण के दबाव को सहन करने में मदद मिली।
- मूंगफली की 93 विमोचित प्रजातियों में सात गुणवत्तात्मक गुणों: कच्ची प्रोटीन (CP), प्राकृतिक डिटर्जेन्ट रेशे (NDF), अम्लीय डिटर्जेन्ट रेशे (ADF), अम्लीय डिटर्जेन्ट लिग्निन (AD L), कुल शर्करा (TS), उपपचयी ऊर्जा (ME) तथा पात्र में कार्बनिक पदार्थ की पचनीयता (IVOMD), की भिन्नता का मूल्यांकन किया गया। मूंगफली की 3 विमोचित प्रजातियों TG 22, VRI 2 एवं M 13 को एक या अधिक गुणों के लिए आशाजनक पाया गया तथा इन्हें चारा की गुणवत्ता के विकास के लिए प्रजनन में दाता के रूप में उपयोग किया जा सकता है।
- नत्रजन एवं चारा की गुणवत्ता के 6 गुणों के बीच आपसी सम्बन्धों से संकेत मिला है कि रेशे के तीनों अंशों के साथ नत्रजन की मात्रा का सार्थक रूप से नकारात्मक सह-सम्बन्ध है जबकि कुल शर्करा, उपपचयी ऊर्जा तथा पात्र में कार्बनिक पदार्थ की पचनीयता एवं नत्रजन का सार्थक रूप से उच्च सकारात्मक सह-सम्बन्ध है। परिणामों से सुझाव मिलता है कि नत्रजन की मात्रा के लिए चयन के साथ-साथ दो महत्वपूर्ण गुणों उपपचयी ऊर्जा तथा पात्र में कार्बनिक पदार्थ की पचनीयता विकसित होती है जबकि रेशे के अन्य अंशों में विचारणीय कमी आती है।

Summary

- Girnar 2, a Virginia bunch variety was released for commercial cultivation in the north-western zone (northern Rajasthan, Punjab and Uttar Pradesh) of India for *kharif* season.
- For incorporating resistance/tolerance of different biotic and abiotic stresses into the superior agronomic background, 20 fresh crosses were attempted in *kharif* 2008.
- A total of 85 new advanced breeding lines were developed during the season.
- Based on the performance in IVT, an advanced breeding culture PBS 12160 has been promoted to advanced varietal trials.
- Amongst forty selections derived from a single cross, the range of yield of pod was 2263-3438 kg/ha and that of kernel 1419-2329 kg/ha. Comparatively the best yields of the parental lines were 1448 kg/ha and 609 kg/ha. Interestingly, except two genotypes, all these high-yielding genotypes had a significantly high SCMR.
- F1 generations of different crosses attempted in *kharif* 2007 were raised in *kharif* 2008 and the true hybrids were identified.
- A total of 209 single plant selections was made in different filial generations (F 3 to F 5) of the crosses attempted in the previous years for incorporating resistance/tolerance to different biotic and abiotic stresses in agronomic background.
- In *kharif* 2008, a total of 371 advanced breeding cultures, developed under the project, were maintained.
- Nucleus seed of two varieties Girnar 1 and Girnar 2 was produced. A total of 6.7 q nucleus seed of Girnar 2 was supplied to SFCI for entering this variety into seed multiplication chain.
- Segregating material of 23 crosses attempted for different breeding programmes was supplied to five AICRP-G centers for location specific selection and varietal development.
- The lowest population of jassids and thrips were observed with spray of monocrotophos (0.04%) followed by commercial formulation of *V. lecanii* (2g/L).
- The seed treatment with Imidacloprid (0.0035%) + 2 sprays of 0.008% Imidacloprid at 30 and 45 DAS was found significantly superior in reducing jassids population. Advanced breeding lines NRCG CS nos' -101, 108, 241 and 290 were found moderately resistant against jassids during the rainy season of 2008.
- Cultivars GG 5, GG 7 and R 9251 were found moderately resistant to jassids and GG 2, GG 3, GG 7, Kadiri 4, Kadiri 5, R 9251 and TAG 24 were found moderately resistant to thrips.
- Minimum oviposition of *Caryedon serratus* was observed in cultivars, GG 3, Jyoti, R 8808 and TAG 24 (<40 mean number of eggs) as compared to CO 2 (116.3).
- The egg, larval, pupal and adult period of *C. serratus* at a temperature of 27.6°C and RH 79.6% were 4.3, 30.2, 17.6 and 19.8 days, respectively.
- Among the new insecticides tried for seed treatment for control of sucking pests, fipronil @ 1 mL/kg seed was found significantly superior in reducing jassid population while thiomethoxam @ 1g/kg seed was the best in reducing thrips population.
- Two spray application of 0.08% imidachloprid at 30 and 45 DAS effectively reduced jassids and thrips

- The sucking pests like thrips and jassids were found maximum during October and highest population of aphids and leaf miners were recorded during December. *Helicoverpa* and *Spodoptera* continued to be present in low numbers during rainy season.
- The two genotypes *viz.*, NRCG CS-73 and 85 showed resistance to ELS, LLS and rust.
- The genotypes, NRCG CS -329 and 346 showed multiple diseases (ELS, LLS, rust and stem rot) resistance.
- Two genotypes *viz.*, NRCG CS-296 and CS-263 recorded resistant reaction (<5% incidence as against the highest 41.86% in the susceptible check KRG 1) to PBND under field conditions at Raichur, a hot spot location.
- Significant reduction in the disease severity of LLS was observed by soil application of enriched *Trichoderma* plus foliar spray of culture filtrate of *V. lecanii* at 50% dilution on the first appearance of the leaf spots followed by two sprays at 15 days interval.
- In IDM experiment, the lowest incidence of stem rot and the severity of ELS, LLS and rust were observed in the treatment, where tebuconazole was applied as seed treatment (1.5 g/kg) and foliar spray (1mL/L)
- Among the new fungicides, the least disease incidence of stem rot (3.85%) and pod rot (13.3%) was observed with the seed treatment of tebuconazole (2 g/kg) recording highest pod yield.
- The crop residues of groundnut, soybean, pigeon pea, green gram, and black gram stimulated mycelial growth, sclerotial germination of *Sclerotium rolfsii* and enhanced stem rot incidence.
- On the basis of studies on morphological and pathogenic variability in isolates of *S. rolfsii* in conjunction with vegetative compatibility and diversity analysis, four isolates *viz.*, NRCG-SR 6, 7, 18 and 57 were identified that could be used in a consortium for development of sick plot.
- Seed and seedling vigour was studied to identify traits associated with drought tolerance and potential lines were identified, which could be utilized to improve groundnut cultivars.
- Among the 30 Spanish groundnut cultivars, photosynthesis and its associations with several physiological, morphological, yield attributes and pod yield were studied. Cultivars with low and high photosynthetic rate were identified and their use in elucidating the source sink relationship was suggested.
- Root architecture under normal irrigation and water deficit conditions was studied in germplasm lines and cultivars and traits associated with drought tolerance were identified.
- Consortia of PGPR, PSM and groundnut rhizobia were tested and a consortium of PSM and rhizobia was found promising for enhancing yield of groundnut (GG 2).
- Inoculation of consortium of phosphate solubilising microorganisms (PSM) resulted in enhancing yield of groundnut cultivar Girnar 2 by 9.6%.
- Inoculation of AM fungi *Glomus fasciculatum* and *Glomus mosseae* resulted in enhancement in pod yield of groundnut, cultivar GG 2 by 23%.
- Talcum powder based culture used for seed bacterization proved to be a good delivery system for a consortium of beneficial bacteria.
- A liquid formulation (modified King's B broth) supported high shelf life of *Pseudomonas maculicola* S1(6).

- Phosphorus, boron and zinc were found to be important nutrients for ensuring proper filling of pods and hence their application is essential for maintaining proper seed size and also quality in large-seeded groundnut.
- Out of 110 genotypes screened in the field, the following K- and S-efficient genotypes were identified:
  - K-efficient: Chitra, GG 13, CSMG 84-1, GPBD 4, LGN 2, Tirupati 3, and ALR 2.
  - S-efficient: CSMG 84-1, Tirupati 3, GG 7, GG 13, ALR 1, SP 250 A, and ICGV 86590.
- Groundnut cultivars gave a positive response to the application of copper
- A few high Fe- and Zn-density cultivars were identified
- On the basis of performance in field in NEH region the cultivars GG 7, GG 20, GG 13, TG 37A, ICGS 76, and CSMG 84-1 were identified as high yielding cultivars.
- Intercropping of groundnut with maize, rice, sesamum, or mung was feasible in NEH region.
- Among the large-seeded groundnut cultivars, TPG 41, CSMG 84-1, ICGS 76, and NRCGCS 268 performed well in NEH region and applications of P, Ca, B and organic manures were among the critical inputs for large-seeded groundnut in this region.
- Among the organic sources, pig-slurry, vermi-compost, poultry manure and green leaf of *Gliricidia* and subabul were found to be the most promising.
- Groundnut-wheat-green gram cropping system with the application of FYM (5 t/ha) + RDF (50%) to both groundnut and wheat crops was found to be most sustainable with highest total system productivity (groundnut equivalent yield) and soil organic carbon.
- Application of citric acid (CA) increased pod yield of groundnut over no application and being higher when applied either with FYM or SSP. The highest pod yield was recorded with the application of 2 kg CA along with 1 t FYM/ha.
- The maximum population of free-living N_2-fixers in the soil was observed with '2 kg CA + 1 t FYM/ha'. Analysis revealed that the population of free-living N_2-fixers increased when CA was applied with FYM and decreased when applied with single super phosphate.
- Forty-seven accessions of seed forming species of the section *Arachis* and three accessions of the section *Rhizomatosae* were also obtained from National Bureau of Plant Genetic Resources (NBPGR), Regional Station, Hyderabad and established in field gene bank.
- A total of 351 accessions containing (184 ICRISAT and 167 mini-core accessions of NRCG) representing wide variations for different morphological traits were multiplied in *kharif* season. One thousand seven hundred and sixty-two germplasm accessions including wild relatives of groundnut were supplied to 40 indenters for use in the crop improvement programmes
- Based on mean performances, coefficient of variability, genetic coefficients of variations and heritability of both qualitative and quantitative traits indicated that the following accessions could be used as parents for improving specific traits in groundnut:
  - For earliness, NRCG 14407
  - For compact plant type, NRCG 14425
  - For high root bio-mass, NRCG 14356

- For more secondary branches, NRCGs, 14377, 14470
- For high pod yield, NRCGs, 14365, 14368, 14433

- Evaluation for fresh seed dormancy in Spanish bunch mini-core collection indicated that four accessions, NRCG 14329, NRCG 14349, NRCG 14350 and NRCG 14409 were found to possess a long dormancy period of 60 days while in four others ((NRCGs'14326, 14336, 14368, 14380) the dormancy period was up to 40 days.
- Seven accessions (PI 268573, SPANISH 2B, MTUTU C, SCHWARZ 21, LE 36, SPZ PURPLE, NCAc 515) recorded less than 5% infection against Peanut Stem Necrosis Diseases (PSND) when screened at a hotspot center, Kadiri, Andhra Pradesh.
- Genetic transformation work has been initiated using mtlD, annexin and defensin genes
- Genotyping of the RILs for water-use-efficiency and fungal diseases tolerance are in progress
- Among different intercropping systems, the population of *A. flavus* was significantly low in groundnut-pearl millet intercropping system in both *kharif* 2007 and summer 2008.
- The results on long-term crop rotations revealed that garlic and onion crops significantly reduced the soil population of *A. flavus* and aflatoxin contamination in the subsequent groundnut crop.
- Field studies with organic carrier enriched with isolates of *Trichoderma* spp. revealed that neem or castor cake enriched with the isolate NRCG T12 effectively reduced *A. flavus* population and aflatoxin contamination.
- The lowest infestation of bruchids (*C. serratus*) in pod and kernels, seed infection and colonization of *A. flavus* and the levels of aflatoxin B_1 were invariably low in the pods dried with inverted windrow method and subsequently stored along with a desiccant in polyethylene bags.
- Post-harvest storage studies revealed that a positive association exists between infestation of groundnut kernels by bruchids (*C. serratus*) and seed colonization of *A. flavus* and aflatoxin contamination.
- Blanching in conjunction with manual and electronic sorting was found to be a very effective method for removing aflatoxin-contaminated kernels from the bulk lot.
- The protease production potential of some proteolytic fungi was evaluated on de-oiled groundnut cake. The fungus *Aspergillus nidulans* MTCC 831 showed maximum protease production during solid substrate fermentation (SSF).
- The optimum temperature and pH at which the neutral protease of *A. nidulans* showed maximum activity were 50° C and 7.0, respectively (280.26 IU/mg protein). The enzyme is a protein of about 78 KD size. When used in combination with detergents available in the market, the washing capacity of the detergents improved indicating the compatibility of the protease enzyme with the detergents.
- Fresh crosses were effected to incorporate the trait of large-seed in high yield potential background. Segregating material in different generations were advanced to next respective filial generations and phenotypic selections were made for large-pod size and/or pod yield. Eleven advanced breeding lines (seven Spanish, one Virginia) possessing large pod/seed and/or pod yield superiority were developed.

- Seventy-seven cultures including germplasm lines from both NRCG and ICRISAT, and advanced breeding cultures developed under the project were evaluated in a preliminary yield evaluation trial. Similarly another 26 advanced breeding cultures were evaluated in large-seeded yield evaluation trial for single year (*kharif* 2008) and 12 advanced breeding lines over two years (*kharif* 2007 and 2008) along with yield checks.
- Over two years (*kharif* 2007 and 2008) ICGV 97051 recorded the highest pod (1661 kg/ha) and kernel (1084 kg/ha) yields though these figures were statistically at par with those of check variety GG 20 (1570 kg pods and 1137 kg kernels/ha.
- Twenty-nine germplasm lines were also evaluated in summer 2008.
- Among eleven breeding lines selected based on pod yield and reactions to major diseases, highest pod yield was observed in NRCGCS-360 (134 g/10 plants) followed by NRCGCS-376, NRCGCS-366 and NRCGCS-359.
- Mutants NRCGCS-389, NRCGCS-394, NRCGCS-407 and NRCGCS-401 were promising for significantly higher pod yield and its related traits over the parent (GG 2) as well as elite cultivar (GG 20).
- NRCGCS-108, NRCGCS-109 and NRCGCS-206 scored 3 for LLS against maximum score of 7 in susceptible check (KRG 1) at hot spot location. NRCGCS-215, NRCGCS-241, NRCGCS-244, NRCGCS-245 and NRCGCS-260 were highly resistant to PBND by recording less than 5% incidence. The natural incidence of stem rot ranged between 2.1% (NRCGCS-221 and NRCGCS-108)
- Wild *Arachis* Accessions NRCG 11811 (*A. stenophylla*), 11831(*A. glabrata*) and 12035 (*A. appresipilla*) recorded lower SLA as well as higher SCMR and were tolerant to water limited stress.
- The low Na/K uptake ratio in wild *Arachis* accessions 11846, 11821 and 11817 support their tolerance to NaCl induced salt stress.
- Variation for seven fodder quality traits, crude protein (CP), neutral detergent fibre (NDF), acid detergent fibre (ADF), acid detergent lignin (ADL), Total sugars (TS) metabolizable energy (ME) and *in vitro* organic matter digestibility (IVOMD) were evaluated in 93 released groundnut varieties. Three groundnut varieties, TG 22, VRI 2 and M13 were found promising for one or more traits and can be used as donors in breeding for fodder quality improvement.
- Inter relationship between nitrogen content and six fodder quality traits indicated that nitrogen content is significantly and negatively correlated with the three fibre fractions while the relationship of nitrogen with total sugars, metabolizable energy and *in vitro* organic matter digestibility was positive and highly significant. The results suggested that selection for nitrogen content would simultaneously improve the two important quality traits, metabolizable energy and *in vitro* organic matter digestibility while considerably reducing the other fibre fraction in the fodder.

Research Accomplishments

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

(CHUNI LAL, A. L. RATHNAKUMAR, K. HARIPRASANNA (up to 23.8.09), VINOD KUMAR, T. V. PRASAD, P. C. NAUTIYAL AND A. L. SINGH)

Hybridization

In *kharif* 2008, 20 crosses were attempted for incorporating tolerance of different biotic and abiotic stresses and to develop mapping populations for some of the important traits like root traits, fresh-seed dormancy, and tolerance of stem rot and other foliar fungal diseases. Out of 8116 total hand pollinations only 1520 resulted in probable hybrid pods. Thus the rate of success of crossing was 18.7%. This low rate of success was attributable to the unfavouarble excessive and continuous rains, which prevailed during the *kharif*-2008 season.

Selections and generation advancements

During *kharif* 2007 twenty F_1s and forty-four F_2s developed were raised and true hybrids were identified based on the hybrid vigor in F_1 and segregation in F_2 generations. Eight such crosses in F_2 generation were rejected, as these crosses did not show explicit segregation in F_2. Two hundred and nine single plant selections were made in different filial generations (F_3 to F_5) in the crosses attempted in the previous years for incorporating resistance/tolerance to different biotic and abiotic stresses. Eighty five non-segregating new advanced breeding cultures were identified in F_6 (71) and F_7 (14) generations.

Multiplication and maintenance of advanced breeding cultures

In *kharif* 2008, in all 371 advanced breeding cultures (Table 1) developed earlier were raised for maintenance. These cultures, among others included 48 advanced breeding cultures developed for high water use efficiency and 51 mutants of variety Girnar 1 also.

Table 1. Attributes of advanced cultures multiplied and maintained

Purpose	Multiplication		Maintenance	
	Spanish	Virginia	Spanish	Virginia
Yielding ability	6	9	34	18
Earliness	0	0	19	32
Resistance to abiotic stresses	14	42	10	9
Dormancy	4	7	39	33
Viability/BNF	0	0	8	2
Disease resistance	4	1	18	26
Insect resistance	0	0	5	6
A. flavus (aflatoxin) resistance	0	0	12	2
Mutants	-		50	
WUE lines	-		48	

Identification of resistant/tolerant genotypes for foliar fungal diseases

In *kharif* 2008 there were heavy incidences of foliar fungal diseases like rust, early leaf spot (ELS) and late leaf spot (LLS) in all the groundnut fields of NRCG. An advanced breeding culture PBS 22042 exhibited moderate resistance reaction of 3 on a scale of 1-9 to all the three diseases (rust, ELS and LLS) against as high as 8 in the susceptible genotype like PBS 21085 observed for these diseases in the scale of 1 - 9.

Evaluation of advanced breeding lines developed for different breeding objectives

Station Trials for Yield Evaluation

Advanced breeding lines developed for tolerance of different biotic and abiotic stresses were evaluated in the replicated trials in RBD with three replications in two-row plot size in preliminary yield evaluation trial for one year and in four-row plot size in advanced yield evaluation trial for two years. Observations were recorded on phenological (days to 50% of plants to flower; DF_{50}), WUE (SCMR and SLA), and yield and yield component traits (pod yield, PY; kernel yield, KY; 100-seed mass HSM; weight of 100-selected matured kernels HSMK; sound mature kernels, SMK; shelling turnover, SP; and harvest index based on kernel yield (HI_k).

However, *kharif* 2008 was also unusual year as the fields were waterlogged due to excessive rains particularly during reproductive phase (peg and pod formation stage) like the previous *kharif* 2006 and 2007. Water stagnated in the fields for several days and hence the yields were very poor.

The observations recorded are discussed trial-wise hereunder.

Preliminary Yield Evaluation Trial of Spanish Groundnut Lines

Along with three checks namely GG 2 (local check), GG 7 (zonal check) and TG 37A (national check), in a preliminary yield evaluation trial a total of 12-advanced breeding cultures of Spanish groundnut were evaluated in *kharif* 2008. GG 7 was found to be the best check variety for days to 50% flowering (26 days), SCMR (27), pod yield (1212 kg/ha) and kernel yield (773 kg/ha). For SLA (178 cm^2/g), HSM (29 g), HSMK (34 g) and SMK (61 %), TG 37A was the best among the check varieties. The local variety GG 2 was found to be the best check for shelling turnover (64%).

When the performance of advanced breeding cultures was compared with the best check variety, none of the cultures was statistically found superior to the best check for days to flowering, SMK and shelling out turn.

For WUE trait SCMR, six advanced breeding cultures (PBS 11085, PBS 14068, PBS 16042, PBS 16044, PBS 16045, PBS 12176 and PBS 12177) recorded significantly higher values over the best check, with highest value of 33.7 in PBS 16043. Only one advanced breeding culture PBS 16045 (60 cm^2/g) was found to give SLA superior to the best check variety. These cultures having high SCMR and low SLA, are likely to be water-use-efficient.

In case of pod and kernel yields also only one advanced breeding culture PBS 14068 (PY, 1325 kg/ha; KY, 836 kg/ha) performed significantly superior over the best check GG7 (py,1212kg/ha; KY,773kg/ha). Four advanced breeding cultures (PBS 11085, PBS 14068, PBS 16041 and PBS 12177) were identified to have superior HSM and HSMK over the best check TG37A(HSM, 29g; HSMK,34g).

Advanced Yield Evaluation Trial of Spanish Groundnut Lines

Single year of evaluation

Thirty-eight advanced breeding cultures of Spanish groundnut along with three check varieties were evaluated in *kharif* 2008. Analysis of variance indicated that there existed sufficient genotypic variation for different traits in the materials studied. For days to flowering none of the culture outperformed the best check GG 7 which completed 50% flowering in 25 DAS. The cultures namely PBS 16026B, PBS 16027, PBS 16032, PBS 16038 and PBS 16039 were found superior for SCMR. For SLA, eight cultures namely, PBS 14060, PBS 16026A, PBS 16026B, PBS 16027, PBS 16031, PBS 16032, PBS 16038 and PBS 16039 had statistically lower SLA than the best check variety. Highest SCMR (37) was observed in genotypes PBS 16026B and PBS 16038, whereas lowest SLA (147 cm^2/g) was recorded in PBS 16031. For pod and kernel yields two advanced breeding cultures (PBS 11056 and PBS 16038, with 1439 and 1481 kg/ha pod yields, and 847.67 and 867.00 kg/ha kernel yields, respectively) were found to possess good potential. Similarly genotypes with good potential for other traits were also identified.

Two years of evaluation

In *kharif* 2007 and 2008, twenty-one advanced breeding Spanish cultures were evaluated along with three checks GG 2, JL 24 and SB XI. Pooled analysis of data of two years indicated that genotypic differences were highly significant for all the traits studied. Differences due to years were also significant for traits like SCMR, pod and kernel yields, HSM, SMK and SP, whereas significant G x E interactions were observed for days to 50% flowering, pod and kernel yields, HSM and HSMK. Genotypic means over two years when compared with the check varieties, it was observed that no genotype gave significant performance for days to 50% flowering, shelling turnover and SMK over the best check variety GG 2 for days to flowering (27 days) and shelling (61%), and SB XI for SMK (43 %). Nine advanced breeding lines (PBS 11056, PBS 11057, PBS 16025, PBS 16027, PBS 16031, PBS 16032, PBS 16033, PBS 16038, and PBS 16040) gave significantly superior SCMR as well as SLA over the best check variety GG 2 for these traits (SCMR, 27; SLA 197cm^2/g). It indicates that these cultures, which have high SCMR and low SLA, are supposed to possess high water use efficiency. Out of these

nine cultures, three (PBS 11056, PBS 16038, PBS 16040) gave significantly higher pod and k yields over the best check variety SB XI. The HSM of eight advanced breeding cultures and HSM eleven advanced breeding cultures were significantly superior over the best check variety, SB XI.

Preliminary Yield Evaluation Trial of Virginia Groundnut Lines

Along with two check varieties, GG 20 and Somnath, 33 advanced breeding lines of Virg groundnut were subjected to preliminary evaluation. Although analysis of variance indic significant differences due to genotypes, none of the test entries surpassed the best check for any of traits studied, except for pod yield for which one test entry PBS 22064 (1449 kg/ha) that significantly superior to the best check. This test entry also gave the highest kernel yield (944 kg/ though statistically at par with best check.

Advanced Yield Evaluation Trial of Virginia Groundnut Lines

Thirty-two advanced Virginia breeding lines were evaluated in *kharif* 2008. ANOVA revea significant differences due to genotypes. Two test entries PBS 24100, PBS 30162 were significa early in flowering (25 and 27 days, respectively) compared to the best check variety Somnath (30 da One entry, PBS 26007 was found significantly superior for SCMR (33) while two other entries P 21087 and PBS 26013 were found superior for SLA (189 and 173 cm^2/g, respectively) compared to best check. For pod and kernel yields none of the test entries was significantly superior over the check GG 20 (1830 kg pods and 1272 kg kernels/ha). However, one entry PBS 22042 gave pod (1 kg/ha) and kernel (1448 kg/ha) yields that were statistically at par with GG 20. This entry has also gi shelling out turn of 74%, which is exceptionally high under NRCG farm conditions; and significa high harvest index (26%) derived from kernel yield. For HSM only PBS 24093 (47g) was significa superior over the best check (GG 20, 43g). PBS 22042 also exhibited tolerant reaction to foliar fu diseases (rust, early leaf spot and late leaf spot).

Evaluation of early maturing Spanish and Virginia advanced breeding lines in summer season

In summer 2007 and 2008, forty advanced breeding lines derived from a cross of Chico x R 3 and its reciprocal were grown along with parental lines in a RBD with 3 replications. Observations w recorded on days to flower initiation (FI, d), days to 50% of the plants to flower on plot basis (F50 SPAD chlorophyll meter reading (SCMR), specific leaf area (SLA, cm^2/g), shelling percent (SP), seed mass (HSM, g), sound mature kernels (SMK, %), fodder yield (FY, g), harvest index (HI, %), yield (PY, kg/ha) and kernel yield (KY, kg/ha).

Analysis of variance revealed that except for SLA, for all the traits studied, genot differences existed implying, thereby, the presence of considerable genetic variability for these t among the genotypes. Except also for SLA and FY, the differences due to years were also signific Significant G x E (genotype x year) interactions existed for all these traits, except for SCMR and SL

When the improvement of the advanced breeding cultures over the parents was examined on basis of performance *per se*, 17 advanced breeding Spanish cultures were found superior over Spanish check variety Chico. A good number of transgressive segregants, which outperformed parental lines, could be identified. Similarly, when advanced Virginia lines from this cross w compared with the Virginia parental line, all the lines were found superior.

Eight advanced breeding lines recorded significantly higher pod and kernel yields over the best parental lines, besides two lines SE 32 and SE 38 recorded significantly higher kernel yields. Pod and kernel yields of the selected genotypes was in the range of 2263 - 3438 kg/ha and 1419 - 2329 kg/ha, respectively compared to the best yields of their parental lines 1448 kg/ha and 609 kg/ha, respectively. Interestingly, except two genotypes, all these high yielding genotypes had significantly high SCMR. As high SCMR is known to contribute to imparting water-use efficiency of a groundnut, the high yielding genotypes in this case are likely to possess high water-use efficiency also. Of the eight genotypes recording high pod and kernel yields, four genotypes took significantly less number of days to initiate flowering compared to the parental line Chico, which has widely been used as donor parent for early maturity. Days taken by a genotype from sowing to first flower to bloom, is one of the component traits of early maturity. Thus, genotypes recording high yield coupled with early flower initiation identified in this study are likely to mature early also.

Genetics of quantitative traits

Detection of epistasis for surrogates of water-use efficiency and heat tolerance

Information on genetic control of quantitative traits is highly essential for developing a breeding strategy aimed at simultaneous improvement in attributes finally contributing to enhanced yield. Predominant role of additive gene effects have been reported for SLA and SCMR in groundnut. However, in case of cellular membrane thermostability, no such information is available in this crop. The present study was undertaken to unravel epistasis, if any, for proxy traits of WUE (SCMR and SLA) and heat tolerance (CMT).

The method used to detect epistasis was based on triple test-crosses (Kearsey and Jinks, 1968) as modified by Ketata *et al.* (1976). Two cultigens TAG 24 and TMV 2NLM (hereafter referred to as L1 and L2) were crossed in *kharif* 2006 to produce F1 hybrid (hereafter referred to as L3). These three testers were crossed with nine diverse genotypes in *kharif* 2007. The experiment, with a total of 39 treatments comprising of 11 cultigens (L1 and L2 testers and nine cultivars), 19 single crosses including L3 tester, and nine three-way crosses, was planted in summer 2008 in a randomized block design with three replications. Each treatment was sown in a plot of 3-rows each of 3 m. Distance between rows was 60 cm and between plants 10 cm.

Observations were recorded on SLA and SPAD. Tissue tolerance to heat stress was assessed by the *in vitro* cellular membrane thermostability (CMT) assay which provides a measure of relative cell injury (RCI), a low RCI value indicating higher CMT and *vice versa*. The statistical analysis was carried out using the 'INDOSTA' programme.

Analysis of variances for test crosses revealed significant differences due to parents (for SCMR and CMT), and crosses (SCMR, SLA and CMT). Though testers were significant for SCMR only, cultures were found to be significant for all the three traits studied.

Seed enhancement

Nucleus Seed Production of NRCG Groundnut varieties

Nucleus seed of Girnar 1 and Girnar 2 was maintained. In *kharif* 2008, 16 and 280 kg nucleus seed of Girnar 1 and Girnar 2, respectively was produced. A total of 5000 single plants of Girnar 2 were harvested separately for maintenance breeding.

Basic seed production of PBS 12160

The advanced breeding line PBS 12160 was in final stage of testing *i.e.* Advanced Varietal T of All India Coordinated Research Project on Groundnut in zone IV. In anticipation of its b identified in the ensuing annual groundnut workshop, seed production programme of this variety taken up in *kharif* 2008, and 68 kg of basic seed was produced. Besides, 1500 single plants v harvested to take up nucleus seed production of this variety in summer 2009.

Advanced breeding lines

Seed enhancement of two advanced breeding cultures PBS 30051, entered in AICRPG tria *kharif* 2008 and PBS 30086 to be entered in AICRP-G for testing at multi-locations in *kharif* 2009, taken up and 140 kg and 23 kg seedpods, respectively of these cultures were produced.

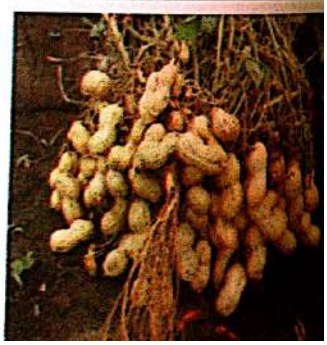
Advanced lines in AICRP-G Trials

Three advanced lines JUG 27, PBS 12160 and PBS 24004 were evaluated in IVT I in *kharif* 2 and IVT II in *kharif* 2007 of drought, Spanish and Virginia trials. At All India varietal level of evalua the test entry PBS 24004 did not perform better, and hence was dropped. The test entry JUG 27 has g encouraging performance over two years under mid- and end-of-season drought situations, and h was promoted to advanced drought tolerance varietal trials (ADVTT) conducted in *kharif* 2008. The entry PBS 12160 has given highest yields in Zone IV over two years, and hence has been promote AVT. This entry was tested in AVT in this zone in *kharif* 2008, and also agronomic trials were condu for this variety in this zone. Two more advanced lines; PBS 30044 and PBS 30073 were tested in IV in *kharif* 2008 under Spanish trials. One advanced culture PBS 30051 was tested in IVT I under Spa trail in *kharif* 2008.

Supply of Segregating Material to AICRP-G Centres

Detailed information on the available segregating materials in F_3 to F_6 generations of diffe crosses harvested in *kharif* 2008 was sent to all the AICRP-G centres. Request from five centre different crosses was received. The requested seed of 23 crosses attempted for breeding objectives tolerance of drought, foliar diseases and stem rot; and high yield, shelling turn over, harvest index, early maturity were supplied to these centres (Jalgaon, Dharwad, Aliyar Nagar, Junagadh and Anand

Release of Girnar 2 variety



Girnar 2, developed at NRCG, Junagadh was tested in the name of PBS 24030 in the All India Coordinated Research Project on Groundnut (AICRPG) trials conducted during *kharif* 2002-2006, and on the basis of its superior performance it was released for commercial cultivation in north-western zone (northern Rajasthan, Punjab and Uttar Pradesh) for *kharif* season. Girnar 2 was found to be superior to both the national checks, M 335 and Kaushal, for pod (36 and 35%, respectively) and kernel (46 and 37%, respectively) yields. It also out-yielded the Zonal checks, GSMG 84-1 by 12% and 17%, and HNG 10 by 12% and 10% with respect to pod and kernel yields, respectively. In the station trials conducted at NRCG, Junagadh during *kharif* seasons of 2000 and 2001, this variety had 17% pod-yield advantage over the commercial variety Kadiri 3.

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

(T.V. PRASAD*, VINOD KUMAR AND G.D. SATISH KUMAR**)

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Activity 1: Management of insect pests in groundnut based production system (T.V. Prasad)

Integrated Pest Management in groundnut based inter cropping system

The experiments on integrated insect-pest management (IPM) in groundnut based intercropping system were carried out during *kharif* 2007 and *kharif* 2008. The cultivar GG 20 was sown at an inter-row spacing of 45 cm in a plot of 6 m x 5 m with three replications. Groundnut was intercropped with sunflower (local variety), castor (GAUCH-4), pigeon pea (BDN-2), soybean (local variety), green gram (K-851), cluster bean (local variety), Bt cotton (MRC 6301), desi cotton (Deviraj) and hybrid cotton (G Cot 10) in row-to-row ratio of 3:1.

The pooled results indicated cluster bean supported significantly small population of jassids at 30, 45 and 60 DAS than the other intercrops in both the years. Among the intercrops studied, the population of thrips was higher in soybean and red gram intercrops while that of thrips was lower in castor and hybrid cotton and it remained low at 30 DAS, and at 45 and 60 DAS also, it remained low.

Maximum pod yield was obtained in groundnut as a sole crop. Among the intercrops, the highest grain yield was obtained in red gram (2205 kg/ha), which was followed by castor (1427 kg/ha). The pooled data showed that intercropping of groundnut with red gram gave the highest CBR (1:3.40), which was followed by intercropping with castor (1:3.23).

Effect of bio-pesticides on sucking insect pests of groundnut

Among various pesticides tested for their efficacy in controlling sucking pests of groundnut, the lowest population of jassids and thrips (5.20 and 5.49 per 5 sweeps, respectively) was observed with spray of the reference chemical pesticide viz., monocrotophos (0.04%)- and this was followed by the biopesticide *V. lecanii* (2g/L) the next best treatment with a population of jassids (7.40 per 5 sweeps) and thrips (5.53 per 5 sweeps) compared to control (untreated). However, compared to control (2178 kg pod/ha), the spray application of *V. lecanii* recorded the highest yield (2549 kg pod /ha).

Evaluation of new molecules against sucking pests of groundnut

Various new molecules *viz,* imidachloprid, carbosulfan, acetamiprid, profenophos and thiomethoxam were evaluated for their efficacy against sucking pests of groundnut. The results indicated that seed treatment with imidacloprid (0.0035%) + 2 sprays of 0.008% imidacloprid (30 and 45 DAS) was significantly superior in reducing jassid population compared to control and other treatments, with highest yield of groundnut of 1298 kg/ha compared to only 925 kg/ha obtained from control.

Screening of genotypes and cultivars

Out of 29 genotypes screened for resistance to jassids under field conditions during *kharif* 2008, the genotypes NRCG CS nos' -101, 108, 241 and 290 were found moderately resistant (< 5 jassids/5 sweeps) and NRCG-CS- 101, 220, 263 and 266 were found to be moderately resistant (< 3 thrips/5 sweeps).

Out of 57 released Spanish bunch varieties screened for resistance to sucking pests, varieties GG 5, GG 7 and R-9251 were found to be moderately resistant to jassids (< 5 jassids/5 sweeps); varieties GG 2, GG 3, GG 7, Kadiri 4, Kadiri 5, R-9251 and TAG 24 were found to be moderately resistant to thrips (< 4 thrips/5 sweeps).

Out of 51 released Virginia varieties screened, none was found free from jassid and thrip infestation. Compared to other varieties, however, for jassids, varieties BAU 13, CGMS 84-1, M 522, MH 2 and MH 4 were found to be moderately resistant (< 7 jassids/5 sweeps) while for thrips, varieties MH 2 and MH 4 were found to be moderately resistant (< 4 thrips/5 sweeps).

Screening of groundnut varieties and genotypes for their relative resistance to damage by *Caryedon serratus*

In laboratory conditions, the number of eggs laid on the pods of 21 Spanish varieties, were counted and the accompanying loss of weight was also worked out. The minimal oviposition was observed on the pods of GG 3, Jyoti, R 8808, and TAG 24 (<40 mean number of eggs) as compared to CO 2, which recorded 116 mean no. of eggs. Minimal loss of weight was (< 15%) observed in GG 3, GG 4, GG 6, VRI 3, TAG 24 and TG 3 while that observed on the pods of ICG (FDRS) 10 and CO 1was very high (> 50%).

Bio-ecological studies of *Caryedon serratus*

The life cycle of *C. serratus* was studied under prevailing laboratory condition during *kharif* 2008 on the preferred host, groundnut. The average temperature and relative humidity were 27.6°C and 79.6% respectively. The results indicated that egg, larval, pupal and adult period were 4.3, 30.2, 17.6, and 19.8 days, respectively.

Effect of seed treatment of insecticide (Imidachloprid) on sucking pests in Summer 2009

Among the different doses (1, 2, 3, 4, and 5 g/kg seed) tested, seed treatment with imidachloprid (70% WS) @ 5 g/kg seed proved to be the best in controlling the populations of jassids and thrips (2.02 and 3.19/5 sweeps, respectively) as compared to untreated control (6.87 and 10.11/5 sweeps, respectively).

Monitoring of major insect pests of groundnut

In the crops sown at monthly intervals, the populations of *Helicoverpa armigera*, *Spodoptera litura* and *Aproaerema modicella* were monitored using pheromone traps and that of aphids (*A. craccivora*, and *Hysteroneura setariae*) by using cylindrical sticky trap while the populations of jassids and thrips were monitored using the sweep net. The sucking pests like thrips and jassids were maximum during October (23.8 and 20.0/5 sweeps, respectively) and the highest population of aphids (436.8/trap and leaf miners (100.3/trap) were recorded during December. *Helicoverpa* and *Spodoptera* continued t be present in low numbers throughout the year (Fig. 1).

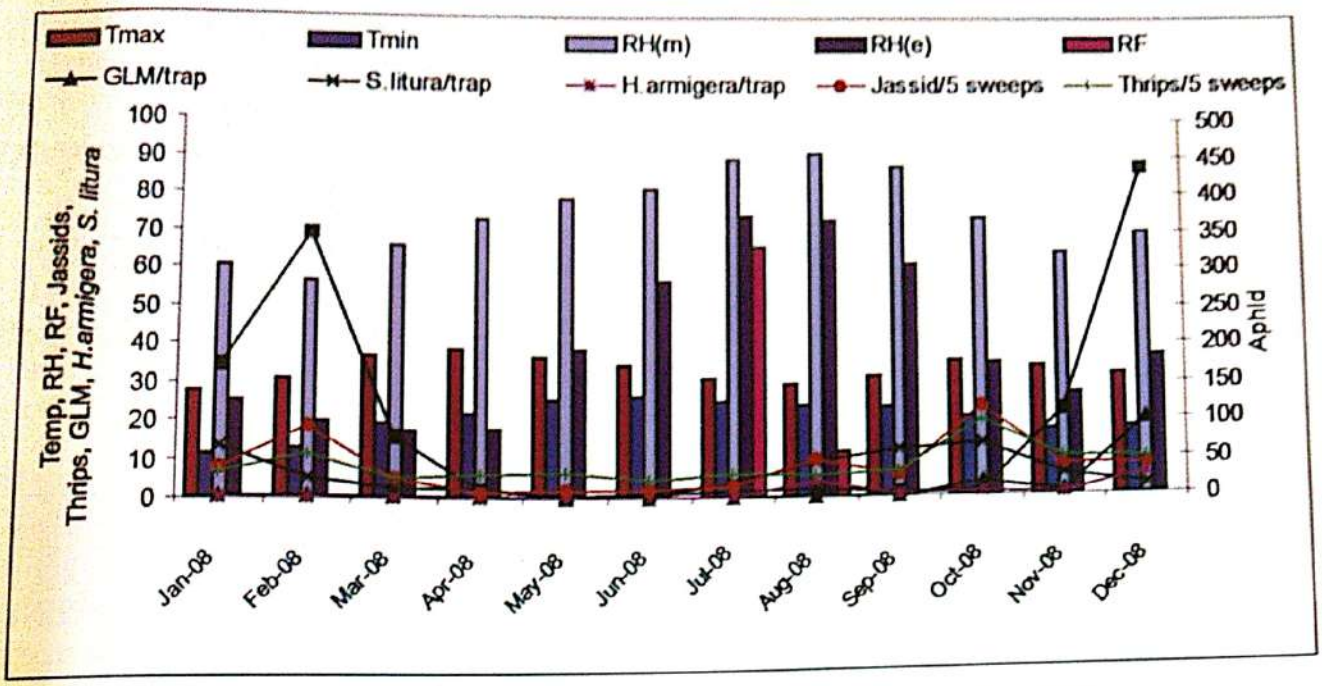


Figure 1. Parameters of weather vis-a-vis population of pests during *kharif* 2008

(Tmax= maximum temperature (^{0} C); Tmin= minimum temperature (^{0} C); RH (m) = relative humidity in morning (%); RH (e) = relative humidity in evening (%); RF= rainfall (mm);

Activity 02: Integrated management of major diseases (ELS, LLS, rust, collar rot, stem rot, PBND) of groundnut (Vinod Kumar)

Disease resistance

Kharif 2008

A total of 94 genotypes along with susceptible check (GG 20) were evaluated for resistance to early leaf spot (ELS), late leaf spot (LLS), rust and stem rot diseases under field conditions in the rainy season of 2008. The plants were raised in the sick plots which were inoculated with stem rot pathogen (*Sclerotium rolfsii)* at the time of sowing and then again at 30 days after sowing (DAS), and foliar disease pathogens at 30 DAS by spreading the diseased leaflets collected from previous season's crop. Observations on foliar fungal diseases were recorded by adopting a 1-9 modified scale and those on stem rot as percent incidence. Observations on pod yield (g/3 m row) were also recorded.

Screening of 19 genotypes for resistance to ELS, LLS, rust, and stem rot, was continued for the 3rd year. The incidences of soil borne diseases *viz.*, collar rot and stem rot were in the ranges of 0.0-58.0% and 0.0-53.0%, respectively. The severities of fungal foliar diseases ELS, LLS and rust as recorded on 1-9 modified scale were in the ranges of 2.0-6.8, 1.5-6.2, and 1.8-6.8, respectively. Six genotypes showed resistance to collar rot, three to stem rot, and two to ELS, LLS and rust while two genotypes (NRCG CS 329 and 346) showed multiple diseases (ELS, LLS, rust and stem rot) resistance.

Among 34 promising genotypes (screened earlier between 2003-2007 and some of which possessed multiple disease resistance), which were screened further during 2008, only two genotypes, NRCG CS-73 and 85, showed resistance to ELS, LLS and rust while the other genotypes showed only moderate resistance.

Among the 40 new genotypes screened for the first time, five genotypes, NRCG CS -365, 394, 398, and 399, showed resistance to stem rot while one genotype, NRCG CS-385, showed mode resistance to ELS.

During rainy season of 2008, under artificially inoculated sick-soil conditions in conc blocks, 20 genotypes including susceptible and resistance checks were screened separately resistance to collar rot (*A. niger*) and stem rot (*S. rolfsii*) pathogens. The disease incidences of colla and stem rot in susceptible check, GG 2 were 24.5% and 50% respectively. However, the highest dise incidence of stem rot (83.3%) was observed in genotype NRCG CS-300. The genotypes NRCG CS- and 25 showed resistance to stem rot (incidence < 20%), and genotypes NRCG CS-85 and 132 sho resistance to collar rot (incidence < 10%). As for pod yield, the genotype NRCG CS-104 recorded highest yield (104 g/2m row)) followed by CS-78 (51 g/2 m row)), CS-110 and CS-113 (both 49 g/ row) while the yield of the check variety GG 2 was quite low (25 g/2 m row).

Summer 2009

Screening of genotypes for resistance to PBND under field conditions at Raichur

A total of 14 promising genotypes were evaluated during summer 2009 for resistance to PBN under field conditions at Raichur- a hot spot location. The disease incidence was recorded at three stag i.e. 40 and 60 DAS, and at harvest. The incidence of PBND was in the range of 3.0% (CS 296) to 33 (CS 280). Two genotypes *viz.*, NRCG CS 296 and CS 263 recorded resistant reaction (<5% inciden compared to the highest of 41.9% in the susceptible check KRG 1).

Screening for resistance to stem rot and collar rot under artificially inoculated conditions

Eighteen genotypes were evaluated for resistance to stem rot (*S. rolfsii*) in concrete bloc during the summer season of 2009. Artificial inoculation was made twice, first at the time of sowing a second at 21 DAS. The genotype NRCG CS-343 was found to be highly resistant with a zero perce disease incidence. Another genotype, CS 160, was identified as resistant with a disease incidence 16.7%. The highest incidence of 80% was observed in CS-168 while it was 25.9% in GG 2.

Also, 20 genotypes were evaluated for resistance to collar rot pathogen (*Aspergillus niger*) concrete blocks. Artificial inoculation was made at the time of sowing. Eight genotypes *viz.* NRCG C nos' -81, 104, 110, 164, 272, 316, 331, and 334 did not suffer any incidence of disease and hence we identified to possess promising resistance while the highest value for incidence was 39.58%.

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

A field experiment was conducted during *kharif* 2008 to study the effect of soil-application o enriched *Trichoderma harzianum* (Isolate T-170) and foliar application of culture filtrates o *Verticillium lecanii* and *Trichoderma* on soil borne and foliar fungal diseases of groundnut Observations on foliar fungal diseases were recorded on 1-9 modified scale while those on soil borne diseases were recorded as percent incidence.

The results revealed that the incidence of aflaroot and collar rot was below 10%. Pod rot incidence varied from 9.7 to 22.7%.

The application of castor cake enriched with *Trichoderma* or castor cake alone significantly reduced pod rot incidence. There was significant reduction in the disease severity of late leaf spot (LLS) by soil application of enriched *Trichoderma* plus foliar spray of culture filtrate of *V. lecanii* at 50% dilution on the first appearance of the leaf spots followed by two sprays at 15-day intervals. Soil

application of *Trichoderma* followed by foliar spray of spore suspension of *Trichoderma* significantly reduced the LLS disease. The reduction in the intensities of ELS and rust by different treatments were, however, non-significant.

Integrated Disease Management

With groundnut cultivar GG 2, a field trial was conducted in RBD with three replications and six treatments during *kharif* 2008. Observations on major foliar fungal diseases (ELS, LLS, and rust) and soil borne diseases (collar rot, stem rot and pod rot) were recorded. The components of IDM were:

T_1	:	Seed-treatment with *Trichoderma* (10g/kg) + two sprays of Hexaconazole (1ml/L) after the first visible symptoms of foliar diseases and 2nd after 15 days thereafter
T_2	:	Seed treatment with Mancozeb (3g/kg) + two foliar sprays of Hexaconazole (1ml/L)
T_3	:	Seed treatment with Tebuconazole (1.5g/kg) + two foliar sprays of Tebuconazole (1ml/L)
T_4	:	Soil-application of *Trichoderma* (4.0 kg/ha) + castor cake (250 kg/ha) + two sprays of Hexaconazole (1ml/L)
T_5	:	Seed treatment with *Trichoderma* (10g/kg) + T_4
T_6	:	Control

The results indicated that the lowest incidence of stem rot and the severity (percent disease index) of ELS, LLS and rust were observed in T_3 (Tebuconazole: seed treatment followed by two foliar sprays)- the differences were statistically significant. The differences among the treatments with respect to incidences of collar rot and pod rot were, however, not significant. Compared to the control, the pod yield was significantly more in all the treatments and it was highest in T_3.

Management of soil-borne disease through organic amendment

A field trial in RBD with three replications and ten treatments with susceptible cultivar GG 20, was conducted during the rainy season of 2008 to study the effect of soil application (in furrow) of fresh leaves of karanj (*Pongamia pinnata*) (500 kg/ha), banyan (500 kg/ha), *Calotropis procera* (100 kg/ha), custard apple (100 kg/ha), and castor cake (500 kg/ha), cotton seed cake (500 kg/ha), gypsum (500 kg/ha) and lime (100 kg/ha) at the time of sowing for management of stem rot and collar rot diseases. The field was inoculated with *A. niger* at the time of sowing and with *S. rolfsii*, 21 DAS. For management of stem rot, the effect of soil application of elemental sulphur @ 20 kg/ha, was also studied.

The results revealed that the maximum incidence of collar rot (5.3%), stem rot (26.6%) and pod rot (48.6%) were observed in the control. The incidences of soil borne diseases (stem rot and pod rot) reduced significantly with the application of *Pongamia* leaves and the application of castor cake. However, the least incidence of stem rot was observed with the application of elemental sulphur. The highest pod yield (834 kg/ha) was recorded with application of lime followed by application of castor cake (792 kg/ha) as compared to control (707 kg/ha).

Evaluation of new fungicides against soil borne diseases

During *kharif* 2008, a field experiment was conducted in RBD to study the effect of seed treatment (with systemic fungicides), on the soil borne diseases. The fungicides used were hexaconazole (2mL/kg); hexaconazole (1 mL/kg) + captan (3 g/kg); carbendazim + mancozeb (SAF) (3

g/kg); Tebuconazole (1.5 g/kg); Propiconazole (2 mL/kg); Vitavax (2 g/kg); Carbendazim (2 g/kg); Mancozeb (3 g/kg); and Captan (3 g/kg). Untreated seeds were used as control for comparison.

The results showed that the incidence of soil borne diseases was significantly reduced by various treatments. The least incidences of stem rot (3.85%) and pod rot (13.3%) were observed in the crop raised from the seeds treated with Tebuconazole (2 g/kg), this crop also gave the highest pod yield (877 kg/ha), and was followed by crop raised with the seeds treated with Carbendazim + Mancozeb (stem rot 5.10%; pod rot 20.7% and pod yield 817 kg/ha).

Studies on effect of different crop residues and plant extracts on growth of *Sclerotium rolfsii*

The types of crops that are raised in the field and the residues left behind after harvest influence the microflora of the soil. Some crop residues may promote growth and multiplication of *S. rolfsii* while the others may inhibit it. Experiments were undertaken to study the effect of crop residues on mycelial growth and sclerotial germination of *S. rolfsii* and the incidence of stem rot on groundnut. Aqueous leaf extracts (5%) and dried crop residues of 12 crops *viz.*, groundnut, soybean, pigeon pea, green gram, black gram, sunflower, sorghum, pearl millet, maize, wheat, onion, and garlic were taken. The results showed that the leaf extracts of garlic, onion, pearl millet, sunflower and sorghum completely inhibited the mycelial growth. Aqueous leaf extracts of pigeon pea, green gram and black gram not only moderately inhibited mycelial growth and sclerotia formation but the sizes of sclerotia were also small compared to those in control. Aqueous leaf extracts of groundnut and soybean enhanced the mycelial growth and there was an increase in the number and size of sclerotia. The effect of these crop residues on germination of sclerotia, rate of mycelial growth and subsequent production of sclerotia was also studied. The germination of sclerotia was lowest on the residue of sunflower (15.2%), followed by garlic (17.5%), onion (19.2%), pearl millet (21.5%), sorghum (27.3%) and maize (29.2%). The rate of mycelial growth and sclerotial formation on residues of these crops was also very slow. Even after 20 days of incubation, the number of sclerotia produced on these residues varied from 17 to 59. The highest germination of sclerotia was on the residue of soybean (88.27%), followed by those of groundnut (81.70%), green gram (73.28%), black gram (62.25), pigeon pea (57.78%) and wheat (47.54%). The rate of mycelial growth and sclerotial production in the residues of soybean, groundnut, green gram, black gram and pigeon pea was very high and the mycelial growth covered the entire surface of the crop residues. After 20 days of incubation, the number of sclerotia produced on these crop residues varied from 669 to 1105. In control, germination of sclerotia was 61.0% and the number of sclerotia produced was 578.

In pot trials, the lowest incidence of stem rot (3.33%) was observed on groundnut plant grown on soils having the residues of sunflower and garlic. The highest incidence of stem rot was observed in the groundnut plants grown on soils having residues of soybean and groundnut (100% and 96.67% respectively). Thus the study showed that crop residues of groundnut, soybean, pigeon pea, green gram, and black gram stimulated mycelial growth, sclerotial germination and enhanced stem rot incidence.

Studies on vegetative compatibility among the isolates of *Sclerotium rolfsii*

For identifying suitable consortia of compatible isolates for inoculation in the sick plots, various combinations of isolates in pairs (400 permutations and combinations) were tested in petri dishes. Vegetative compatibility matrix revealed that out of 3481 combinations, only 1512 were compatible (44%). Among the incompatible combinations, the mycelia of the two isolates interacted and formed inhibition zone at the line of interaction showing their antagonism. Mycelial lysis was apparent in the zone of inhibition (Fig. 2). In a few isolates, after 20 days, the width of the inhibition zone varied 5 to 9

mm. The observed extent of antagonistic reactions showed the wide diversity among the isolates. On the basis of the results on morphological and pathogenic variability in conjunction with vegetative compatibility and diversity analysis, four isolates *viz.*, NRCG-SR 6, 7, 18 and 57 were identified for use in a consortium for development of sick plot.

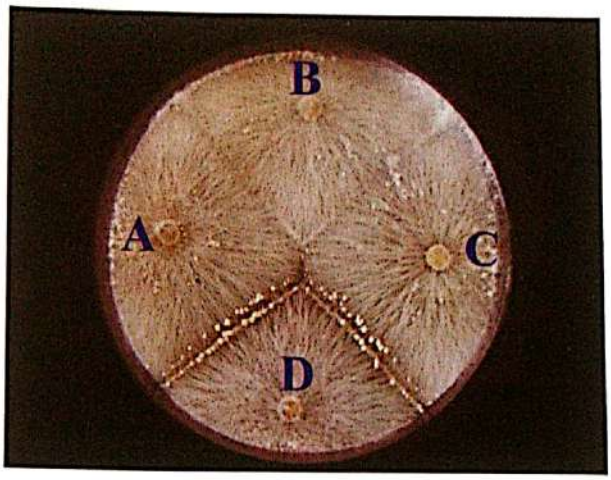


Figure 2: Mycelial growth of four isolates of *Sclerotium rolfsii* showing compatibility among the isolates A, B and C and incompatibility (zone of lysis) of isoloate D with A and C

Studies on dynamics of soil population of *S. rolfsii* in sick plots

At intervals of one-month (before addition of inoculum) soil samples were collected from each micro-plot in the sick-plot and also from the control plot. These samples were evaluated for their population of S. *rolfsii* in terms of colony forming unit (cfu)/g soil. The results showed that the population of *S. rolfsii* increased from negligible level to the highest level of 31 x 10^3 cfu/g soil in December and then decreased in the following months (Figure 3).

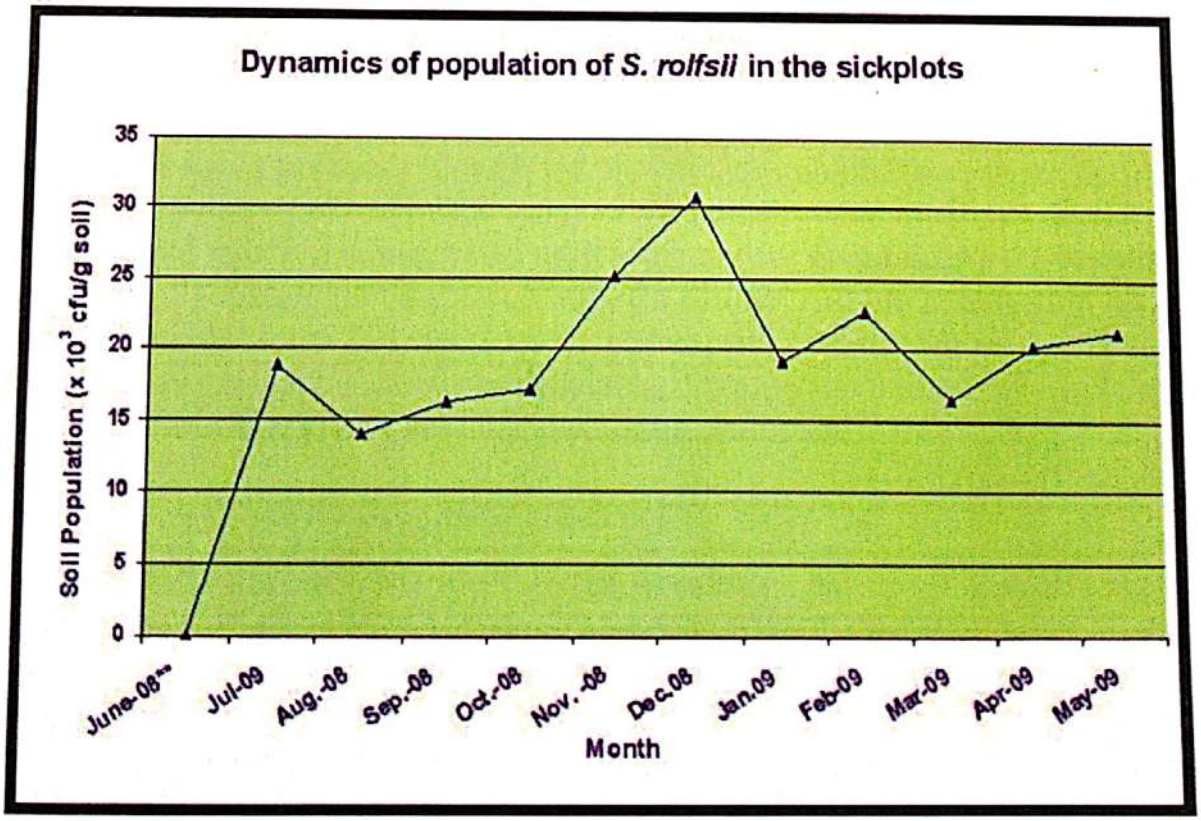


Figure 3: Average soil population of *S. rolfsii* in micro-plots

Seed enhancement of genotypes and cultivars with promising resistance to diseases

The seed multiplication of 30 promising cultivars and genotypes (Code 1-1, CS 296, CS 298, CS 266, CS 263, CS 168, PBS 12169, CS 251, CS 297, CS 77, CS 292, CS 109, OG 52-1, CS 253, CS 280, CS 19, CS 144, CS 102, CS 301, CS 270, CS 160, CS 287, CS 254, ALR 2, CS 101, CS 289, CS 241, CS 273, CS 243, and CS 272) identified earlier for having resistance to one or other disease was taken up during summer 2009 for their further evaluation at their respective hot spot locations.

PROJECT 03: PHYSIOLOGICAL STUDIES ON ENVIRONMENTAL STRESSES IN GROUNDNUT

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

Traits of drought tolerance associated with seedling vigour

Germplasm accessions and cultivars of groundnut possessing agronomic desirable traits associated with seed and seedling vigour and suitable for cultivation under rain-dependent conditions were identified. These cultivars and germplasm accessions were evaluated for tolerance to drought and high temperature stresses (under simulated conditions). Genetic variations in germinability and lengths of root, hypocotyl and epicotyl, opening of cotyledons, and growth of secondary roots were observed among the genotypes evaluated. Four Spanish cultivars *viz*., TAG 24, Girnar 1, J 11, and KRG 1 were identified as the promising ones for sowing in drought prone areas. Germplasm accessions *viz*. NRCG 12752 (SHANTUNG) and 12642 (57-C-3-4-4-1-1-1) were identified to be tolerant of high temperature during the stages of germination and showed early seedling growth. On the basis of studies on utilization of food reserve in the seed, a total of 10 cultivars including both Virginia and Spanish, and belonging to three different seed-weight groups and types, it was observed that both medium and high seed-weight groups were efficient in utilization of reserve-food while the low seed-weight group was found relatively inefficient in mobilizing food-reserve from the cotyledons to establish seedlings with high vigour. An inverse and significant relationship (r = -0.71, n=15) between specific leaf area (SLA) and total seedling biomass was established (Fig. 1), i.e., lower the SLA (thick leaf) higher the biomass, higher the SLA (thin leaf) lower the biomass was also observed. Thus it was clear that the parameters such as 100-seed weight, efficient utilization of food-reserve, development of secondary roots, and low SLA are desirable traits in groundnut, especially for cultivation in rain-dependent system. The tolerant lines/cultivars so identified could be used as donor parents in breeding programmes aimed at improving seed vigour in groundnut.

Two cultivars, Kadiri 3 (Virginia) and ICGS 11 (Spanish) showed the least influence of seed-maturity stages and storage-period on seed vigour, whereas cultivar GG 2 showed the most. Total sugar content was high in immature seeds; in addition, these seeds imbibed more water during germination than that absorbed by seeds of rest of the categories (optimally- and over-mature). This could be the cause of imbibitional injury in immature seeds, leading to poor germination. On the other hand, over-mature and optimally-mature seeds showed high Ca content and the relationship between seed Ca content and germinability (r=0.79), and seed Ca content and seedling vigour (r =0.84) were positive (Table 1). More research work is, however, needed on this aspect to utilise high seed-Ca genotypes for improving seed and seedling vigour through breeding programmes.

Evaluation of cultivars for photosynthetic efficiency

Chlorophyll fluorescence was measured in 30 cultivars during summer and rainy seasons with the help of Hansatech, Fluorescence Monitoring System, FMS 2. Observations on photosynthetically active radiations (PAR), leaf temperature, steady state fluorescence yield (Fs), light adapted fluorescence maximum (Fm`), quantum efficiency of PS II (ÔPS II R) and electron transport rate (ETR) were recorded. Wide genetic variations in the parameters such as Fs (steady state fluorescence), Fm (light adapted fluorescence maximum), light adapted variable fluorescence (fv), antennae efficiency of PS II $(F_m`-F_0)/F_m`$, photochemical quenching co-efficient (qP), non-photochemical quenching

co-efficient (qPQ), alternative definition of non-photochemical quenching (NPQ) and chlorophyll a fluorescence (F_0/F_m), were observed vis-à-vis photosynthetic efficiency (Table 2), and growth and yield traits (Table 3). The F_0/F_m showed lower values of chlorophyll `a` fluorescence under water deficit stress conditions compared to normal conditions, indicating acclimation to water deficit stress and less damage to thylakoid membrane in stressed plants. The cultivars showing contrast in the parameters of chlorophyll fluorescence and traits related with drought will be analysed for their DNA-polymorphism to identify molecular markers associated with photosynthetic efficiency and drought tolerance.

Root profile under well irrigated and water deficit stress

Root architecture is known to play an important role in crop performance, particularly under water scarcity environments. Groundnut, is by and large grown under rain-dependent conditions and so far not much is known on the genetic control of root traits. A study was undertaken with six cultivars varying in specific leaf area (SLA) *vis-à-vis* WUE. Significant genetic variability was observed in root traits recorded in three years (2006, 2007 and 2008). Each year, the root traits were studied at 60, 70 and 80 days after emergence. Results showed that genetic variations existed in root length (cm), root length density (cm. m^{-3}), specific root length (cm g^{-1} m^{-2}), total root dry weight (g. $plant^{-1}$), shoot dry weight (g. $plant^{-1}$), root dry weight (g. m^{-2}), root weight density (gm^{-3}) and root shoot ratio, under both normal and water deficit stress conditions. Under the water-deficit stress conditions, cultivar Girnar 1 showed least reduction in root length, root length density, total root dry weight in all the samples drawn from different stages of growth. In Girnar 1, the root-shoot ratio was least affected due to water deficit stress at 70 days after emergence and in ICGS 44 at 80 days after emergence. Due to water deficit stress, the cultivars JL 24 and ICGV 86031 showed the least reduction in root weight (g. $plant^{-1}$) at 80 days after emergence. In conclusion, under stress conditions root growth was hampered in terms of both root-shoot ratio and number of roots in different soil layers, i.e., 0-15, 15-30 cm, 30-45 cm and beyond 45 cm (Fig. 2). Root volume also changed significantly under the water deficit stress conditions (Fig. 3). Genetic variations, observed in this study, could be utilized in breeding programmes for improving drought tolerance in groundnut. The root traits under normal and water deficit conditions are yet to be related with the leaf water status and growth and pod yield vis-à-vis drought tolerance in groundnut.

Analysis of late embryogenesis abundant proteins (LEAs)

During seed maturation, various events happen including accumulation of storage products, the suppression of precocious germination and often the induction of dormancy. Mature embryo of various species also contains a highly abundant set of hydrophilic heat stable protein referred to as late-embryogenesis abundant (LEA) proteins, resembling the heat shock proteins. These proteins generally disappear following germination. The role of such proteins in seed longevity, dormancy and cross tolerance mechanisms in plants is still obscure. Hence, it was of interest to investigate the SDS-PAGE protein profile in groundnut seed during desiccation and germination in seed dormant and non-dormant cultivars. Comparison of protein profiles of seed dormant and non-dormant types before harvest, at final-harvest and during different hours of curing showed variation in interplay of protein bands of both low and high molecular weights. Protein profile also varied due to application of ethrel, whereas little or no difference was observed between protein profiles of ABA treated and non-treated seeds at 24 h of germination. Seed during curing or desiccation remained physiologically active and probably the proteins appearing during desiccation helped the seed in prolonging its viability and vigour though these proteins disappeared during germination. Detailed studies are required to understand the role of LEAs protein in longevity, dormancy and in desiccation tolerance. During seed maturation and germination major changes in physiological status and metabolic events take place. In groundnut seed, ABA also maintains the dormancy by inhibiting ethylene production.

Table 1. Calcium content of seeds of six groundnut cultivars of different habit and seed-maturity groups

Cultivar	Ca content (%)
GAUG 10 (HYR)**	0.38
M 13 (HYR)	0.38
Kadiri 3 (HYB)	0.39
ICGS 11 (VUL)	0.38
Girnar 1 (VUL)	0.37
GG 2 (VUL)	0.34
CD (P=0.05)	0.02
Maturity groups	
Over-mature	0.39
Optimum-mature	0.38
Immature 0.36	
Natural seed lot	0.38
CD (P=0.05)	0.02

**HYB, Virginia bunch, HYR, Virginia runner, VUL, Spanish

Table 2. Comparison of physiological traits related with drought tolerance in 30 groundnut cultivars under normal (100% cpe) and water deficit stress (50% cpe) conditions.

Parameter	Fo (bits)		Fm (bits)		Fo/Fm		Fv (bits)		Fv/Fm	
	Control	Stress	Control	Stress	Control	Stress	Control	Stress	Control	Stress
Minimum	18.5	19.7	638	615	0.022	0.023	494	445	0.724	0.638
Maximuma	31.5	24.3	905	928	0.047	0.038	776	782	0.857	0.838
Average	24.54	21.71	778	748	0.032	0.029	627	595	0.798	0.787
Parameter	PAR		Fs (bits)		Fm') (bits)		PSII		ETR	
	Control	Stress	Control	Stress	Control	Stress	Control	Stress	Control	Stress
Minimum	700	919	19.5	20.7	24.2	24.8	0.130	0.092	53.51	40.9
Maximum	1137	1121	32.5	25.3	40	28.5	0.245	0.202	102.88	92.26
Average	1019	1066	25.5	22.7	31.3	26.4	0.186	0.142	80.02	63.37
Parameter	qP		qNP		NPQ		Transpiration (m mol $m^2 sec^{-1}$) g_s		(mol $m^2 sec^{-1}$)	
	Control	Stress	Control	Stress	Control	Stress	Control	Stress	Control	Stress
Minimum	0.75	0.66	1.12	1.16	16.83	22.05	1.63	0.9	53	19
Maximum	0.88	0.83	1.37	1.72	36.14	38.58	3.43	2.33	168	55
Average	0.84	0.77	1.21	1.25	25.95	28.20	2.54	1.50	96	30.69
Parameter	T_{leaf}-T_{air} (°C)		SPAD (units)		RWC (%)		Chlorophylls (mg g^{-1})		Carotenoids (mg g^{-1})	
	Control	Stress	Control	Stress	Control	Stress	Control	Stress	Control	Stress
Minimum	1.07	1.73	30.6	29.5	81.18	68.81	6.36	3.93	2.71	1.66
Maximum	2.20	2.53	47.3	48.8	90.49	88.66	16.72	8.04	6.12	2.92
Average	1.54	2.14	39.27	38.92	86.31	81.45	11.41	6.184	4.23	2.386

Table 3. Pod yield and dry matter accumulation in 30 groundnut cultivars under normal (100% cpe) and water deficit stress (50% cpe) conditions

Parameter	SLA ($cm^2 g^{-1}$)		Pod weight ($g m^{-2}$)		Vegetative weight ($g m^{-2}$)		Total biomass (gm^{-2})	
	Control	Stress	Control	Stress	Control	Stress	Control	Stress
Minimum	102	98	72	33	119	140	191	173
Maximum	161	135	253	169	777	509	1029	612
Average	127	123	162	108	423	310.6	585	418

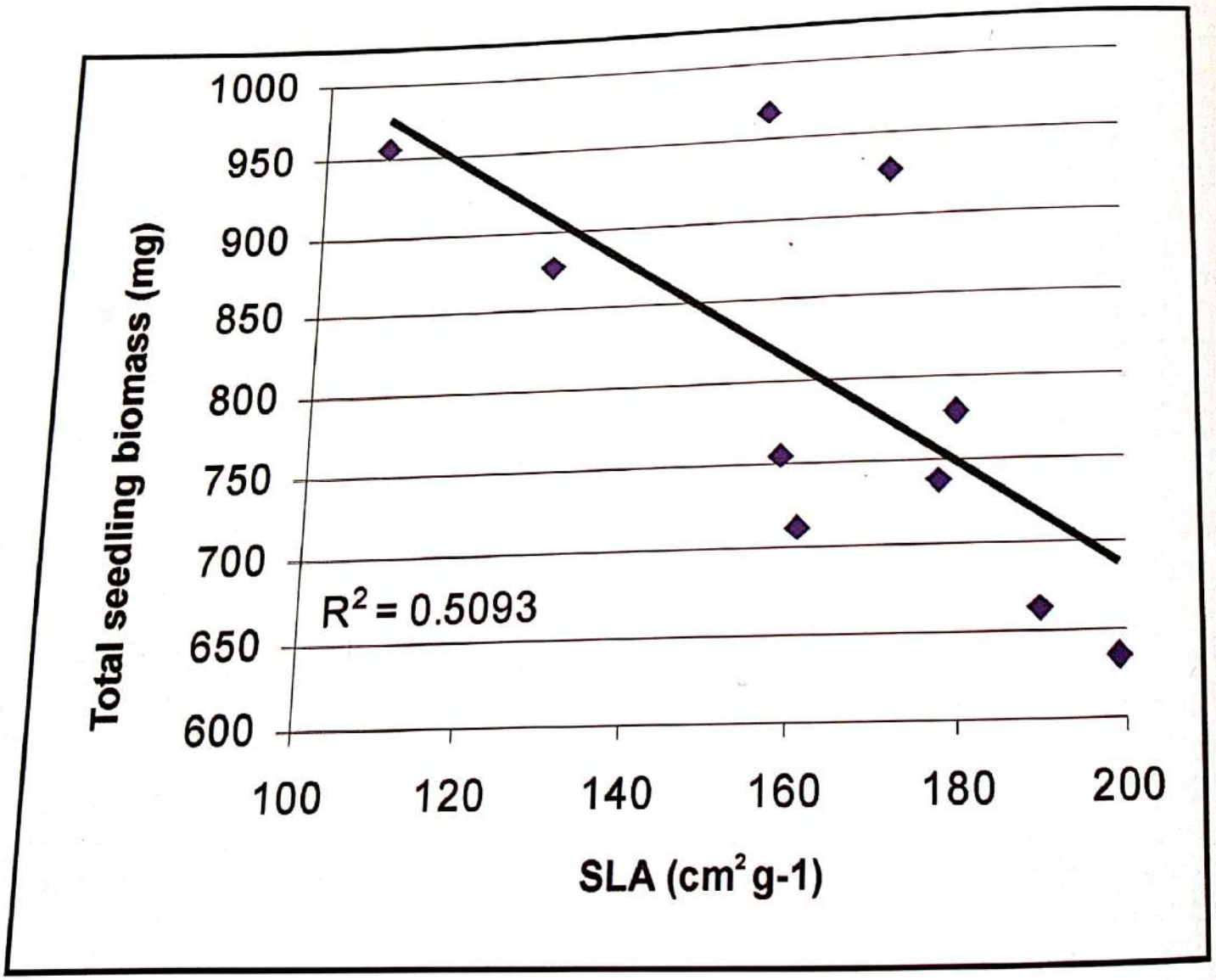


Figure 1. Relationship between seedling biomass and specific leaf area (SLA) in 30 day old seedlings in ten groundnut cultivars belonging to Spanish and Virginia types

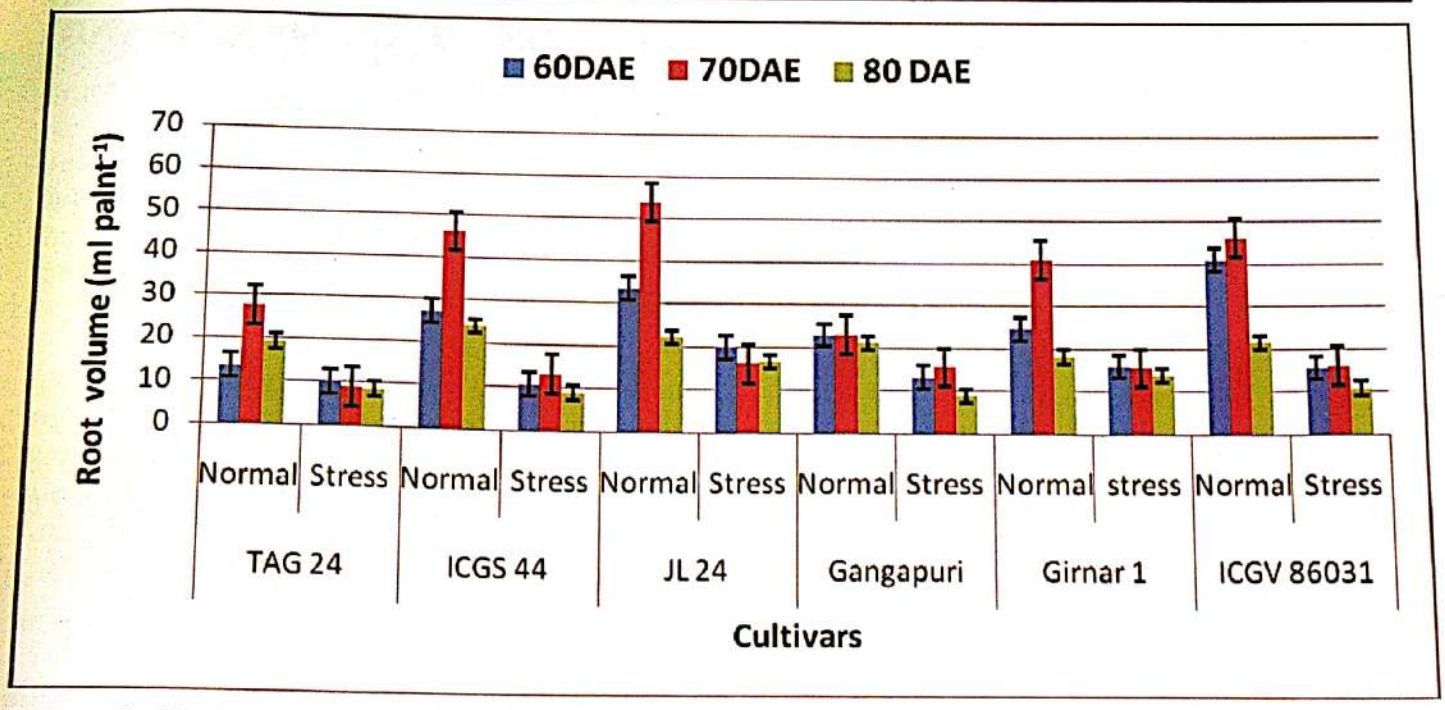


Figure 2. Root volume in six groundnut cultivars under normal and water deficit stress conditions at 60, 70 and 80 days after emergence

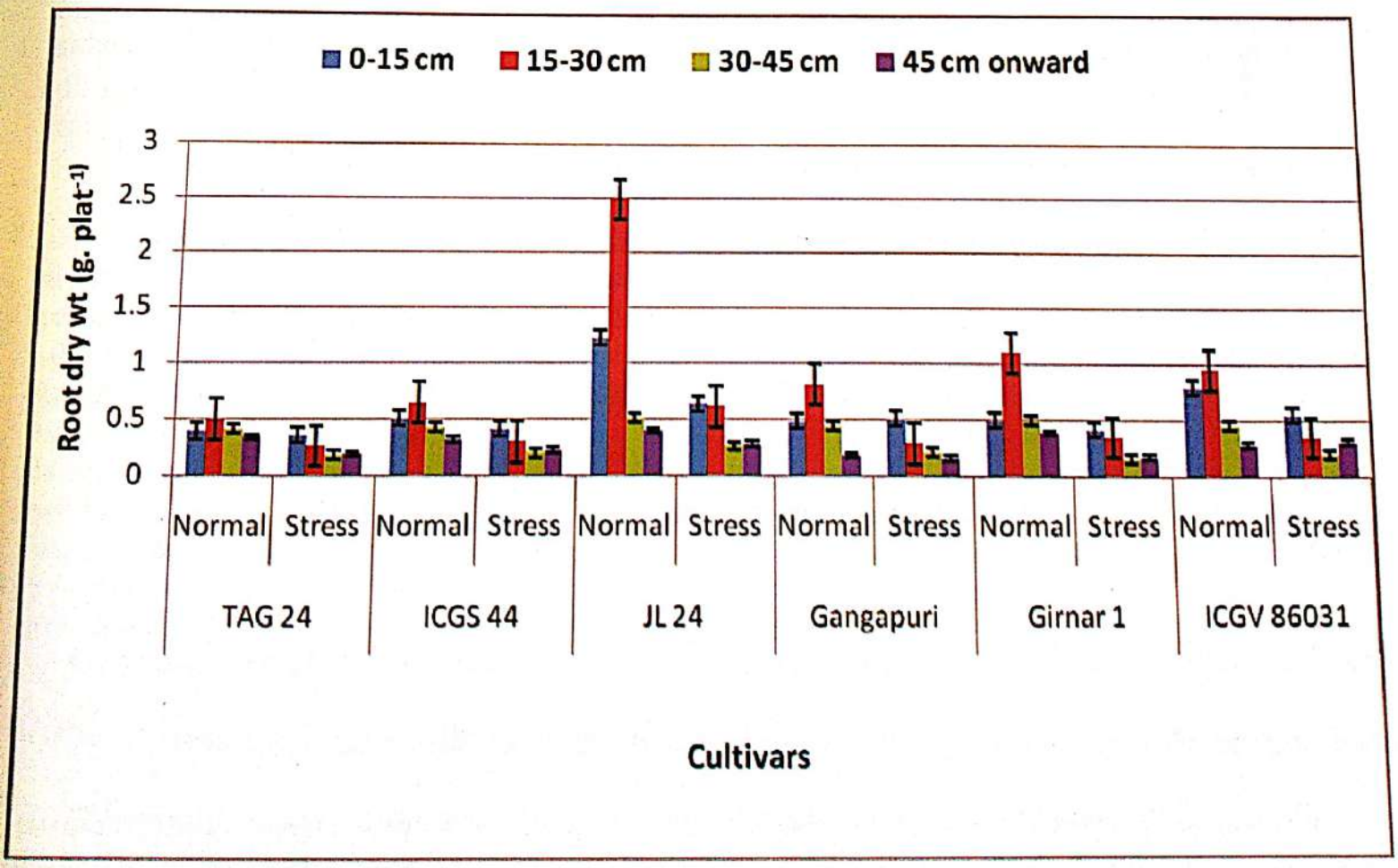


Figure 3. Root dry weight in six groundnut cultivars under normal and water deficit stress conditions at four different soil depths

PROJECT 04: MICROORGANISMS IN RELATION TO SOIL HEALTH AND PLANT NUTRITION IN GROUNDNUT

(K. K. PAL AND R. DEY)

Consortia of beneficial microorganisms

Evaluation of consortia of microorganisms for enhancing the growth and yield of groundnut

Phosphate solubilizing microorganisms, groundnut-rhizobia and plant growth promoting rhizobacteria were tested within the stated groups and also in various combinations for their compatibility. On the basis of compatibility tests, seven combinations were identified comprising compatible strains of PGPR (*Pseudomonas fluorescens* biotype G BHU1 and *Pseudomonas maculicola* S1(6); consortium D), PSB (*Pseudomonas* sp. BM8; *Bacillus polymyxa* H5; consortium E), and rhizobia (NRCG 4 and NC 92; consortium F). All the seven consortia (D, E, F, DE, DF, EF, and DEF) were tested in field trials.

During *kharif* 2008, all the consortia were evaluated for their performance. Inoculation with consortia of different combinations of PGPR, PSM and rhizobia brought about improvement in root and shoot growth and biomass production, nodulation and nodule mass (Table 1). The consortium E of phosphate solubilising microorganisms was found to be the best as it brought about the maximum improvement in pod yield (9.6%) and was followed by the combinations of PGPR, PSM and rhizobia (7.2%) (Table 1).

Evaulation of VAM fungi on the growth and yield of groundnut

A trial was conducted in pots during the summer and *kharif* seasons of 2008 to study the effects of inoculation of AM fungi on the growth and yield of groundnut. Four AM fungal cultures *viz.*, *Glomus etunicatum, Glomus fasciculatum, Glomus mosseae,* and *Gigaspora scutellospora*, obtained from the Division of Microbiology, IARI, New Delhi, were used. Inoculation with different AM fungi (1500-2000 chlamydospres/100 g soil) significantly improved the growth of groundnut cultivar GG 2 in terms of biomass of shoot and root, number and mass of nodules, and pod-yield. An increase in root volume was also observed. Inoculation with *G. fasciculatum* and *G. scutellosopra* increased the root volume at 45 DAS by 54-58% (Table 2) while inoculation with *G. fasciculatum* and *G. mosseae* enhanced the yield by 23%.

During *kharif*, inoculation with *Glomus fasciculatum*, *Glomus mosseae* and *Gigaspora scutellospora* significantly improved nodulation, root volume, pod yield and VAM root colonization.

Studying the role of groundnut genotypes on rhizodeposition and microbial population

Using two parental lines *viz.*, GG 2 and ICGV 86031 and their six progenies an effort was made to study the role of groundnut genotypes on rhizodeposition and microbial population in the rhizosphere. Compared to parental lines, three progenies (JUG 22, JUG 24 and GUJ 48) were high yielding and the remaining three (JUG 43, JUG 46 and JUG 47) were low yielding. It was hypothesized

that it should be possible to enhance nutrient uptake and thus yield of groundnut by manipulating the population of any or both beneficial and deleterious microorganisms in the rhizosphere through the genetic constitution of groundnut. Population dynamics of different groups of microorganisms, recorded at 7 DAE and subsequently at 7-day intervals in the rhizosphere of varieties and advanced breeding lines, indicated that the population of cyanogenic fluorescent pseudomonads was high in the rhizospheres of breeding lines giving low yields compared to the population of these microorganisms in the rhizosphere of the high yielding parental lines GG 2 and ICGV 86031. The population of cyanogenic fluorescent pseudomonads increased appreciably over the period of time.

Results of a replicated trial in *kharif* 2008 indicated that among the breeding lines with good yield, the population of cyanogenic fluorescent pseudomonad was maintained at low levels while in the breeding lines with low yield, with passage of time the population increased several folds. Though increase of fluoresecent pseudomonads vis-à-vis cyanogenic strains was not always linear either in low- or high-yielding lines, there was an indication that in low-yielding lines the population of deleterious cyanogenic strains increased while in high-yielding lines it decreased with passage of time. The increase in the population of cyanogenic fluorescent pseudomonads was identified as one of the causal factors for low yields. Further studies are, however, required for understanding this phenomenon.

Evaluation of new strains of groundnut rhizobia

A pot-trial was taken up during summer 2008 to evaluate the newly isolated *nod*$^+$ *nif*$^+$ strains of groundnut rhizobia. Nine strains *viz.*, HTT 6, PUR 3, PAS 17-2, FN 1, BN 10, HTT 7, FN 2, BNX 2, and BN 1 having competitive trait like production of siderophore besides capability of producing IAA like substances were tested. In cultivar GG 2, inoculation with two strains PUR 3 and BN 10 proved highly effective in increasing the nodulation and pod yield (Table 3). Other strains, which proved to be effective, were FN 1 and BN 1.

Ten new isolates of *nif*$^+$ *nod*$^+$ groundnut rhizobia were subsequently tested in a field trial during *kharif* 2009 keeping NC 92 as the standard culture (Table 4). Compared to the uninoculated control, the isolate NRCG 17 enhanced the pod yield of cultivar Girnar 2 by 19%.

Studying shelf-life of culture in different liquid formulations

Different liquid formulations of *Pseudomonas maculicola* S1(6) were prepared by taking Kings' medium B as the basal medium. These formulations were named as KB, K1, K2, K3, K4, K5 and K6. Two sets were stored, one at room temperature and the other in refrigerator at 4°C. Population of *Pseudomonas maculicola* S1(6) was monitored at 30-day intervals onto KB medium. The maximum population was observed in two formulations K1 and K2 under refrigerated conditions and after storing for ten months the population of recorded in these preparations was 4×10^7 cfu/mL.

RAPD analyses of PGPR, rhizobia and other important cultures

For DNA fingerprinting of important PGPR cultures, RAPD profiles of *Pseudomonas aeruginosa* BM 6 (Figure 1), *Pseudomomas aeruginosa* ACC 7, *Pseudomonas fluorescens biotype* G BHU1 (Figure 2) and *Pseudomonas maculicola* S1(6) (Figure 3) were generated using Operon RAPD Primer Kit A (OPA 1 to OPA 20). Marked variations in the profiles were observed though there was species level similarity between two strains like ACC 7 and BM 6.

Table 1. Effect of inoculation of consortia of microorganisms on the growth and yield of groundnut cultivar Girnar 2 (*kharif* 2008)

Treatments	Pod yield (kg/ha)	Haulm yield (kg/ha)	HSM (g)	Shelling turnover (%)
Control	2388	4430	43.3	62.9
BHU1 + S1(6)	2254	4527	44.5	63.3
BM8 + H5	2618	4780	46.7	65.8
NRCG4 + NC 92	2411	4512	42.7	62.1
BHU1 + S1(6) + BM8 + H5	2163	4617	43.6	61.9
BM8 + H5 + NRCG4 + NC 92	2325	4322	42.4	63.2
BHU1 + S1(6)+ NRCG4 + NC 92	2326	4457	42.7	64.8
BHU1 + S1(6) + BM8 + H5 + NRCG4 + NC 92	2559	4852	45.4	65.8
CD (5%)	**165**	**250**	**1.10**	**1.47**

Table 2. Effect of inoculation of mycorrhizal fungi on the growth and yield of groundnut cultivar GG 2 (pot-experiment, *kharif* 2008)

Treatments	PY (g/p)	SL (cm/p)	RDW (g/p))	NN/p	RV (cc/p)	Arb. (%)	Ves. (%)
Control	3.78	29.9	0.66	37.0	14.4	4	1
G. etunicatum	3.95	32.8	0.79	41.0	14.8	28	32
G. fasciculatum	4.91	31.2	0.88	65.0	15.0	42	37
G. mosseae	4.87	35.3	0.95	57.0	19.7	61	42
G. scutellospora	3.69	33.6	0.91	66.0	20.3	55	31
LSD (0.05)	**0.38**	**2.4**	**0.19**	**18.0**	**2.8**	-	-

PY= pod yield ; SL = shoot length; RDW = root dry weight; NN = nodule number; RV = root volume; Arb. = arbuscule; and Ves. = vesicle

Table 3. Evaluation of newly isolated rhizobia for BNF parameters and yield in groundnut cultivar GG 2 (pot experiment, *kharif* 2008)

Treatments	RL(cm/p)	SL (cm/p)	NN/p	NDW (mg/p)	SDW (g)/p	PY (g/p)
Control	52.0	19.1	54	120	10.70	6.25
HTT 6	54.2	19.8	67	157	11.38	6.63
PUR 3	55.9	21.5	88	190	11.89	9.64
PAS17-2	50.9	19.9	72	193	11.62	6.45
FN 1	50.7	19.7	62	147	10.44	7.22
BN 10	55.5	21.0	79	183	12.13	7.82
HTT 7	48.3	18.1	56	110	9.53	6.18
FN 2	48.8	17.2	36	33	10.25	5.85
BNX 2	48.6	17.8	57	110	10.48	6.35
BN 1	51.8	18.9	64	217	12.00	7.28
CD(5%)	**3.2**	**1.1**	**13**	**31**	**1.33**	**0.70**

RL= root length; SL = shoot length; NN = nodule number; NDW = nodule dry weight; SDW = shoot dry weight; and PY= pod yield

Table 4. Evaluation of newly isolated rhizobia for yield and BNF parameters in groundnut cultivar Girnar 2 (field experiment, *kharif* 2008)

Treatments	PY (kg/ha)	HY (kg/ha)	HKW (g)	SP (%)
Control	1670	3020	42.7	66.3
SRR 7	1745	2940	44.2	66.7
NRCG 5	1720	3220	42.1	67.2
NRCG 17	2070	3340	45.3	67.5
NRCG 20	1660	3220	42.6	65.7
SRR 10	1725	3360	44.0	65.2
PAS 17-2	1730	3040	42.6	65.7
NRCG 16	1670	3170	40.4	66.1
NRCG 11	1690	3010	44.2	67.3
NRCG 29	1660	3000	40.3	65.3
PUR 3	1595	2980	44.5	66.8
NC 92	1720	3130	46.0	67.8
CD(5%)	**215**	**305**	**1.8**	**NS**

PY= pod yield; HY = haulm yield; HKW = hundred kernel weight; and SP = shelling percent

Figure 1. RAPD profile of *Pseudomonas aeruginosa* BM 6 generated using Operon primer Kit A

igure 2. RAPD profile of *Pseudomonas fluorescens* biotype G isolate BHU1 generated using Operon primer Kit A

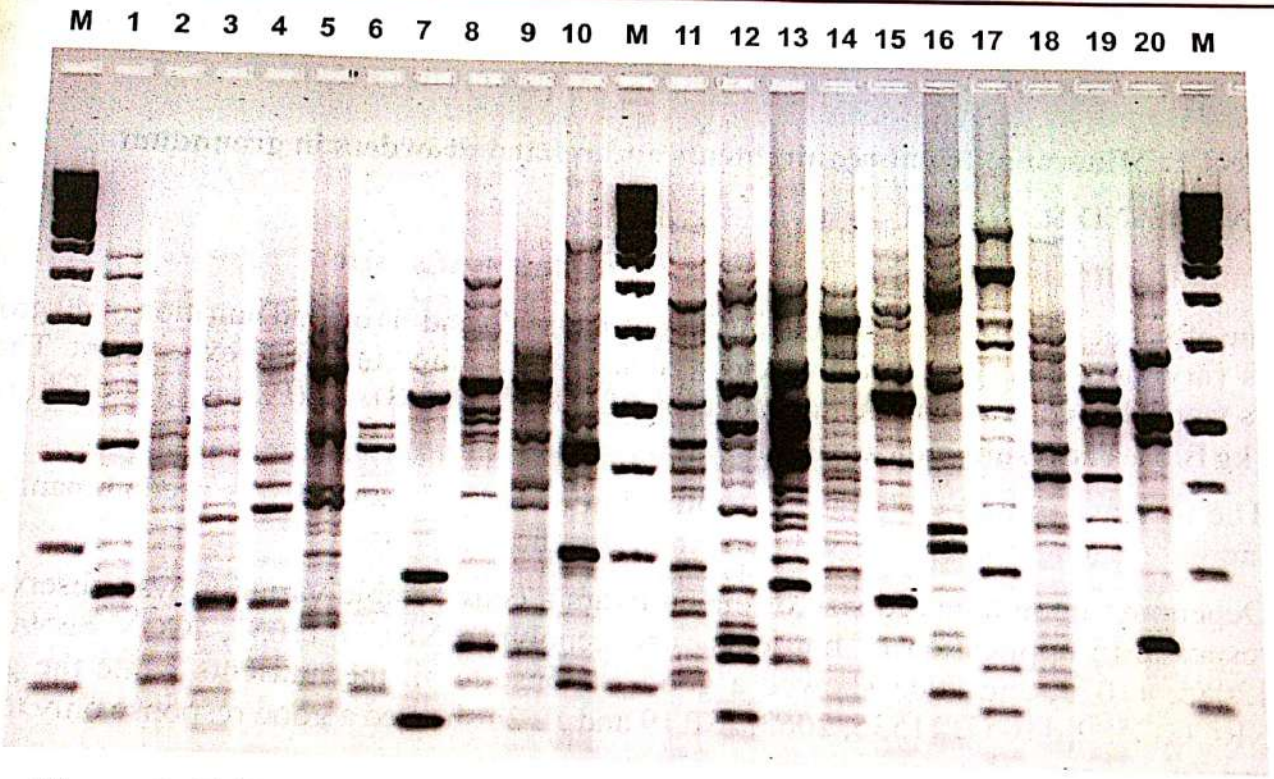


Figure 3. RAPD profile of *Pseudomonas maculicola* S1(6) generated using Operon primer kit A

PROJECT 05: MANAGEMENT OF MINERAL NUTRITION AND ASSOCIATED STRESSES IN GROUNDNUT

Sub Project 1: Mineral nutrient requirements and related disorders in groundnut

(A. L. SINGH AND R. S. JAT)

P, K, Zn and B nutrition in groundnut cultivars varying in seed size

The effect of macro- (P and K) and micro-nutrients (Zn and B) on pod nutrition of 40 groundnut genotypes varying in their pod structure and seed size was studied in a field experiment. The three treatments were: T1 (control, without any addition of P, K, Zn and B), T2 (P_{50} +K_{100}) and T3 (T2+ 2 kg Zn/ha + 1 kg B/ha. The results indicated that:

- The increase in pod yield due to application of P, K, Zn and B was predominantly due to increase in length and width of the pods and also those of seeds.
- Depending upon the seed size of the cultivars a considerable variation was observed in the response to application of nutrients. The genotypes NRCG 11057, ICGV 86590, NRCG 12085, 11073, and 2063 showed a good response to all the nutrients while the genotypes NRCG, 7599, 11057, 11535, 2063, JSP 19 and JL 24 showed a good response only to added B and Zn.
- The large-seeded groundnut cultivars not only required more P and K but also showed higher P density in their seeds and shells than those of small seed size genotypes. The contents of boron and zinc also increased in seeds and shells and this effect was more pronounced in large seeded genotypes.

Screening for K- and S-efficient genotypes

To identify K- and S-efficient groundnut genotypes, 110 genotypes were grown in field under two conditions- unfertilized and fertilized (control, 50 kg K/ha and 20 kg S/ha treatments) and based on the relative performance and nutrient contents of the tissues the nutrient-efficient and inefficient groundnut genotypes were identified:

- K-efficient: Chitra, GG 16, GG 13, GG 11, GG 4, CSMG 84-1, GPBD 4, LGN 2, Tirupati 3, Kadiri 3, and ALR 2.
- S-efficient: CSMG 84-1, Tirupati 3, GG 7, GG 13, ALR 1, SP 250 A, and ICGV 86590.
- K-inefficient: MH 2, MH 4, RS 138, Jyoti, Kisan, Jawan, and TG 3.
- S-inefficient: MH 2, MH 4, UF 70-103, RS 1, NRCG 7472, Chico, and TG 17.

Studies on the various levels and modes of application of Mo in groundnut

The doses of Mo and modes of application were evaluated in micro-plots with four groundnut cultivars (GG 2, GG 7, ICGS 76, and GG 20). The results indicated that the application of sodium molybdate as seed-dressing (0.5 kg ha^{-1} or 5g/kg seed) or soil application (1.0 kg/ha) increased the pod yield. The cultivars GG 2 and GG 7 responded better to seed dressing than to soil application while the cultivars ICGS 76 and GG 20 responded better to soil application. Moreover, the application of Mo as sodium molybdate up to 0.5 kg ha^{-1} was found to be beneficial for all the four cultivars.

Seed treatment with micronutrients

The micro-plot experiment on treatment of seeds with various sources of micronutrients *viz.* copper sulphate, manganese sulphate, iron sulphate, zinc sulphate, and sodium molybdate in commonly grown cultivars GG 2, GG 7, ICGS 76, and GG 20 revealed that all the cultivars responded well to the applied micronutrients and their yields increased significantly. Though, in general, the maximum response to zinc was noted, this was followed by iron, and all the cultivars with only a little variation, showed a good response of Mo, Mn and Fe. The cultivars GG 2 and ICGS 76 responded well to Cu also. The maximum increase in yield due to application of Zn was seen in the cultivars GG 2, GG 7 and GG 20 while it was due to application of Cu in ICGS 76.

Screening core germplasm collection for response to fertilizer application

A total of 194 core germplasm accessions were grown under unfertilized and fertilized conditions to study the response to application of fertilizers and also density of micronutrients in the kernels. The experiment was conducted for the fourth year in *kharif* 2008 but due to excessive rains and consequent stagnation of water in the fields the experiment was vitiated and in many cases the yield was more in control plots than that of corresponding fertilized plots. The genotypes, NRCG 12272, 12879, 12899, 12273, 12581, 12910, 12921, 10807, 12691, and 10967, 12065 performed well with pod yield more than 500 kg/ha and appeared to be tolerant of stagnating water for about 20-30 days. Some of the genotypes that have been identified earlier under normal weather conditions (*kharif* 2006-07 and 2007-08) for having high nutrient density in their kernels are:

- High Fe: NRCG, 17, 355, 1913, 18964, 10191, 12423, 12523, 6937, 12657, and 11700
- High Ca: NRCG 5360, 6811, 7443, 8956, 11651, 12319, 12713, 12393, 12339,
- High Mn: NRCG 3533, 10820, 11126, 12291, and 12321
- High Zn: NRCG, 1451, 3533, 11154, 11895, 12348, 12326, 11925, 12339, and 12299
- High Cu: NRCG 7306, 3648, 3533, 8428, 11346, 11925, 11942, 12543, and 12294
- High B: NRCG 1451, 5001, 7063, 11769, 11868, 12109, 12069, 12255, and 12478.

Screening of groundnut cultivars for high zinc and iron densities in seed

The seed of groundnut cultivars were analyzed for iron and zinc densities in their seeds. The cultivars identified for high Zn in their seeds were GG 2, GG 5, GG 7, JL 24, CO 1, CO 2, Gangapuri, UF 70-103, and ICGV 86590 and those for high Fe were Tirupati 4, GG 2, GG 7, Jawan, M 145, M 335, ICGFDRS 4, ICGV 86590. The other nutrients were also high in the seeds of these genotypes.

Yield targeting in groundnut

An experiment for realizing the targeted yield of 5000 kg/ha was planned by considering the requirements of nutrients on the basis of soil-analysis. The experiment was conducted with three groundnut cultivars *viz.*, GG 20, GG 7 and FeESG 10 during *kharif* and with two cultivars *viz.*, GG 7 and FeESG 10 in summer. In *kharif*, sand was mixed with the soil to alter its physical properties and crop was

raised on raised broad-beds and furrows. The calcareous soil at experimental site contained 45 kg/ha available N, 18.8 kg/ha available P, and 240 kg/ha available K. With the addition of 40 kg N/ha as urea, 50 kg P/ha as DAP (which also supplied 20 kg N/ha), 100 kg K/ha as MOP, 1000 kg gypsum/ha, 10,000 kg FYM/ha, 30 kg S/ha as elemental sulfur, 2 kg Zn/ha as zinc sulphate, and 1 kg B/ha as Agricol, yields of more than 5000 kg/ha in summer and 3500 kg/ha in *kharif* were attained. In summer, the yields of cultivars GG 7 and FeESG 10 were 5047 and 5030 kg/ha, respectively in the fertilized plots compared to 3610 and 3163 kg/ha, respectively in control plots. In *kharif*, the yields of cultivars GG 20, GG 7, and FeESG 10 were 3465, 3268, and 3298 kg/ha, respectively in the fertilized plots compared to 2826, 2605, and 2418 kg/, respectively in the control plots.

Screening, maintenance and multiplication of nutrient-efficient and inefficient lines

A total of 110 nutrient-efficient and in-efficient, and salinity and Al-toxicity tolerant groundnut genotypes were maintained in the field.

Sub project 2: Management of soil acidity and related problems of groundnut

(A.L. Singh, N.P. Singh, M. Datta and H.N. Meena (July 2008)

Screening of groundnut genotypes for Al-toxicity tolerance

Screening in sand culture

Thirty five groundnut genotypes were screened in a pot experiment for tolerance of Al-toxicity (1000 μM of Al as $AlCl_3$). The symptoms of toxicity on roots and subsequently on growth of foliage were noticed 25-30 days after sowing this was accompanied by reduction in growth and pod yield. On the basis of their performance, the genotypes NRCG, 816, 1169, 11657, 2906, 3823, 7105, and 7185 were found to be relatively tolerant to Al-toxicity compared to others.

Screening in field (acid soils)

One hundred germplasm accessions were identified for evaluation in the acid soils of NEH region. The actual number of germplasm evaluated varied from location to location. The crop was raised at Tripura, Mizorum, and Barapani Nagaland under fertilized (lime 500 kg/ha, FYM 10 t/ha, and P 50 kg/ha) and unfertilized (control) conditions. Some of the promising Al-toxicity tolerant lines identified included NRCG 11551, NRCG 2538, and NRCG 11656.

At Tripura, the number of pods varied from 5 to 2/plant in unfertilized plants and 4 to 12/plant in the fertilized ones. With a few exceptions, an increase in weight of pods and seeds was observed in most genotypes due to fertilization (Table 1). Compared to control, the increase in yields of pod and seed varied from 18 to 467% and 29 to 417% respectively (Table 2).

Table 1. Performance of groundnut germplasm accessions in Tripura

Identity of accession	Number of pods/plant		Yield (g/plant)					
			Pod		Seed		Haulm	
	C	F	C	F	C	F	C	F
NRCG 11551	3.67	9.33	3.33	4.66	2.00	3.00	1.00	4.33
NRCG 11236	8.33	6.00	3.66	5.00	2.33	3.66	2.00	3.33
NRCG 10541	9.67	8.33	4.33	8.33	3.00	6.00	4.33	21.33
NRCG 8956	8.00	4.67	2.66	3.66	1.00	2.33	7.66	13.00
NRCG 2190	7.00	11.67	3.66	4.33	2.33	3.00	1.33	8.33
NRCG 10969	5.00	8.66	3.33	7.33	2.33	5.00	2.66	12.33
NRCG 11682	3.66	7.33	3.00	5.00	2.00	3.00	2.66	6.66
NRCG 11148	5.33	9.66	3.33	4.66	2.00	3.00	3.00	14.66
NRCG 10807	9.00	14.66	4.66	9.00	3.33	6.00	1.00	9.00
NRCG 8963	7.66	11.66	6.00	8.66	5.66	5.66	4.33	15.00
NRCG 12296	9.00	13.00	5.33	6.66	4.00	4.66	1.00	11.33
NRCG 6935	6.66	12.00	9.66	12.00	7.33	8.66	2.00	10.66
NRCG 4998	4.00	2.00	2.66	3.66	1.33	2.33	2.33	4.66
NRCG 2203	11.33	13.33	6.66	8.00	5.33	7.00	3.66	6.66
NRCG 10988	3.66	6.00	4.66	6.00	3.00	4.00	1.33	6.00
NRCG 6937	7.00	15.00	3.33	4.33	2.33	3.33	1.33	6.66
NRCG 10572	11.33	17.33	7.00	8.00	5.00	6.00	2.00	7.33
NRCG 11653	8.33	18.00	5.33	6.33	6.00	5.00	1.33	14.66
NRCG 10751	7.33	13.66	4.66	6.00	3.00	4.33	2.00	14.33
NRCG 8964	5.66	10.33	2.66	3.66	1.66	2.66	4.00	18.66
NRCG 10388	8.33	17.00	3.66	4.66	1.66	3.00	1.33	10.66
NRCG 666	3.66	7.66	3.00	4.33	1.66	3.33	2.00	9.66
NRCG 10259	6.00	8.66	4.33	6.00	2.66	4.00	3.00	7.00
NRCG 3198	6.33	5.33	4.66	5.66	2.00	4.00	7.00	10.33
NRCG 2273	5.33	8.00	2.66	4.00	1.33	2.66	4.00	6.66
NRCG 12294	9.00	10.33	6.66	9.00	4.00	5.66	4.33	10.33
NRCG 11656	4.00	9.66	3.33	14.00	2.00	10.33	2.00	10.66
NRCG 10809	10.33	23.00	3.00	12.33	2.66	9.00	3.00	14.33
NRCG 10496	6.33	16.33	3.66	9.66	2.66	3.66	1.66	7.33
NRCG 8428	12.33	18.00	5.66	5.00	4.00	4.00	1.00	5.33

Table 1 (contd.). Performance of groundnut germplasm accessions in Tripura

Identity of accession	Number of pods/plant		Yield (g/plant)					
			Pod		Seed		Haulm	
	C	F	C	F	C	F	C	F
NRCG 3491	7.00	10.66	5.00	6.33	3.33	6.66	1.00	5.33
NRCG 5405	7.00	5.00	2.33	9.00	1.33	3.00	2.66	4.66
NRCG 10456	7.66	11.66	3.00	4.33	2.33	4.66	2.66	4.66
NRCG 201	6.66	16.66	6.00	6.33	4.33	3.66	2.00	4.66
NRCG 11126	5.00	15.66	8.66	5.66	6.00	8.33	1.00	10.66
NRCG 5001	4.00	7.66	2.00	11.33	1.33	2.66	2.66	11.33
NRCG 675	5.33	15.66	8.33	8.33	6.66	6.33	3.33	9.00
NRCG 11276	4.33	24.00	17.66	10.00	13.66	7.33	3.33	12.00
NRCG 11679	8.66	13.00	8.00	10.00	5.00	7.33	3.66	8.00
NRCG 11154	9.33	11.66	4.66	6.66	3.33	5.00	3.00	5.00
	CD (5%)		CD (5%)		CD (5%)		CD (5%)	
Accessions (A)	2.98		3.06		2.38		2.95	
Treatment (T)	0.66		0.68		0.53		0.66	
A x T	5.94		4.34		3.39		4.19	

C = control (unfertilized); and F = fertilized

Table 2. Change in pod and seed yields due to fertilizer application

Identity of accession	Change in yield over control (%)	
	Pod	Seed
NRCG 11551	40	50
NRCG 11236	37	57
NRCG 10541	92	100
NRCG 8956	38	133
NRCG 2190	18	29
NRCG 10969	120	115
NRCG 11682	67	50
NRCG 11148	40	50
NRCG 10807	93	80
NRCG 8963	44	-
NRCG 12296	25	17
NRCG 6935	24	18
NRCG 4998	38	75
NRCG 2203	20	31
NRCG 10988	29	33

Table 2 (contd.). Change in pod and seed yields due to fertilizer application

Identity of accession	Change in yield over control (%)	
	Pod	Seed
NRCG 6937	30	43
NRCG 10572	14	20
NRCG 11653	19	-17
NRCG 10751	29	44
NRCG 8964	38	60
NRCG 10388	27	81
NRCG 666	44	101
NRCG 10259	39	50
NRCG 3198	21	100
NRCG 12273	50	100
NRCG 12294	35	42
NRCG 11656	320	417
NRCG 10809	311	238
NRCG 10496	163	38
NRCG 8428	-12	-
NRCG 3491	27	100
NRCG 5405	286	126
NRCG 10456	44	100
NRCG 201	6	-16
NRCG 11126	-35	39
NRCG 5001	467	100
NRCG 675	-	-5
NRCG 11276	-43	-46
NRCG 11679	25	47
NRCG 11154	43	50

Experiment on organic farming

Among various organic farming approaches evaluated in NEH region, the traditional practice of 'Bun' farming was more nature friendly and also practical for poor farmers. The organic fertilizers were invariably found superior to inorganic ones. The application of FYM alone @ 10 t/ha was found to be the best in NEH region characterized for its highly eroded soils. FYM also reduced the effect of Al-toxicity. Some of the promising sources identified for their potential as organic fertilizers included pig slurry (20 t/ha), vermi-compost (5 t/ha), poultry manure (5 t/ha) and green leaf of *Gliricidia* (10 t/ha) and subabul (10 t/ha).

In Nagaland and Tripura, the residues of hedge row crops of *Tefrosa microphylla, Crotolaria microphylla, Plemangia* and *Glirricidia*, generally grown on the bunds, when incorporated as organic manure, evinced a good response in groundnut and rice.

Nutrient management in bold-seeded groundnut

The NEH region has good potential for growing confectionary groundnut as water is not a limiting factor there and as such the potential of genotypes is realized to a great extent. Soil acidity, however, is a major impediment in further enhancing the realization of the genetic potential. Accordingly, field experiments were conducted to identify the key nutrients required for large-seeded groundnut and to develop the ameliorative measures. The experiments to study the effects of organic nutrients as such or in combinations with inorganic nutrients indicated that in these soils a combination of organic and inorganic sources worked better than that of inorganic sources alone.

For growing large-seeded groundnut, application of P, Ca and B nutrients and organic fertilizers was found essential not only for realizing high yields but also for ensuring the quality of produce. It was observed that FYM not only provides several nutrients but also brings down the soil acidity and the Al-toxicity and thus brings about significant improvement in yield.

Table 3. Influence of various INM practices on the yield and yield attributes of large- seeded groundnut in Tripura

Treatment	Pod number /plant	Pod weight (g/plant)	Seed weight (g/plant)	Haulm weight (g/plant)	100-seed weight (g)	Yield (kg/ha)	
						Pod	Haulm
T1- Control	9.21	4.33	2.88	5.11	47.3	313	341
T2- P50	8.77	4.88	3.33	5.00	49.7	504	572
T3- K100	8.11	3.33	2.22	4.79	44.3	319	356
T4- lime (2.5 t/ha)	8.44	6.11	3.88	4.44	46.0	304	365
T5- T4 + P50	11.88	7.44	5.00	9.77	55.0	694	668
T6- T2+T3+T4	14.77	10.44	7.55	10.00	54.7	746	740
T7- T6+boric acid (13 kg/ha)	14.55	12.22	9.33	9.55	50.7	522	547
T8- T6+cowdung (10t/ha)	13.99	5.99	4.21	14.22	49.7	467	510
SE(±)	2.47	1.46	1.12	2.6	2.2	46	63
LSD 0.05	**7.47**	**4.41**	**3.38**	**7.8**	**6.8**	**139**	**190**

Sub-Project 3: Development of sustainable production technologies for north-eastern India

(A. L. Singh, J.B. Misra and H.N. Meena (From July 2008) N.P. Singh, Subrata Biswas, K.A. Pathak, A.K. Vishwakarma, R. Bhagawati, Magan Singh, P.H. Bhatt and L.S. Rathor (ICAR Research Complex for NEH Region)

Evaluation of released cultivars of groundnut and nutrient efficient lines

A large number of groundnut genotypes comprising released cultivars and nutrient-efficient lines were evaluated over the years in NEH region and the following genotypes suitable for cultivation in various states of this region were identified:

- Mizorum: TKG 19A, GG 20, ICGS 76, ICGV 88448, CSMG 84-1, ICGV 86590, and M 13.
- Tripura: GG13, M 13, TG 37A, NRCG 7599, NRCG 6450, and NRCG 6155.
- Arunachal Pradesh: GG 7, NRCG 1308, and 7599.
- Nagaland: ICGS 76, CSMG 84-1, GG 7, FeESG 8 and 1, and three CS lines (148, 268 and 281)

Among the 14 varieties grown at Tripura under fertilized conditions (NPK,40:60:50) and cowdung (5 t/ha), the number of pod, weight of pod, and the weight of seed varied from 22 to 45/plant, 13.8 to 75.0 g/plant and 9 to 28 g/plant, respectively. The shelling turnover varied from 63.9% (FeESG 10) to 79.8% (GG 6). The variety, GG 13 gave the highest 100-seed weight (60 g) and the variety TG 37A gave the highest pod yield (2732 kg/ha).

A few early maturing varieties could easily fit in the cropping system of the NEH. The high yielding groundnut genotypes were also tolerant of Al-toxicity, ELS, LLS and rust.

A view of the DGR-NEH collaborative experiment in Tripura

Table 4. Performance of various groundnut genotypes in Tripura

Variety	Pod formation (no./plant)	Pod weight (g/plant)	Seed weight (g/plant)	Haulm weight (g/plant)	100-seed weight (g)	Shelling turnover (%)	Yield (kg/ha)	
							Pod	Haulm
ICGS 76	44	37.8	28.3	30.0	57.7	75.7	1521	1272
GG 12	28	25.1	18.3	34.0	54.7	74.8	1799	1804
GG 13	34	29.2	20.8	37.0	60.3	71.1	1669	2028
TG 37 A	37	26.7	17.8	16.2	44.0	67.4	2732	1231
FeESG 10	22	13.8	9.0	15.8	35.3	63.9	905	760
FeESG 8	25	16.0	11.4	19.4	46.3	71.9	1062	1488
K 134	35	74.7	18.3	20.1	46.0	74.0	1627	1146
GG 6	25	14.1	12.7	12.8	38.3	79.8	909	908
SB XI	34	18.4	13.6	15.7	38.7	71.4	1192	1463
GG 11	24	18.4	12.1	20.3	64.0	67.9	1817	2135
Kaushal	29	22.9	16.2	25.2	47.7	70.5	1859	1961
GG 4	34	23.6	18.6	18.3	37.0	78.7	1055	1160
GG 2	45	24.4	17.8	16.2	39.3	73.4	1490	1284
GG 8	31	32.4	23.7	14.8	52.0	73.3	1773	1635
SE(±)	4.8	4.36	3.2	2.1	2.0	3.68	193	169
CD (5 %)	**14**	**12.63**	**9.2**	**5.1**	**4.8**	**10.66**	**559**	**489**

Identification of suitable groundnut varieties for various intercropping systems

In Tripura, the groundnut (FeESG 8) was intercropped with sesamum and mung in vario treatment combinations, T1-sole groundnut, T2- sole sesamum , T3- sole mung, T4-groundnut sesamum (1:1), T5- groundnut + sesamum (2:2), T6- groundnut + mung (1:1) and T7- groundnut mung (2:2). The NPK dose applied was 40:60:50 kg/ha in combination with cowdung (5 t/ha) a results are presented in Table 5. The data indicates that groundnut in combination with sesamum at 2 could produce the highest groundnut equivalent yield (8.29 q/ha) followed by the combination (6.9 q/ha) with mung (1:1). However, earlier field experiment in Manipur with three intercropping systen (Rice + Groundnut, Maize + Groundnut and Green gram + Groundnut) and four varieties of groundn (ICGS 76, TKG 19A, JL 24 and ICGV 86590) demonstrated highest groundnut yield in maize groundnut intercropping and the varieties ICGV 86590 and TKG 19A were most suited.

Table 5. Yield and yield parameters in various intercropping with groundnut

Treat-ments	Yield and yield attributes of groundnut						Groundnut equivalent yield (kg/ha)	
	Pod formation (no./plant	Pod weight (g/plant)	Seed weight (g/plant)	Plant weight (g/plant)	Shelling turnover (%)	Pod yield (kg/ha	Sesamum*	Mung*
T1	23.49	17.49	9.16	31.33	53.24	645	-	-
T2	-	-	-	-	-	-	773	-
T3	-	-	-	-	-	-	-	480
T4	35.49	17.33	11.16	27.49	65.88	-	724	-
T5	23.99	12.83	7.83	14.66	59.43	-	829	-
T6	26.33	15.50	10.50	15.33	67.91	-	-	695
T7	14.83	13.00	8.33	13.33	64.01	-	-	522
SE(±)	8.61	5.28	3.02	5.83	6.18	11.9	-	-
CD 5%	**55.03**	**33.75**	**19.27**	**37.3**	**39.47**	**53**	-	-

*Selling price of groundnut, sesamum and mung were Rs 20, 25 and 30/kg, respectively.

Table 6. Productivity of confectionary and large seeded groundnut

Groundnut variety	Pod formation (no./plant	Pod weight (g/plant)	Seed weight (g/plant)	Plant weight (g/plant)	100-seed weight (g)	Shelling turnover (%)	Productivity (kg/ha)	
							Pod	Haulm
GG 20	20	27.1	12.6	22.44	67	74.3	562	881
HNG 10	48	24.1	17.7	23.22	46	71.7	1299	1263
ICGS 76	28	26.2	18.1	19.77	64	69.4	976	1368
BAU 13	23	14.9	8.0	26.99	88	51.5	990	1602
TPG 41	31	12.7	8.2	16.66	67	65.1	775	770
GG 7	27	21.7	15.3	21.55	56	68.8	1181	1429
Somnath	13	7.6	5.1	12.10	73	67.2	796	1188
NRCGCS 148	25	17.9	14.1	29.99	88	78.9	888	1370
NRCGCS 268	20	9.9	6.6	12.99	75	64.3	1141	1338
NRCGCS 281	21	14.2	9.6	12.44	80	67.1	852	849
SE(±)	4.6	4.99	3.5	4.54	3.28	3.8	179	231
CD5%	**13.7**	**14.78**	**10.2**	**13.44**	**9.71**	**11.3**	**530**	**684**

Table 5. Yield and yield parameters in various intercropping with groundnut

Treat-ments	Yield and yield attributes of groundnut						Groundnut equivalent yield (kg/ha)	
	Pod formation (no./plant	Pod weight (g/plant)	Seed weight (g/plant)	Plant weight (g/plant)	Shelling turnover (%)	Pod yield (kg/ha	Sesamum*	Mung*
T1	23.49	17.49	9.16	31.33	53.24	645	-	-
T2	-	-	-	-	-	-	773	-
T3	-	-	-	-	-	-	-	480
T4	35.49	17.33	11.16	27.49	65.88	-	724	-
T5	23.99	12.83	7.83	14.66	59.43	-	829	-
T6	26.33	15.50	10.50	15.33	67.91	-	-	695
T7	14.83	13.00	8.33	13.33	64.01	-	-	522
SE(±)	8.61	5.28	3.02	5.83	6.18	11.9	-	-
CD 5%	**55.03**	**33.75**	**19.27**	**37.3**	**39.47**	**53**	-	-

*Selling price of groundnut, sesamum and mung were Rs 20, 25 and 30/kg, respectively.

Table 6. Productivity of confectionary and large seeded groundnut

Groundnut variety	Pod formation (no./plant	Pod weight (g/plant)	Seed weight (g/plant)	Plant weight (g/plant)	100-seed weight (g)	Shelling turnover (%)	Productivity (kg/ha)	
							Pod	Haulm
GG 20	20	27.1	12.6	22.44	67	74.3	562	881
HNG 10	48	24.1	17.7	23.22	46	71.7	1299	1263
ICGS 76	28	26.2	18.1	19.77	64	69.4	976	1368
BAU 13	23	14.9	8.0	26.99	88	51.5	990	1602
TPG 41	31	12.7	8.2	16.66	67	65.1	775	770
GG 7	27	21.7	15.3	21.55	56	68.8	1181	1429
Somnath	13	7.6	5.1	12.10	73	67.2	796	1188
NRCGCS 148	25	17.9	14.1	29.99	88	78.9	888	1370
NRCGCS 268	20	9.9	6.6	12.99	75	64.3	1141	1338
NRCGCS 281	21	14.2	9.6	12.44	80	67.1	852	849
SE(±)	4.6	4.99	3.5	4.54	3.28	3.8	179	231
CD5%	**13.7**	**14.78**	**10.2**	**13.44**	**9.71**	**11.3**	**530**	**684**

Evaluation of confectionary groundnut genotypes in NEH region

Ten confectionary and large-seeded groundnut varieties, *viz.*, GG 20, HNG 10, ICGS 76, BA 13, TPG 41, GG 7, Somnath, NRCG CS 148, 268 and 281 were evaluated for their yield potential NEH region under high management conditions (FYM 10 t/ha + PSM + PGPR and all fertilizers) Mizorum, Tripura, Barapani and Nagaland where the high yielding genotypes were NRCG CS 2 TPG 41, CSMG 84-1, ICGS 76 and hence any of these could be used. But, when these were grown, low fertility soils of Tripura even by applying NPK (40: 60:50) + 5 t/ha cowdung, the performance these were poor (Table 6) with pod yield varying from 562 to 1299 kg/ha and varieties HNG 10 and G 20 showing the highest yield. Thus to obtain high yield the FYM was more essential for large seed groundnut.

PROJECT 06 : DEVELOPMENT OF SUSTAINABLE PACKAGES OFPRACTICES FOR GROUNDNUT BASED CROPPING SYSTEMS

(R. S. JAT, H. N. MEENA, I. K. GIRDHAR, K. K. PAL AND P. C. NAUTIYAL)

Permanent experiment on nutrient dynamics in groundnut based cropping system

A long-term experiment with five popular groundnut based cropping system *viz.*, sole 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. Different combinations of organic and inorganic fertilizer regimes were tried to study the nutrient dynamics and sustainability of these systems. The results revealed that the application of 'FYM + 50% RDF' did not have any significant effect on pod yield of groundnut compared to application of 100% RDF. The cropping systems differed in pod yield of groundnut. The groundnut pod yield in groundnut-wheat and groundnut-wheat-green gram cropping systems was significantly higher than monoculture groundnut system, pod yield being highest with the groundnut-wheat $_{(FYM+50\%RDF)}$-green gram cropping system. Where as, groundnut pod yields in 'groundnut + pigeon pea' and 'groundnut + pearl millet' intercropping systems were significantly lower than in sole groundnut. The trend was the same for the harvest index. Shelling outturn was also significantly affected with the nutrient management and cropping systems. The shelling outturn was significantly higher in 'groundnut + pigeon pea' and 'groundnut + pearl millet' intercropping systems. The shelling outturn was highest with the 'groundnut + pearl millet $_{(50\%\ RDF)}$. Analysis for groundnut equivalent yield (GEY), however, revealed that the nutrient management did not bring about any significant improvement in pod yield. Where as in cropping systems 'groundnut-wheat', 'groundnut-wheat-green gram', and 'groundnut + pigeon pea' significantly higher GEY was obtained compared to that in groundnut monoculture. The GEY of 'groundnut + pigeon pea $_{(100\%\ RDF)}$' was significantly higher than those of other systems and associated nutrient management practices.

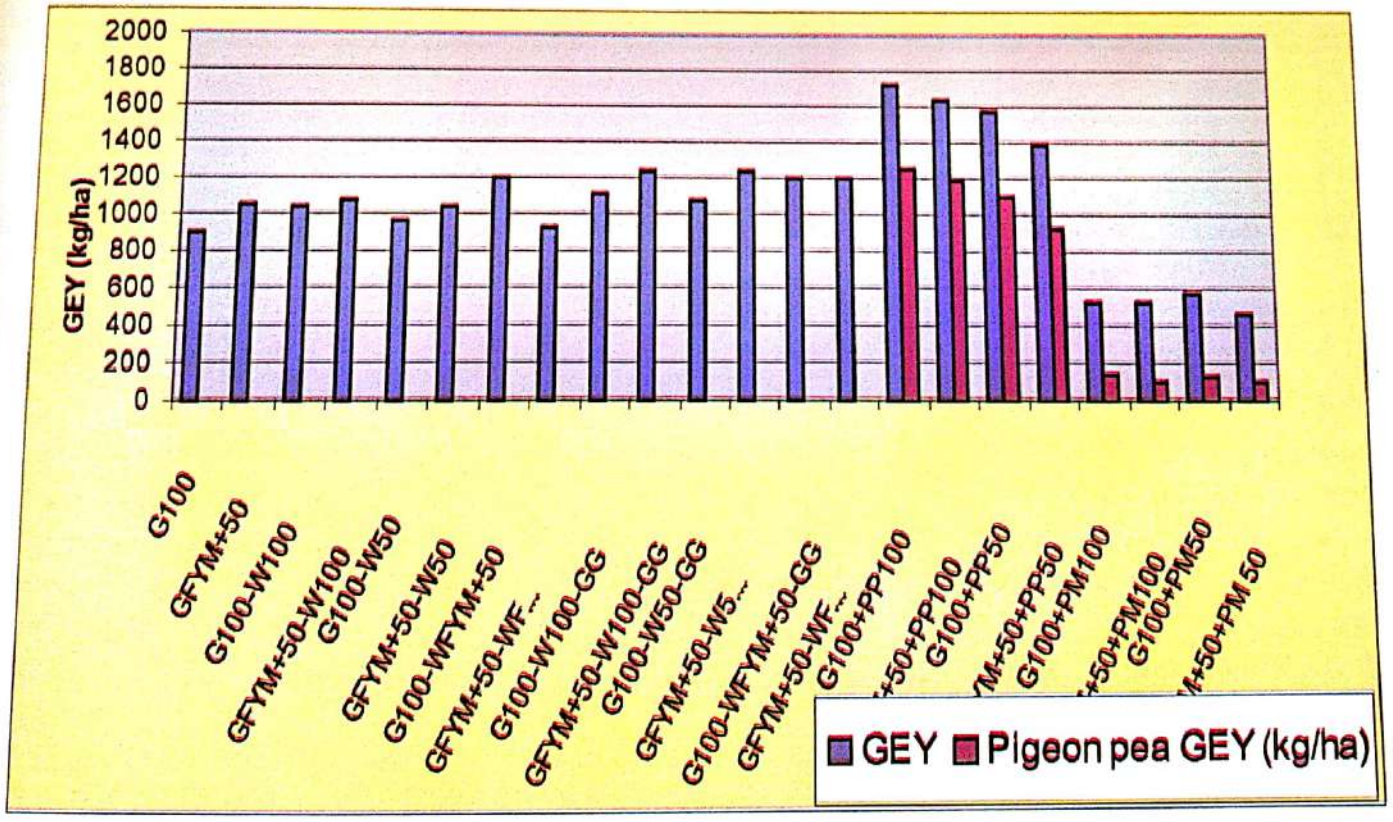


Figure 1. Effect of nutrient management and cropping systems on groundnut equivalent yield

Table 1: Effect of nutrient management and cropping systems on yield attributes of ground crop

Treatment	Pod yield (kg/ha)	Straw yield (kg/ha)	Harvest index	Shelling turnove (%)
100% RDF	842	1518.9	34.5	69.8
FYM+50% RDF	861	1427.5	36.0	70.2
$CD_{0.05}$	NS	61.2	0.5	0.3
CV%	11	14.0	13.0	10.1
Groundnut	973	1767.6	35.8	70.2
G-W100	1056	1750.8	37.5	68.5
G-W50	1004	1704.5	37.0	70.4
G-W FYM+50	1065	1715.0	37.7	69.6
G-W100-GG	1173	1736.1	40.2	69.3
G-W50-GG	1159	1788.7	39.3	69.4
G-WFYM+50-GG	1205	1662.4	42.0	68.6
G+PP100	458	999.6	31.2	69.9
G+PP50	467	1052.2	30.6	71.0
G+PM100	399	1003.8	28.3	70.6
G+PM50	407	1024.8	28.3	71.6
$CD_{0.05}$	61	69. 8	0.5	1.1
CV%	10	11.0	10.0	11.5

Role of citric acid in P availability and development of technology for application in groundnut

The experiment was laid out in the *kharif* 2008 to enhance the availability of phosphorus by application of citric acid (CA). The treatments consisted of three levels of citric acid (2, 4 and 6 kg/ha) and a control. Five methods of application were tried *viz.*, CA alone, CA with FYM 2t/ha, CA with FYM 1t/ha, CA with SSP 250kg/ha and CA with SSP 125 kg/ha). The results of first year revealed that application of CA increased the pod yield of groundnut compared to control and the effect was high when CA was applied with either FYM or SSP. The highest pod yield was recorded with '2 kg CA+1t FYM/ha'. The response was low if CA was applied at the rates of above 2 kg/ha. The analysis of soil-microbial population analysis revealed that when CA was applied in combination with FYM, the population of free-living N_2-fixers was high while it was low if CA was applied in combination with

SSP. The maximum population was observed with '2 kg CA + 1 t FYM/ha'. The response of total population of bacteria and non-fluorescent pseudomonads to CA application was not consistent. With Ca application, the maximum population was, however, recorded with 4 kg and 6 kg/ha.

The population of fluorescent pseudomonads was also high with 'CA + FYM' application. The economic analysis revealed that application of CA in combination with FYM or SSP increased the net returns over control or application of CA alone. The maximum net returns accrued with the application of '2 kg CA + 1 t FYM/ha'. The net returns were higher when CA was applied in combination with FYM than that in combination of SSP.

Table 2. Effect of citric acid and method of application on pod yield, HKM and shelling outturn of groundnut

Treatment	Pod yield (kg/ha)	100 kernel mass (g)	Shelling turnover (%)
Control	625	38.8	70
CA2	623	36.6	68
CA4	606	36.0	70
CA6	673	35.2	68
FYM 2t+CA0	668	38.4	69
FYM 2t+CA2	710	37.7	68
FYM 2t+CA4	676	37.0	68
FYM 2t+CA6	574	37.3	70
FYM 1t/ha+CA0	704	36.8	67
FYM 1t/ha+CA2	852	36.6	69
FYM 1t/ha+CA4	698	35.8	68
FYM 1t/ha+CA6	750	37.4	69
SSP 250kg/ha+CA0	679	37.4	68
SSP 250kg/ha+CA2	718	38.4	69
SSP 250kg/ha+CA4	716	38.4	69
SSP 250kg/ha+CA6	610	36.5	68
SSP 125kg/ha+CA0	756	36.5	67
SSP 125kg/ha+CA2	807	36.4	68
SSP 125kg/ha+CA4	545	37.0	67
SSP 125kg/ha+CA6	591	36.2	70

PROJECT 07: MANAGEMENT OF EXISTING AND EMERGING PROBLEMS OF SOIL AND WATER SALINITY FOR GROUNDNUT PRODUCTION

(I. K. GIRDHAR, R. S. JAT, P. C. NAUTIYAL AND K. K. PAL)

Use of saline water in groundnut based crop rotation and intercropping system

The ground water in arid, semi-arid and coastal regions of Gujarat, particularly Saurashtra area is saline and the availability of good quality water is a limiting factor in crop production. Hence groundnut in this area is generally cultivated only in rain fed condition. Due to uneven distribution of rainfall on groundnut crop undergoes severe moisture-deficit stress during the months of September and October. Hence, possibility was explored to use saline water irrigation in groundnut based cropping systems. This study began in 2002 and continued up to 2009 on the long-term use of saline ground water in different crop rotations *viz.*, Groundnut-Groundnut, Groundnut- Wheat, Groundnut-Mustard and Groundnut-Bajra, instead of taking single rain fed crop of groundnut as is prevalent in the coastal areas of Saurashtra. After seven years of experimentation it could be concluded that water upto 2-3 dS/m salinity can be used for supplemental irrigation to *kharif* groundnut and 4-6 dS/m salinity of irrigation water to wheat, mustard and bajra crops in *rabi* season for obtaining economic yields (about 1000 kg of groundnut, 1700 kg of mustard, 3500 kg of wheat and 4200 kg of bajra per ha). The use of saline water for irrigation to summer groundnut, however, was not successful as there was a build up of high soil salinity with the progressive use of saline water irrigation.

Build up of salts in the root zone as a result of progressive use of saline water for irrigation (ECiw >3 dS/m to groundnut and ECiw >6 dS/m to wheat, mustard and bajra crops) adversely affects the water absorption even if the soil is well watered. This resulted in stunted plant growth and reduced nutrient availability, which decreased the yield significantly. Prolonged use of saline water for irrigation increased the soil pH from 7.8 in year 2002 to 9.0 in 2008, which could also further deteriorate the soil health. Deterioration of soil health as a result of increase in soil pH and salinity over a period of time can, however, be prevented with the application of gypsum to the soil. Oil content of both groundnut and mustard seeds significantly decreased with an increase in salinity from 0.5 to 6 dS/m.

Hence, saline ground water in coastal area of Saurashtra can be used profitably for supplemental irrigation by taking two crops i.e. groundnut-wheat, groundnut-mustard and groundnut-bajra to maximise the yield instead of taking single crop of groundnut under purely rainfed conditions. Further, the above mentioned thresholds of salinity for groundnut, wheat, mustard and bajra crops may vary with variation in the extent and distribution of rainfall, soil texture, leaching efficiency and varieties of the crops. This study was repeated in 2008 in a hot-spot (salinity affected area) at the Regional Research Station of JAU at Khapat in Porbandar district. The data indicated that saline water having 4 dS/m salinity could be safely used for maximising yield of groundnut in light textured soils.

Screening of germplasm and released varieties in saline environment

A large number of germplasm accessions and released varieties of groundnut were screened in saline environment at both DGR, Junagadh and Regional Research Station, JAU, Khapat (Porbandar). The germplasm accessions NRCG 14385, 14476, and 14351 gave maximum pod yield and the accessions NRCG 14408, 14426 and 14332 gave the lowest pod yield. Among the released varieties ICGV 86325, HNG 10, BAU 13, ICGS 76 under Virginia runner group gave the highest yield whereas under Virginia bunch, CSMG 84-1, Somnath and Kadiri 3 showed the highest yield and AK 159, JL 24 and TPG 41 under Spanish bunch group gave the highest pod yield.

PROJECT 08: MANAGEMENT OF GERMPLASM OF CULTIVATED GROUNDNUT (*A. hypogaea* L.) AND ITS WILD RELATIVES

(A.L. RATHNAKUMAR, S. K. BERA, T. V. PRASAD, VINOD KUMAR AND V. V. SUMANTH KUMAR)

Acquisition of new germplasm accessions

Fifteen groundnut varieties released by Oilseeds Research Station, Latur (1), Birsa Agricultral University, Ranchi (1), RVSKVV, Jabalpur (2), Agricultural Research Station, Kadiri, ANGRAU (9), JAU, Junagadh (1) and DGR, Junagadh (1) were added to the germplasm inventory. Forty-seven accessions of seed forming species of the section *Arachis* and three accessions of the section *Rhizomatosae* were also obtained from National Bureau of Plant Genetic Resources (NBPGR), Regional Station, Hyderabad and established in field gene bank of DGR.

Supply of germplasm accessions to indenters

For use in ongoing crop improvement programmes, 1762 accessions including wild relatives of groundnut were supplied to 40 indenters. These recipients included scientists of NRCG (402 acccessions), State Agricultural Universities (1283 acccessions), ICAR Institutes (30 acccessions), AICRP-G centres (40 acccessions) and others (07 acccessions).

Multiplication and conservation of groundnut germplasm

Multiplication of mini-core germplasm and NRCG subset of accessions

A total of 351 accessions comprising 184 ICRISAT mini-core accessions and 167 accessions from the working collections of NRCG representing wide variations for different morphological traits were multiplied in *kharif* season. The seed regenerated from these accessions was in the range of 25 to 130g.

Supply of new germplasm accessions to National Gene Bank

NRCG, being one of the National Active Germplasm Sites (NAGS), the seeds of working collection are to be deposited with National Gene Bank (NGB), NBPGR, New Delhi for their long-term conservation.

A set of 395 germplasm accessions (VUL 116; FST 82; HYB 101; HYR 96) was multiplied in *kharif* season for depositing in NGB, New Delhi. These accessions included ICRISAT mini-core collection and voucher samples and the accessions repatriated under ICAR-ICRISAT collaborative project. A total of 235 accessions, having sufficient seeds, were deposited with NGB for long-term conservation.

For medium-term storage at NRCG

Exotic lines (54), morphologically distinct accessions (45), released varieties (132), and reference varieties (30) identified under DUS project were multiplied in *kharif* season and conserved in the medium-term-cold storage module at NRCG.

Characterization of germplasm

Mutilocational characterization of ICRISAT mini-core collection and sub-set of NRCG working collection

At NRCG, Junagadh, 69 Spanish bunch accessions including check varieties were evaluated in summer season for 31 morpho-physiological traits.

Evaluation and characterization of 351 accessions was completed for two years during *kharif* season at two locations, MPKV Jalgaon and RRS Vridhachalam. At NRCG, 284 accessions of voucher samples received from NBPGR, Hyderabad were evaluated and characterized.

The results on genetic variations for qualitative traits in these accessions indicated that for the market oriented traits of pods like pod beak, pod constriction, shell thickness, pod reticulation and of seeds like colour, shape and size, substantial variability existed thereby indicating the usefulness of the germplasm in crop improvement programmes. The yield and its four important component traits studied at the two locations indicated that wide variations existed for these traits (Table 1).

Table 1. Variation for yield parameters in mini-core collections of NRCG and ICRISAT

Location	Pod yield (g/plant)	Kernel yield (g/plant)	Kernel mass (g/100 kernel)	Shelling turnover (%)
Vridhachalam	3 - 25	2 - 19	14 -111	52 -72
CV (%)	(48)	(50)	(17)	(20)
Jalgaon	4 - 21	3 -14	17-55	67
CV (%)	(28)	(30)	(23)	(5)

Among the voucher samples studied, high yield (>15 g/plant) in two accessions (NRCGs' 17008, 16989); large-seed size (55 g/100 kernel) in two accessions (NRCGs' 16834 and 17010) and high shelling outturn (70%) in ten accessions (NRCGs' 16854, 16909, 17333, 16843, 17015, 16860, 17075, 16912, 16989 and 17071) were observed indicating usefulness of these accessions for trait specific improvement.

In summer season, at NRCG 69 Spanish bunch accessions were characterized for 8 qualitative and 23 quantitative traits to assess the extent of diversity. The similarity coefficients were calculated and by using the coefficient matrix, clustering was done by applying neighbour joining method (Saitou and Nei, 1987). The study indicated that substantial genetic diversity existed for the traits studied (Figure 1). These accessions were grouped in to seven clusters with differential intra- and inter-cluster distances. The number of accessions that were grouped in a single cluster varied from 7-13.

Among 7 clusters, the cluster V containing the accessions, NRCGs' 14326, 14335, 14473, 14420, 14493, and 14425 showed a high variability for number of mature pods, pod yield and hundred seed mass. The other clusters, which showed promise for number of mature pods and pod yield were cluster VI (NRCGs' 14329, 14334, 14409, 14423, 14414, 14437, 14485 and 14486), cluster VII (NRCGs' 14385, 14393, 14411, 14436, 14461, 14465 and 14482) and cluster III (14365, 14377, 14389, 14422, 14424, 14433, 14462 and 14472)

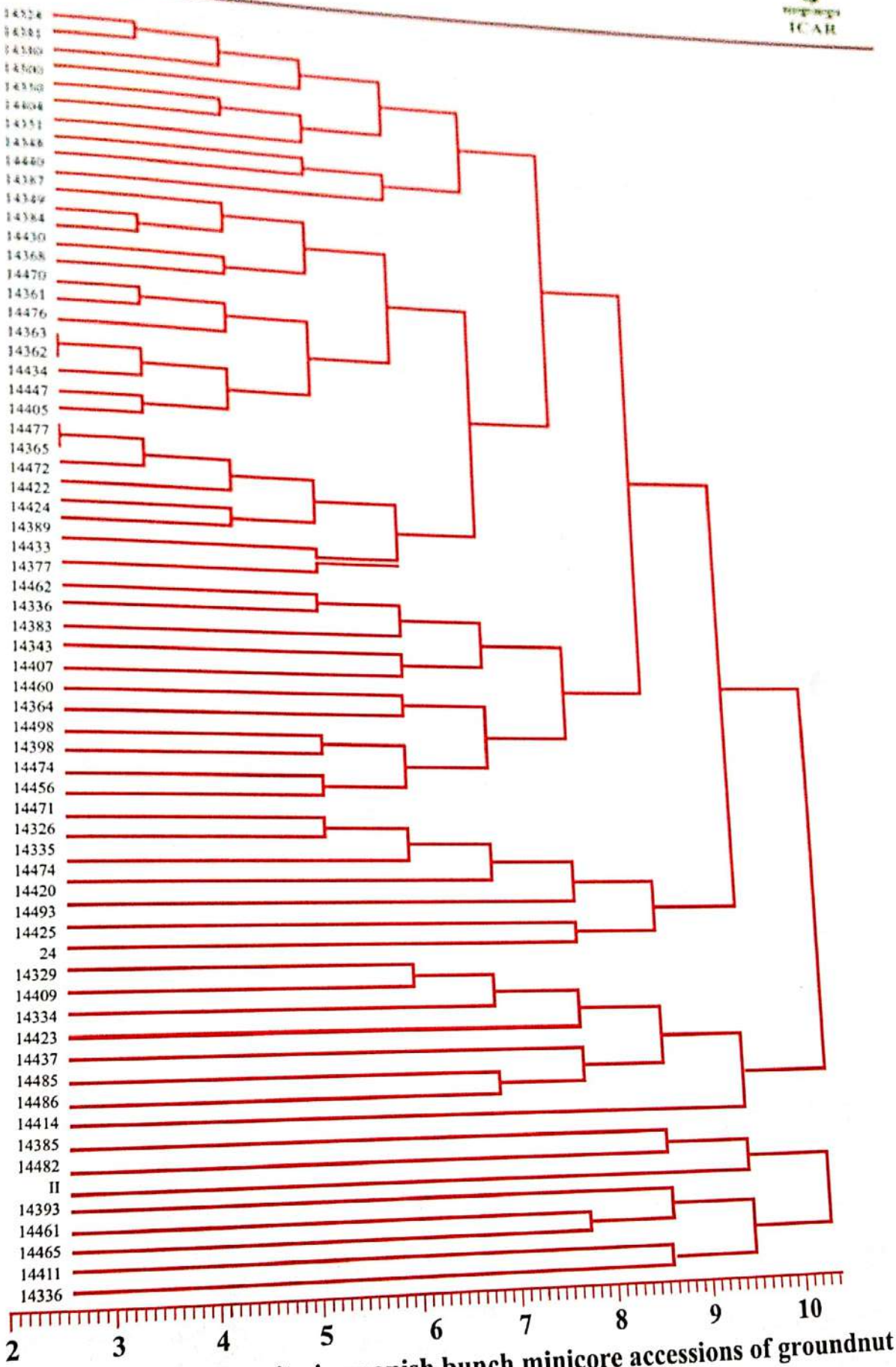


Figure 1 : Genetic deversity in spanish bunch minicore accessions of groundnut

Based on mean performances, coefficient of variability, genetic coefficients of variations and heritability of both qualitative and quantitative traits the following accessions were identified for use as parents for improving specific traits in groundnut:

- For earliness, NRCG 14407
- For compact plant type, NRCG 14425
- For high root bio-mass, NRCG 14356
- For more secondary branches, NRCGs, 14377, 14470
- For high pod yield, NRCGs, 14365, 14368, 14433
- For yield related traits (no. of mature pods, seed mass and shelling outturn), NRCG 14433, 14365

Evaluation of Spanish bunch mini-core accessions for the presence of fresh seed dormancy

An experiment was carried out under laboratory condition to evaluate 64 diverse Spanish bunch germplasm accessions from a sub-set of working collection of NRCG (sub-species *fastigiata* var. *vulgaris*) along with two Spanish bunch non-dormant check varieties, JL 24 and GG 2 for the presence of fresh seed dormancy. The seeds, obtained from the crop raised in the field during summer 2008 were used. The seeds were removed from mature pods immediately after harvest and placed on moist filter paper and then incubated at 35±2°C and 65% relative humidity.

Significant differences were observed among the genotypes for number of days taken for complete and extent of germination. Both the check varieties exhibited 100% germination within 4 weeks. Seeds of four accessions, NRCG 14329, NRCG 14349, NRCG 14350 and NRCG 14409 did not germinate even after 8 weeks of incubation indicating the presence of very long seed dormancy.

In another four accessions (NRCGs'14326, 14336, 14368, 14380) the germination was very low (below 20%) even at eight weeks of incubation (Figure 2) indicating the presence of good degree of fresh dormancy in these genotypes. The seeds of two accessions, NRCG 14474 and 14348 exhibited only 50% germination after 8 weeks of incubation (Figure 3) indicating the presence of partial dormancy. These genotypes can be used as sources of fresh seed dormancy in Spanish bunch breeding programmes for developing varieties for the areas where rains are frequent late in the *kharif* season coinciding with harvest.

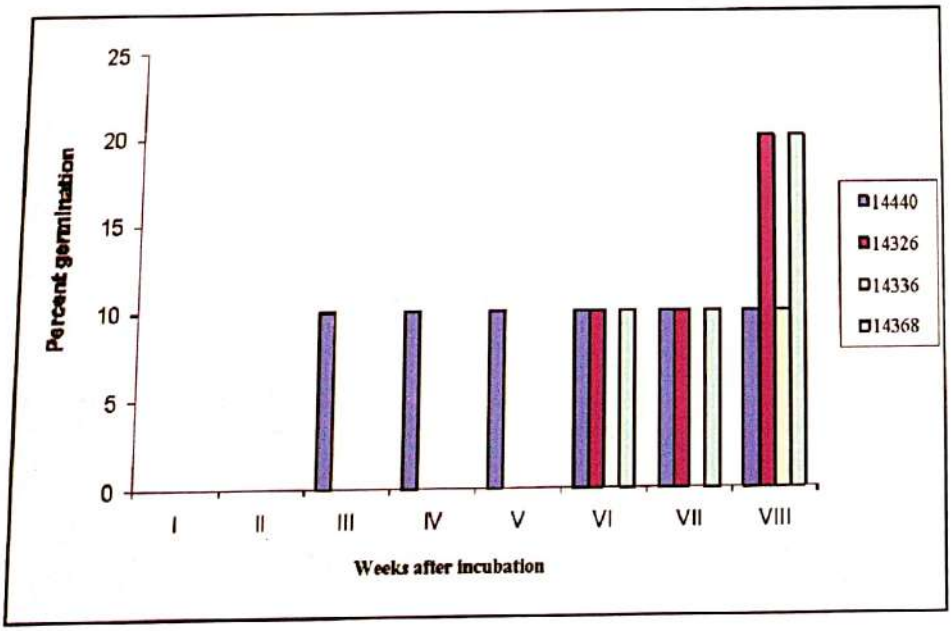


Figure 2. Germination of some dormant and partially dormant accessions

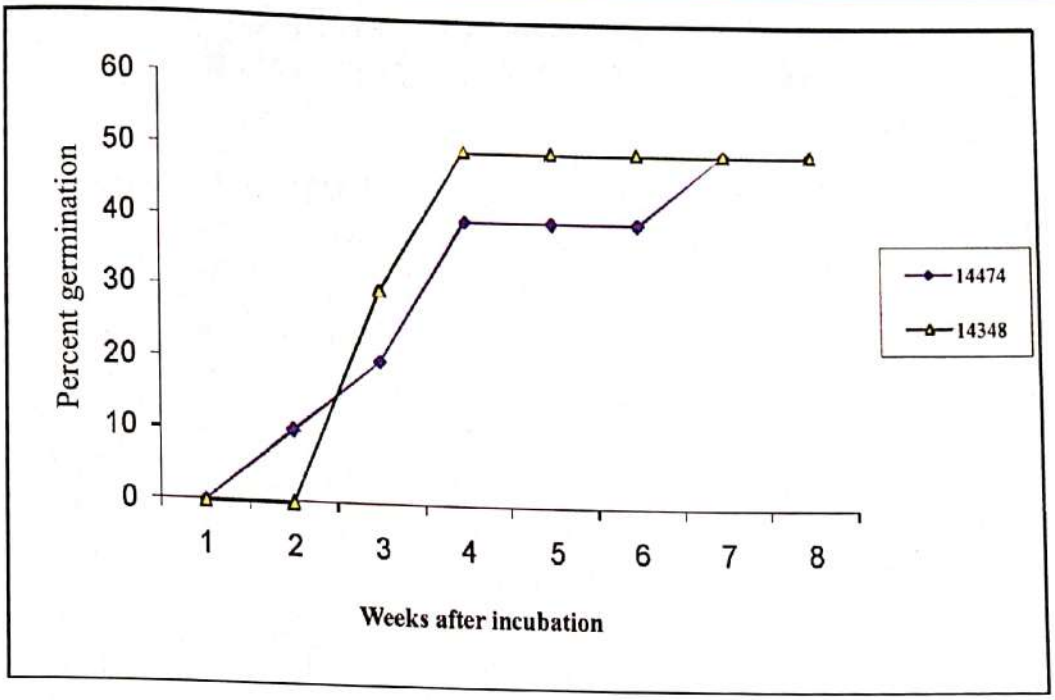


Figure 3. Germination of partially dormant accessions

Screening of mini-core germplasm at hot spots

In summer season, 351 common accessions were screened for two virus diseases, Peanut Bud Necrosis Diseases (PBND) and Peanut Stem Necrosis Diseases (PSND) at hot spot centers under AICRP-G. The accession NCAc 515 suffered only 3.5% incidence. The following accessions recorded <5% incidence. The screening will be continued in the ensuing summer season for confirmation.

Hot spot Centre	Disease	Disease pressure	Promising accessions
Kadiri	Peanut Stem Necrosis Disease (PSND)	1.0% -27.0%	PI 268573 (1.0%), Spanish 2B (1.5%), MTUTU C (1.5%), Schwarz 21 (2.0%), LE 36 (2.0%), SPZ Purple (2.5%), NCAc 515 (3.5%)
Kadiri	Peanut Bud Necrosis Disease (PBND)	1.0-21.0%	NCAc 2838 (1.5%), P 2435 (2.0%), Tingo Maria (3.5%), NCAc 515 (3.5%)
Raichur		4%-42%	ICGS' 76 (4.55%), 1668 (4.17%), 7906 (5.41%), 9802 (4.76%), CS 107 (4.26%), NRCG 13122 (5.71%)

Field gene bank of wild *Arachis* species

A field gene bank was maintained comprising 81 accessions under 6 sections: *Arachis* (28), *Caulorhizae* (1), *Erectoides* (6), *Heteranthae* (1), *Procumbentes* (8) and *Rhizomatosae* (37). The seeds and cuttings of these species were supplied to different indenters.

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

(RADHAKRISHNAN T., A. L. RATHNAKUMAR, CHUNI LAL, S. K. BERA, VINOD KUMAR, HARIPRASANNA K. AND T. V. PRASAD)

Genetic transformation

Transformation with *mtlD* gene construct

Agrobacterium mediated genetic transformation was attempted by using 636 de-embryonated cotyledons as explants. These explants were co-cultured with *Agrobacterium tumefaciens* strain harbouring the *mtlD* gene with *npt* II gene. The regeneration of multiple shoots was observed only in 380 explants cultured. Thus the frequency of regeneration was 59.74%. Out of 380 regenerated explants, 207 shoots were isolated for further use. All the isolated shoots were grown on selection medium and 84 putative transgenics were identified (40.6%). Ten putative transgenics were selected randomly for PCR test and two were found positive with expected fragment of 400bp. All the putative transgenics are being screened further. The gene construct with *mtlD* was obtained from Delhi University.

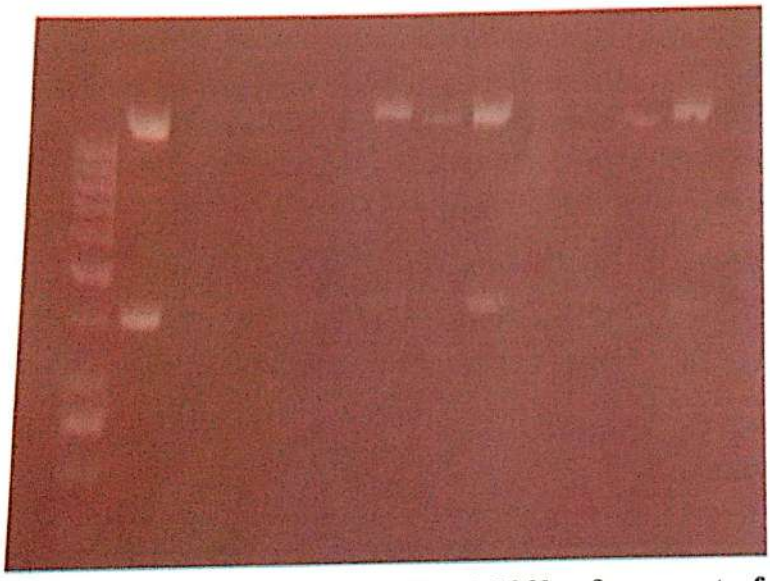


Figure 1. Agarose gel showing amplified 700bp fragment of defensin

Transformation with *defensin* and *annexin* gene constructs

For incorporating tolerance to biotic and abiotic stresses in groundnut through *Agrobacterium* mediated transformation, *defensin* and *annexin* gene constructs were used. De-embryonated cotyledons from mature seeds of cv. GG 20 were used as explants. Direct multiple shoots from cotyledons were induced after co cultivation. Transformed plants were confirmed by PCR amplification of integrated transgene by using primer pairs of *nptII* and *defensin* or *annexin*. The amplification products obtained were 700bp of *nptII*, 500bp of *defensin* and 954bp of *annexin* confirming the presence of transgenes.

Table 1. No. of shoots regenerated and putative transgenics from co-cultured explants

Transgene	Crop	Total explants cultured	Explants showing shoot regenerations	Well developed shoots	Shoots rooted	PCR positive plants
Defensin	Groundnut	583	106	43	1	1
Annexin	Groundnut	559	140	27	0	0

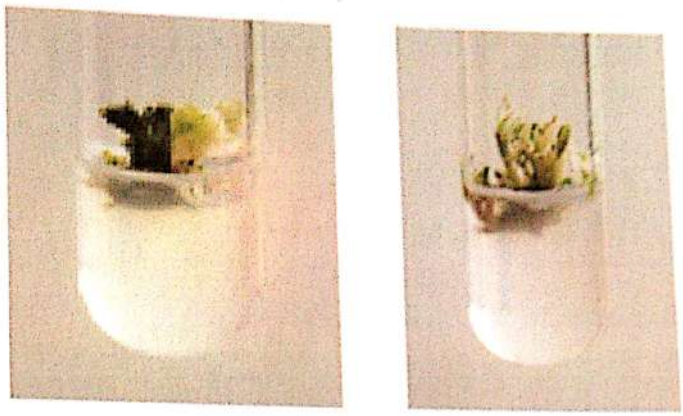


Figure 2. Regenerating embryonic leaves after co-culture

Table 2. No. of shoots regenerated from explants co-cultured for transformation with annexin gene

Transgene	Set	Explants cultured	Explants regenerated
Annexin	I	625	8
	II	625	In selection
	III	575	In selection
	IV	575	In selection
	Total	2400	

Genotyping of the parents of the mapping population

Genotyping of the parental lines

Genotyping of the parental lines (TAG 24, TMV 2 NLM, CHICO, CSMG 84-1, ICG (FDRS) 1 JL 24) of the mapping populations were done using 204 primers comprising 19 primes of PM series a 185 primers of IDT. Out of these primers 54 primers were found to be polymorphic.

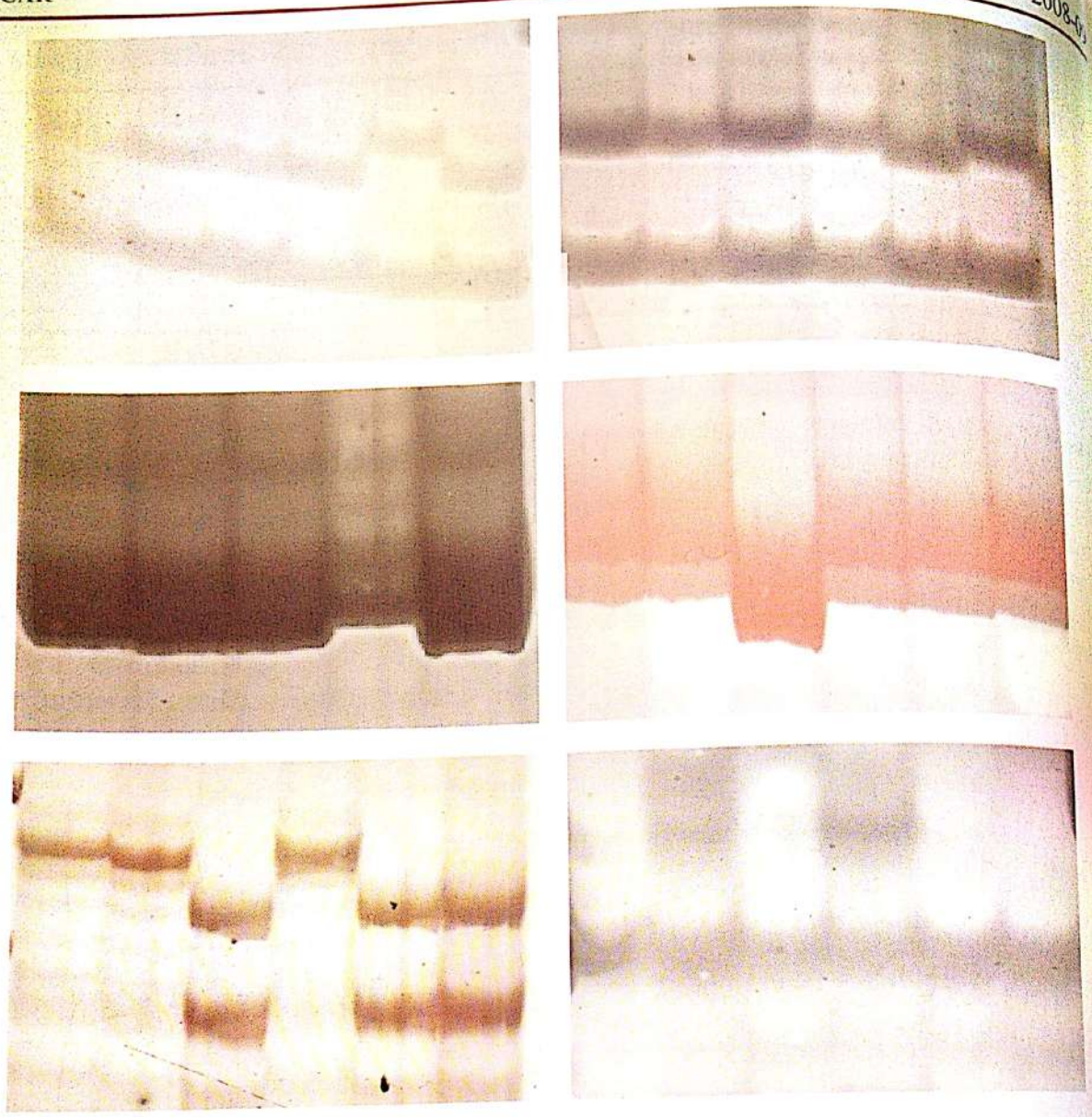


Figure 3. SSR profiles of the parental genotypes

DNA extraction for genotyping of the RILs

DNA from tender leaves of 91 samples the RIL (cross **CHICO x CSMG 84-1)** grown at NRCG was extracted, purified and estimated for subsequent genotyping. DNA from 115 samples from populations grown at Aliyarnagar (*kharif* 2008) for screening of RIL cross **(ICG (FDRS) 10 x JL 24)** was also extracted, purified and estimated for genotyping

Fingerprints of extant varieties for PVPFR

The SSR profiles of 26 varieties, released after 1995, were developed for the fingerprinting by using 6 SSR primers *viz*., IDT111, IDT121, IDT127, IDT137, IDT141 and PM3. The varieties were: TPG 41, TG 37A, TG 26, KADIRI 6, VRI 4, ALR 2, ALR 3, GG 5, GG 6, GG 7, VG 9521, AK 159, JL 220, CO 3, R 8808, OG 52-1, BRS 1, TIRUPATI 4, GG 21, LNG 2, R 9251, CSMG 884, HNG 10, GG 15, DRG 1 and M 522.

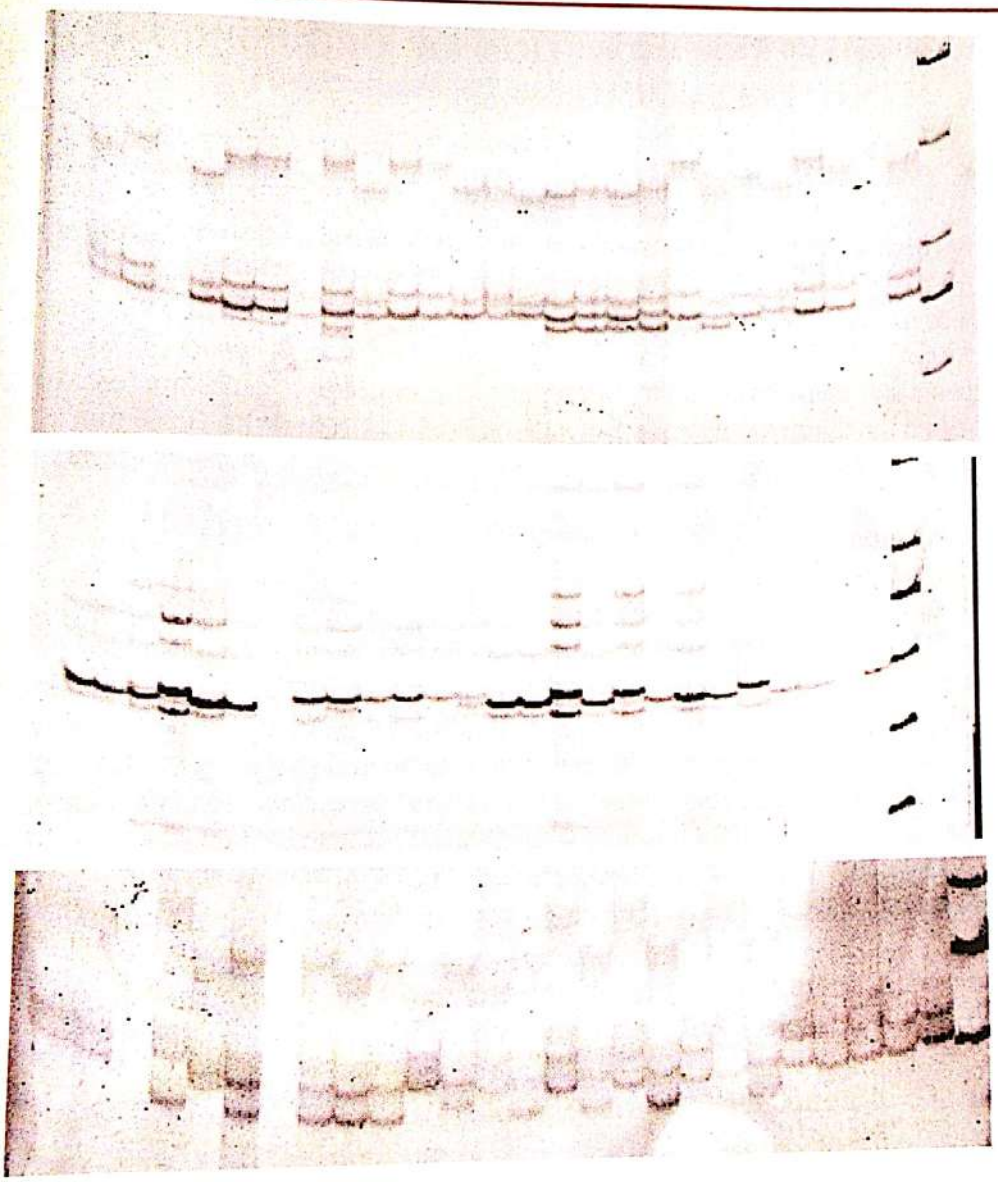


Figure 4. SSR profiles of the extant varieties genotyped for developing fingerprints

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

(J. B. MISRA)

The project was under suspended animation for the period of this report as the PI of the project took over as the Director of DGR, Junagadh.

PROJECT 11: BIOTRANSFORMATION OF GROUNDNUT BYPRODUCTS INTO USEFUL PRODUCTS

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

Evaluation of protease production potential of proteolytic fungi on de-oiled groundnut cake

The protease production potential of *Aspergillus nidulans* MTCC 831, *Beauveria bassiana* 1186, *Rhizopus microsporus* var. *oligosporus* MTCC 556 and *Aspergillus awamori* MTCC 548 was studied on de-oiled groundnut cake. Preliminary screening of four cultures on Skimmed Milk Agar plates (SMA) showed that the diameter of the hydrolysis zones varied from 45 mm to 83 mm after 72 hours of incubation, the maximum was produced by *Rhizopus microsporus* var. *oligosporus* MTCC 556.

Solid substrate fermentation

Solid substrate fermentation was carried out to study the protease production potential of the fungal cultures on de-oiled groundnut cake. It was observed that different fungi produced different types of proteases. In the case of *Rhizopus microsporus* var. *oligosporus* MTCC 556, the maximum enzymatic activity (5.04 IU/g de-oiled cake) was shown in alkaline range of pH at 96 hours while in case of *Aspergillus nidulans* MTCC 831 maximum production of neutral proteases (17.09 IU/g de-oiled cake) was after 72 hours of fermentation and in the case of *Aspergillus awamori* MTCC 548, early production of acid proteases was observed at 48 hours of fermentation and maximum production of acid proteases (9.10 IU/g de-oiled cake) at 48 hours of fermentation. In case of *Beauveria bassiana* 1186, maximum production of alkaline proteases (20.04 IU/g de-oiled groundnut cake) was at 48 hours of incubation.

On the basis of maximum production of proteases under the experimental conditions, *Aspergillus nidulans* MTCC 831 was selected and this enzyme was purified for further studies.

Determination of optimum temperature

The activity of the neutral protease increased gradually with increasing temperature (above 25°C) and reached a maximum at 50°C (280.26 IU/mg protein). With increase in temperature above 50°C, the activity, however, gradually decreased and at 80°C, the enzyme activity could not be detected (Figure 1).

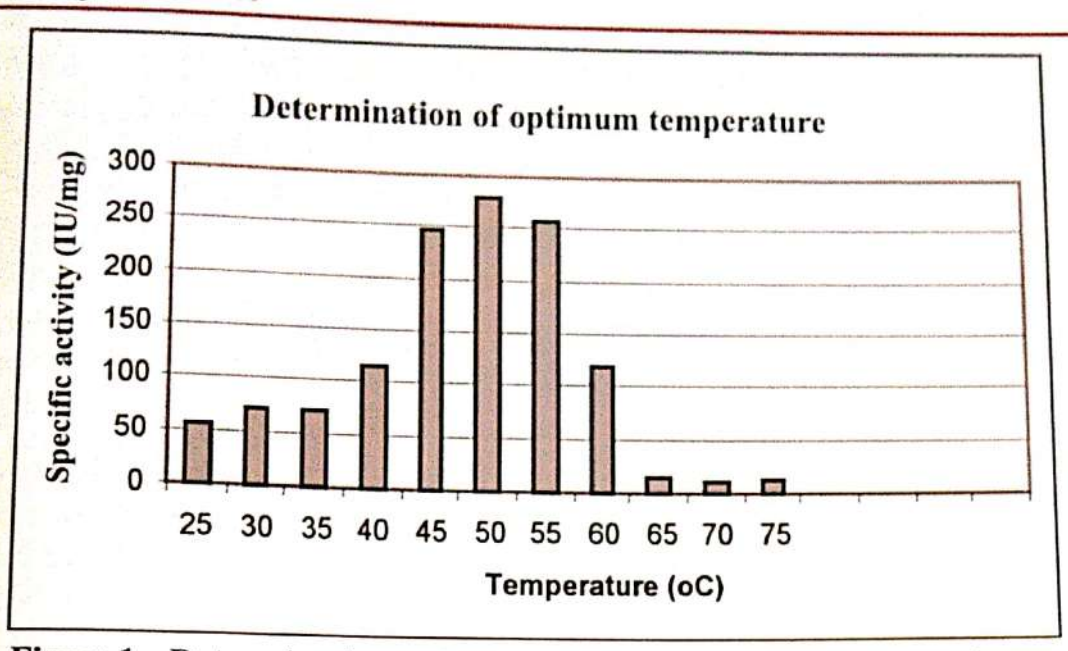


Figure 1. Determination of optimum temperature for maximum activity of purified neutral protease obtained from *Aspergillus nidulans* MTCC 831

Determination of optimum pH

The neutral proteases showed maximum activity (282.14 IU/mg of protein) at pH 7 (Figure 2).

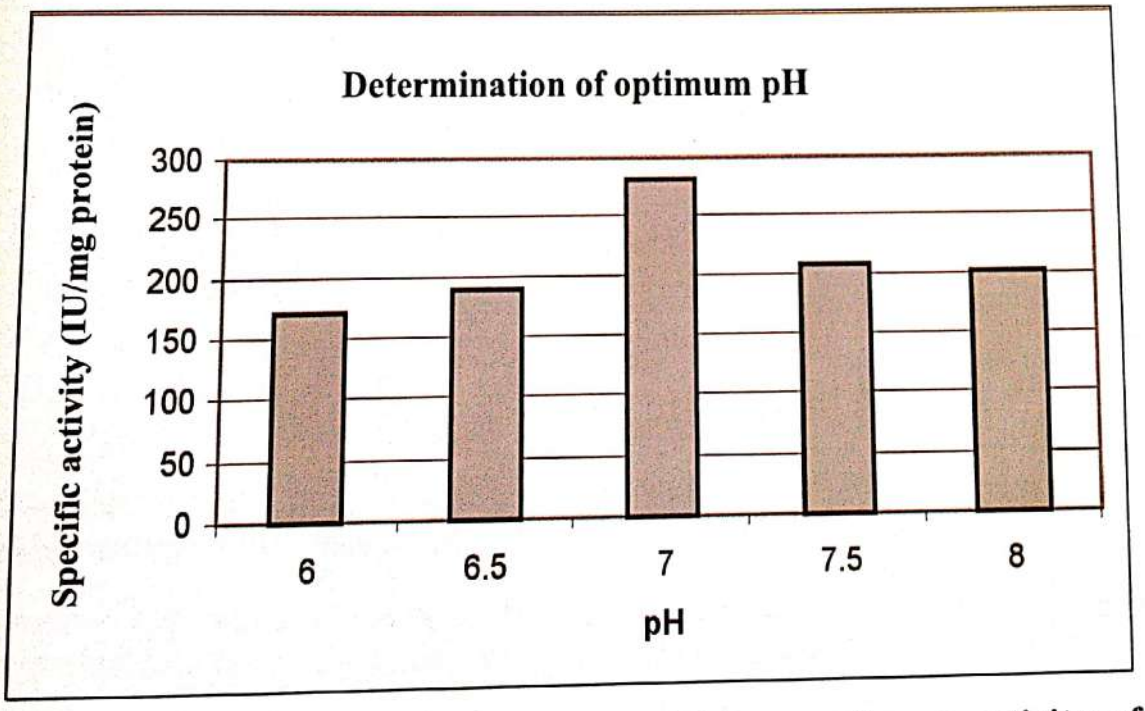


Figure 2. Determination of optimum pH for maximum activity of purified neutral protease from *Aspergillus nidulans* MTCC 831

Sodium Dodecyl Sulphate Polyacrylamide Gel Electrophoresis of proteases

An SDS-polyacrylamide gel electrophoresis was run to ascertain the presence of the proteases produced by *Aspergillus nidulans* MTCC831 and *Rhizopus microsporus* var. *oligosporus* MTCC 556. Analysis of the gel indicated that while *Aspergillus nidulans* MTCC 831 produced a protein of about 78 KD size, *Rhizopus microsporus* var *oligosporus* produced a protein of about 49 KD (Figure 3).

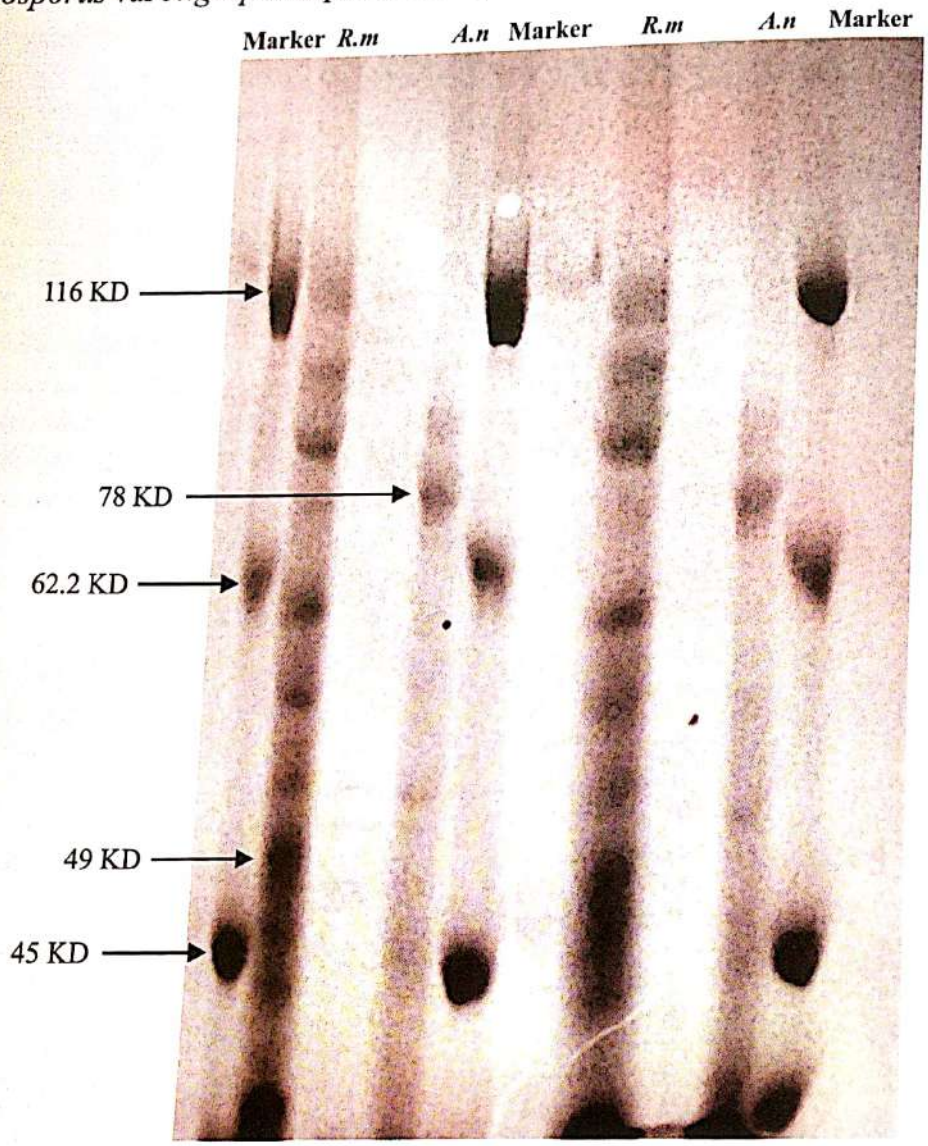


Figure 3. SDS-PAGE of proteases obtained from *Rhizopus microsporus* var. *oligosporus* MTCC 556 and *Aspergillus nidulans* MTCC 831

Compatibility of proteases with commercial detergents

The effect of mixing four different commercial detergents with neutral proteases (obtained from *Aspergillus nidulans* MTCC 831) on the cleansing action of detergents was evaluated. Muslin cloth pieces stained with tea were used as the test material. It was observed that when protease was mixed with the detergents, the cleaning efficiency of all the detergents improved as was evident from the intensity of the left over stain on the muslin cloth and the quantity of stain in the wash water left in the beaker. This indicated that the enzyme had hydrolyzed the protein-bound stains present in tea. Thus the enzyme obtained by fermentation of groundnut cake was compatible with the detergents.

PROJECT 12: PREVENTION AND MANAGEMENT OF MYCOTOXIN CONTAMINATION IN GROUNDNUT

(VINOD KUMAR)

Evaluation of released cultivars and advanced breeding lines for resistance to aflatoxin contamination

In a sick plot, thirty-four genotypes (advanced breeding lines and varieties) showing promising testa resistance to *A. flavus* along with one susceptible (GG 20) and one resistant (J 11) checks were evaluated in augmented block design for resistance to *A. flavus* infection and aflatoxin contamination. The soil was inoculated thrice with the most virulent isolate of *A. flavus*, *AF111* at the time of sowing, flowering and 90 days after emergence. Observation was recorded on incidence of aflaroot. The pod samples were analyzed for seed infection of *A. flavus* and level of aflatoxin contamination. The population of *A. flavus* was monitored in the sick plots. The population was 14.3-16.3 x 10^3 cfu/g soil at the time of sowing which increased to 18.7-20.3 x 10^3 cfu/g soil at pod development stage. The seed infection varied from 11.0 to 16.5%.

Table 1. List of genotypes having testa resistance to *A. flavus*

Sl No.	Genotype	Sl No.	Genotypes	Sl No.	Genotype
1.	ALR 2	2.	CS 44	3.	K 134
4.	B 95	5.	CS 47	6.	Karad 4-11
7.	BAU 13	8.	CS 69	9.	PBS 29077
10.	CS 129	11.	CS 70	12.	RHRG 12
13.	CS 215	14.	CS 74	15.	TAG 24
16.	CS 272	17.	CS 76	18.	TAG 26
19.	CS 273	20.	CS 77	21.	TAG 41
22.	CS 312	23.	CS 78	24.	CS 41
25.	CS 350	26.	CS 80	27.	ICGS 86326
28.	CS 36	29.	ICGS 1	30.	ICGS 86309
31.	CS 38	32.	GG 2	33.	GG-20**
34.	J 11*				

* Resistant Check ** Susceptible Check

Effect of long-term crop rotation and cropping system on soil population of *Aspergillus flavus* and pre-harvest aflatoxin contamination

Effect of cropping system

This experiment was initiated during summer 2007. The soil and pod samples were drawn from the ongoing long-term agronomic trial on five groundnut-based cropping systems *viz.*, groundnut-groundnut, groundnut-wheat, groundnut-wheat-green gram, groundnut-pigeon pea, and groundnut-pearl millet, all raised with different combinations of recommended doses of fertilizers and FYM. The results obtained so far revealed that the population levels of *A. flavus* were higher in *kharif* than those in summer. The levels, recorded at 20 days before harvest, were significantly lower in groundnut-pearl

millet intercrop both during *kharif* and summer. Some kind of association/affinity was apparent between the type of crops grown in the field and the soil population of *A. flavus*. For example, groundnut plots had significantly higher population of *A. flavus* than that in wheat plots.

The seed infection and colonization during *kharif* 2008 were 15.6-40.0% and 7.8-28.9% respectively. Significant differences were also observed among the treatments for seed infection and colonization. The samples were processed for assay of aflatoxins.

Table 2. Effect of cropping system on soil population of *Aspergillus flavus*

Treatment	Treatment details	*Aspergillus flavus* poulation (10^3 cfu/g soil)			
		Kharif 2007		*Kharif* 2008	
		At the time of sowing	20 days before harvest	At the time of sowing	20 days before harvest
T1	G (100%)	4.49	6.48	7.67	9.44
T2	G (FYM + 50%)	4.26	6.78	8.44	9.44
T3	G (100%)-W (100%)	2.93	8.11	5.67	8.55
T4	G (FYM + 50%)-W (100%)	2.15	10.00	9.33	10.45
T5	G 100%-W 50%	3.77	8.67	8.33	9.44
T6	G (FYM+ 50%) -W 50%	4.22	9.33	8.33	11.78
T7	G 100%- W (FYM + 50%)	2.33	7.78	8.44	12.67
T8	G FYM - W(FYM + 50 %)	3.11	8.44	8.89	9.44
T9	G (100%) -W(100%)-GG	3.44	6.55	6.78	9.89
T10	G (FYM + 50%) -W (100%)-GG	4.11	11.78	7.56	8.11
T11	G 100% -W50%-GG	3.99	8.33	6.89	9.78
T12	G (FYM + 50%) -W 50%-GG	3.78	8.33	6.11	9.33
T13	G 100% -W (FYM + 50%)-GG	2.00	10.33	6.11	9.44
T14	G FYM -W (FYM + 50%)-GG	1.55	10.78	6.11	10.44
T15	G 100% + PP 100%	4.48	8.22	6.89	10.55
T16	G (FYM+ 50%) +PP (100%)	4.71	7.33	7.33	8.00
T17	G (100%) + PP 50%	4.04	9.44	6.00	10.34
T18	G (FYM+ 50%) +PP 50%	4.82	8.33	8.22	10.67
T19	G 100% + PM 100%	3.60	5.00	6.00	7.66
T20	G (FYM+ 50%)+PM 100%	2.26	9.00	4.67	10.33
T21	G (100%) + PM (50%)	2.71	5.22	6.45	7.22
T22	G (FYM + 50%) +PM (50%)	2.82	6.83	7.78	10.11
	CD $_{(P=0.05)}$	**NS**	**0.86**	**NS**	**0.60**

Effect of long-term crop rotation

A long-term experiment on groundnut-garlic and groundnut-onion rotation was initiated in *kharif* 2005 to study the effect of crop rotation on population of *A. flavus* and aflatoxin contamination. The soil population of *A. flavus* was estimated in the samples drawn just after sowing and two weeks before harvest (pod development stage). The experiment was laid out in a factorial randomized block design with two cultivars, one susceptible (GG 2) and another resistant (J 11) in main plot and four rotations *viz.* groundnut-garlic-groundnut, groundnut-onion-groundnut, groundnut-groundnut, and groundnut-fallow-groundnut in subplots. At harvest, pods were collected randomly from three spots in each plot and seed infection and colonization by *A. flavus* was recorded. The kernel samples were processed for determination of aflatoxin content.

The results showed that the soil population of *A. flavus* and aflatoxin was significantly low when groundnut was grown after garlic or onion crop in *kharif*. In all the years, however, the population in summer was significantly lower than that in *kharif*. During *kharif* 2008 population varied from 2.44-10.89 $x10^3$ cfu/g soil. The lowest population was observed in the plots where groundnut-garlic or groundnut-onion rotation was followed while the highest population was observed in groundnut-groundnut rotation.

Field studies with organic carrier enriched with isolates of *Trichoderma* spp.

Studies were conducted with the isolates of *Trichoderma*, which were found to be highly antagonistic to *A. flavus* under *in vitro* assay. For this, 50 kg of each of three organic carriers *viz.*, powdered castor (*Ricinus communis*) cake, neem (*Azadirachta indica*) cake, and FYM were mixed with 2.5 kg inoculum (multiplied in sorghum grain medium) of each of the four isolates of *Trichoderma viz.*, NRCG T12, NRCG T16, NRCG T32 and NRCG T34. These mixtures were incubated under shade for about ten days before applying to the soil in furrow. The results revealed that neem or castor cake enriched with the isolate NRCG T12 effectively reduced the *A. flavus* population and also the aflatoxin contamination.

Evaluation of different drying and storage conditions for reducing post harvest aflatoxin contamination

Summer produce of cultivar GG 2 was dried by five methods *viz.*, windrow drying (W, sun-dried in the field), windrow shade drying (WS, pods in one windrow covered by haulms of plants from the adjacent windrows), inverted windrow drying in small heaps (WI), NRCG Method of drying (on bamboo tripod), and the conventional drying (farmers' method) and subsequently stored in four different conditions *viz.*, polyethylene bag and gunny bags with or without desiccants. The pod moisture content and pod zone temperature during field drying were recorded.

After drying in field for 5 days, 10 kg pods were stored in polyethylene bags and ordinary gunny bag with or without desiccant ($CaCl_2$, 10 g kg^{-1} pods) for six months in lab conditions. Initial moisture was estimated prior to pod storage. The temperature and humidity were recorded at the time of harvest, threshing (stripping of pods, on 5th day), prior to storage, and then regularly at intervals of one month just before drawing the samples (200 pods) for recording seed infection of *A. flavus* and determination of aflatoxin B_1.

Compared to other methods, during field drying the pod zone temperature was found consistently higher in WI method. The pods dried by this method had the lowest moisture content

indicating rapid drying and there by infection of *A. flavus* was avoided. After storage for six months, the lowest infestation of bruchids (*C. serratus*) in pod and kernels, seed infection and colonization of *A. flavus* and the aflatoxin B_1 levels were invariably low in pods dried with WI method and stored in polyethylene bags with $CaCl_2$. Pod and kernel infestation by *C. serratus* was as high as 98.5% after six months of storage. A positive association between infestation by bruchids and seed colonization of *A. flavus* (and aflatoxin contamination) was also revealed.

On-site studies on effectiveness of sequential sorting and removing aflatoxin contaminated kernels from bulk groundnut lots

This study was conducted in 2008 in collaboration with the groundnut-processing unit of M/s Jabsons Foods, Bharuch. Farmers' stock of a Virginia bunch groundnut cultivar, GG 20, presumably containing aflatoxins was passed through sequential processes of shelling, sizing and grading (mechanical and camera sorting), roasting, blanching, colour sorting (camera sorting followed by manual sorting) before value-addition and packaging. Ten different lots were taken and sequential sorting was performed.

Study conducted on-site with bulk groundnut lot revealed that the blanching used in conjunction with manual and electronic sorting was very efficient in removing aflatoxin-contaminated kernels. The suspected material was removed from bulk groundnuts by electronic and manual-picking procedures reducing aflatoxins in the separated lot to >2 Mg kg^{-1}. The kernels affected by aflatoxins were easily discernible after blanching, even by the naked eye, by their typical dark brown spots (Figure 1). The larger the size of discoloured spots the higher was the aflatoxin level. When the aflatoxin-affected kernels were split open the white mycelium with greenish sporulation of the *A. flavus* was visible in most of the kernels, but the same was absent in the kernels that developed burnt spots during roasting (Figure 2).

The study conclusively proved that the blanching used in conjunction with manual and electronic sorting is indeed very effective in eliminating aflatoxin-contaminated kernels. A sequential sorting of bulk groundnuts being practiced by a few Indian industries using mechanical screening, electronic eye sorting followed by manual sorting of discoloured kernels is a good measure to rid the final product of aflatoxins. Hence, the groundnut processing industries should follow the sequential sorting procedures to ensure supply of groundnut products free from aflatoxins.

Table 3. Aflatoxin content of different grades of whole groundnut isolated by sequential sorting

Type of lot	Fraction of total lot (%)	Aflatoxin B_1 content* (µg kg^{-1})
Bulk lot	100	100.0-193.5
Lot rejected by mechanical screening	3.0	2166.0-3457.1
Lot rejected by camera sorter	15.4	40.0-74.1
Lot rejected by manual sorting	0.8	150.1-471.0
Good grade HPS lot	80.8	3.3-29.9

* Range of aflatoxin in 10 samples

Table 4. Aflatoxin content of different categories of blanched groundnut

Samples	Aflatoxin B_1 ($\mu g\ kg^{-1}$)	
	Range	*Mean**
Good grade HPS lot after blanching	1.30-9.94	3.31
Blanched kernels without spots	0.00-0.68	0.33
Blanched kernel with large dark brown spots	879.74-1015.18	954.17
Blanched kernel with small dark brown spots	4.97-40.08	13.04
Blanched kernels with burnt spots	0.04-0.33	0.06

* Range of aflatoxin in 10 samples

** Mean of 10 samples taken from different lots (one sample from each lot)

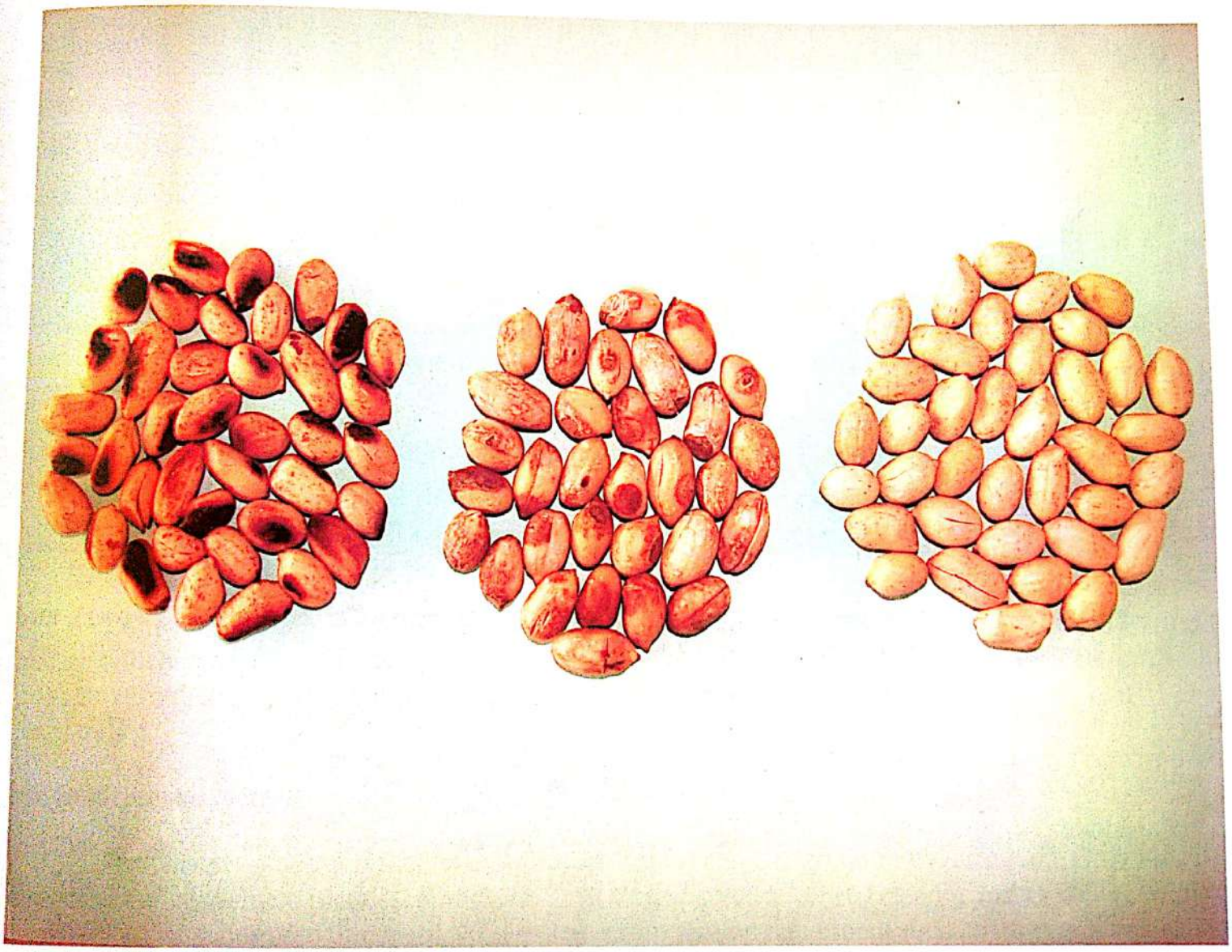


Figure 1. Blanched kernels: a. Kernels with burnt spots, b. Kernels affected by aflatoxins showing typical dark brown spots, c. Good grade

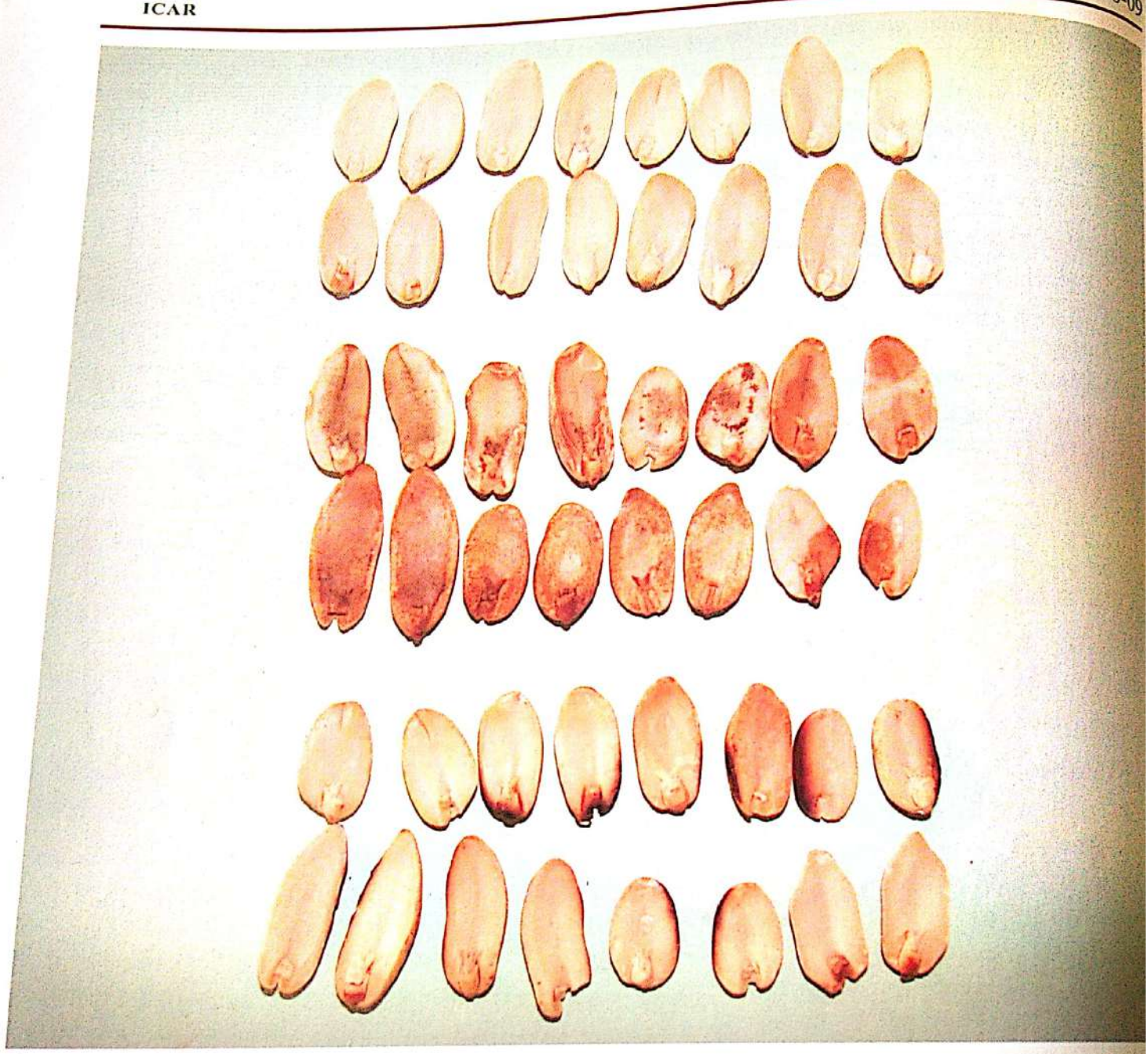


Figure 2. Blanched kernels split open: good (top 2 rows), aflatoxin affected (middle 2 rows), and kernels with burnt spots (bottom 2 rows)

PROJECT 13: IMPACT ASSESSMENT OF IMPROVED GROUNDNUT PRODUCTION TECHNOLOGIES: SUSTAINABLE LIVELIHOOD ANALYSIS

(G. D. SATISH KUMAR)

Impact assessment of adoption of improved technologies

The data were collected by random sampling from the farmers of three *talukas viz.*, Rajkot, Jasdan, and Gondal of Rajkot district in Gujarat. These *talukas* were selected on the basis of their having the largest areas under groundnut crop in the district. A pre-tested, semi-structured interview schedule was used for collecting data. The data were collected by personal interview of farmers.

Socio-economic Status (SES) of the farmers

The results indicated that on an average the age of the farmers was 49 years and they possessed 2.5 ha land with 20 years of direct experience with the groundnut crop. Majority of the farmers (63%) had functional literacy and most (73%) of them belonged to joint-family system. The farmers generally possessed well-built *pacca* houses. About 70% farmers had their own wells while 15% depended on river for irrigation water.

Cropping System

In Rajkot district, groundnut is the major crop of *kharif* season and is grown in about 0.39 m ha. The three selected *talukas* constituted about 35% of the total groundnut area of the district. The major cropping systems of these *talukas* were: groundnut-wheat-groundnut; groundnut-groundnut-groundnut; cotton-groundnut-groundnut; cotton-groundnut-cotton; and groundnut-jeera/cumin/onion-groundnut.

The sequential cropping of groundnut-wheat, groundnut-onion, groundnut-cumin and pearl millet-summer groundnut was observed under irrigated conditions. Farmers also practiced intercropping with castor, pigeonpea, sesame and pearl millet. In groundnut mono-cropping, the farmers grow groundnut year after year in the same field.

Farmers generally grow released varieties of groundnut such as GG 20, TG 37A, and Punjab 1 and also local varieties such as 'samudri', 'shedubar', 'tata sumo', 'Western 20', etc. In other crops the popular varieties were BDN 2 of pigeonpea, GCH 4, 5 of castor, Gujarat Til 1 of sesame and MH 167 of pearl millet.

Farm mechanizaton

The farmers possessed the farm-implements necessary for groundnut cultivation. Only nine per cent of sampled farmers possessed tractors, 75% owned electric/oil engines for lifting water from the wells, 80% had groundnut threshers, 90% had plant-protection equipment such as sprayer. The farmers also owned bullock carts, seed drills (hand operated and mechanical), ploughs, hoes, harrows and multi-purpose iron tool bars. The farm mechanization index indicated that the farmers had sufficient mechanization on their farms.

Adoption of improved management practices
Variety and agronomic practices

An inventory of package of practices for realizing high yields of groundnut was prepared and responses of farmers on adoption were recorded for each practice.

The results (Table 1) indicated that amongst the farmers sampled, though 65% had their soil samples analyzed only 28% were following the soil test based fertilizer application in groundnut. Farmers prepared the field well in advance i.e. before the onset of monsoon rains by using tractor drawn plough (twice) followed by use of harrow. Some farmers (15%) practiced deep ploughing during summer.

Seed-treatment with chemicals such as carbendazim/mancozeb/thiram is very popular with the farmers. Almost all the farmers adopted the chemical seed treatment. Few farmers were using *Rhizobium* for seed treatment. The farmers were using seed rate higher than recommended i.e. even 200 kg pods/ha for variety GG 20 mainly to withstand or overcome the low rate of germination. On an average, for GG 20 a seed rate of 150 kg seed pods/ha was used. The spacing adopted ranged from 45-90 cm between the rows and 10 cm between the plants. Majority of the farmers were using 60 x10 spacing for GG 20 and 45x10 for GG 2.The farmers adopted various sowing methods viz., manual sowing behind the plough, manual seed drill and mechanical seed drill. Majority of the farmers used manual operated seed drill called '*Sathi*' for sowing. The spacing was regulated between the rows by these seed drills.

Most of the farmers applied organic manures such as FYM during field preparation. The average quantity applied was 1.5 t/ha every 2/3 years. Almost all the farmers were applying fertilizer to groundnut. Most of the farmers were using DAP at doses higher than recommended at the time of sowing and urea as split application. The farmers used complex fertilizers for supplying NPK and S. More than 30% of farmers reported symptoms of micronutrient deficiency in groundnut crop but only 18% adopted the control measures such as application of biozyme and morram. Few farmers reported yellowing in groundnut and the reason perceived by farmers for this was heavy rainfall coupled with lack of proper drainage on their fields and some times Fe-S deficiency. The farmers were not adopting any control measure for yellowing.

Farmers normally started their intercultural operations 15 DAS and continued to do so 2-7 times till 50 DAS and stop with peg formation. The main purpose of the interculturing was weed-control and moisture-conservation. Almost 30% farmers possessed knowledge on the benefits of use of weedicides and they adopted the same. Pendimethalin and stomp were most popular weedicides and to a less degree basaline.

Plant protection

The important insect-pests causing damage to groundnut as percieved by the farmers were sucking pests *viz.*, aphids, jassids and thrips, *Helicoverpa*, and white fly. The farmers adopted chemical control methods; spray of insecticides such as quinolphos, endosulphan, imidachlorpicrin, monocrotophos, acephate, chlorpyriphos and phosphomidone. Among the important diseases reported by farmers were stem rot collar rot, root rot, rust and leaf spots. The incidence of stem rot was in some cases was as high as 50% in cultivar GG 20. The farmers adopted control measures such as seed

Table 1. Adoption of improved practices by the farmers (n=85)

Sl. No.	Improved practice	Adoption by farmers	
		Number	Extent (%)
1.	Optimum tillage	82	96.5
2.	Suitable variety	83	97.6
3.	Source of seed	-	
	i. Own	68	80.0
	ii. Formal sources	12	14.1
	iii. Informal sources	16	18.8
4.	Optimum seed rate	41	48.2
5.	Seed treatment: Fungicides	80	94.1
6.	Seed treatment: Biofertilizers	16	18.8
7.	Timely sowing	78	91.8
8.	Method of sowing	-	
	i. Furrow	82	96.5
	ii. Criss-cross	40	47.1
9.	Optimum spacing	34	40.0
10.	Application of organic manures	20	23.5
11.	Soil test based fertilizer application	-	
12.	Fertilizer management	18	21.2
	i. Optimum	8	9.4
	ii. Lower	62	72.9
	iii. Higher	19	22.4
13.	Weed management (chemical)	12	14.1
14.	Application of gypsum	20	23.5
15.	Micro nutrient management	-	
16.	Management of insect-pests	48	56.5
	i. Optimum	10	11.8
	ii. Lower	30	35.3
	iii. Higher	-	
17.	Management of diseases	13	15.3
	i. Optimum	10	11.8
	ii. Lower	45	52.9
	iii. Higher	80	94.1
18.	Timely harvesting	65	76.5
19.	Optimum drying	49	57.6
20.	Storage at optimum conditions		

Integrated Nutrient Management

The groundnut farmers are generally practicing an indiscriminate application of fertilizers, irrespective of actual demand of the crop. Diammonium phosphate (DAP), which is generally being used by the farmers, does not contain sulphur required for biosynthesis of oil. Most farmers of the region do not apply gypsum that contains calcium required for pod filling in groundnut. Thus the very concept of application of fertilizer on the basis of soil-test results is not being practiced. Such an approach not only results in imbalance of nutrients especially of micronutrients in the soil but also upsets soil micro-flora and lowers fertilizer use efficiency (FUE). If such practice continues, in the long run, productivity of soil will decrease and farmers in the area will not be able to sustain their livelihood from the available land. The indication of soil health breakdown is reflected in the increasing incidence of soil borne diseases of groundnut. The combined use of organic, chemical and biological sources of fertilizer and in appropriate proportions will ascertain the balanced nutrition to the crop and sustain the productivity in the long run. Hence, the Integrated Nutrient Management (INM) module developed by DGR was assessed in farmers' fields. The module consisted of balanced use of fertilizers in form of FYM, Ammonium Sulphate (AS), Single Super Phosphate (SSP), Muriate of Potash (MOP), gypsum and PGPR. This module was compared with the farmers practice of nutrient management through application of DAP only.

The results of on-farm trials (Table 4) indicated that application of NPK at recommended levels through AS, SSP, and MOP increased pod yield of groundnut only by 4.24% and haulm yield by 5.13% over farmers practice. Even though the practice gave 9.13% higher GMR over farmers practice, the BCR decreased by 2.54%.

Bt cotton + groundnut intercropping (1:1)

The farmers grow Bt cotton with a spacing of 180 cm to 200 cm. In order to use the space between the rows of Bt cotton, groundnut crop was tried. Groundnut was sown between the rows of cotton at spacing of 90 cm. The results of this trial indicated that the yield of Bt was not much affected by the intercropping system. Compared to sole Bt cotton crop, although the yield of Bt cotton decreased by about 10% in the intercropping system (Table 5), the economics indicated that the decrease in cotton yield was easily compensated for by the yield of groundnut. The technology has the potential for larger scale dissemination.

Table 3. The performance and profitability of improved variety

Economic indicators	Farmers practice	Improved practice	Increase over farmer's practice (%)
Pod yield (kg/ha)	1840	2600	41.30
Haulm yield (kg/ha)	3316	3850	16.10
CoC (Rs.)	18275	18275	19.64
GMR (Rs.)	39475	56000	41.86
NR (Rs.)	24200	37725	55.89
BCR	2.16	3.06	18.57

CoC = cost of cultivation; GMR = gross monetary returns; NR = net returns; BCR = benefit cost ratio

Table 4. The performance and profitability of INM compared to FP

Economic indicators	Farmers practice	Improved practice	Increase over farmer's practice (%)
Pod yield (kg/ha)	1840	1918	4.24
Haulm yield (kg/ha)	3316	3486	5.13
CoC (Rs.)	15275	17100	11.95
GMR (Rs.)	39475	43080	9.13
NR (Rs.)	24200	25980	7.36
BCR	2.58	2.52	-2.51
ICBR	13.26	14.24	7.36

Table 5. The profitability of Bt cotton + groundnut intercropping system

Economic indicators	Farmer's practice	Improved practice	
	Sole Bt cotton	Bt cotton	Groundnut
Pod yield (kg/ha)	2850	2565	1225
Haulm yield (kg/ha)	3600	3100	1820
CoC (Rs.)	27900	29800	
GMR (Rs.)	69300	66500	30450
NR (Rs.)	41400	36700	67150
BCR	2.48	3.25	

The study indicated that for the past few years the farmers were becoming increasingly inclined toward cultivating Bt cotton in place of groundnut. About 30% farmers diversified to Bt cotton while 36% of their area under groundnut was replaced with Bt cotton. The study of cotton farmers revealed that 83% of the farmers adopted Bt cotton and 68% of area under HYVs of cotton/hybrid cotton was shifted to Bt cotton.

To understand the reasons for the change from groundnut to Bt cotton, the cost of cultivation (CoC) of both the crops were worked out (Table 6). A perusal of table 1 indicated that the cost of cultivation of Bt cotton is much higher than groundnut (71%), still farmers preferred Bt cotton over groundnut. The major portion (27.5) of the cost of cultivation was towards seed in groundnut whereas it is towards labour (21%) and plant protection chemicals (12.35%) in Bt cotton. The reason for preferring Bt cotton to groundnut was due to higher gross monetary returns (GMR) and net returns (NR) with Bt cotton compared to groundnut (Table 7). The GMR increased by 97% and NR increased by 119% with Bt cotton compared to groundnut.

Table 6. Cost of cultivation of groundnut and Bt cotton at farmer's field (n=46)

Sl. No.	Item	Groundnut		Bt cotton	
		Total cost (Rs./ha)	Fraction of total cost (%)	Total cost (Rs./ha)	Fraction of total cost (%)
I	Labour				
	i. Hired	2200	13.48	5850	**20.94**
	ii. Family	2475	15.16	5200	18.61
	iii. Bullock	2500	15.31	3500	12.53
II	Seed	4500	**27.57**	1875	6.71
III	Manure	800	4.90	1200	4.29
IV	Chemical fertilizer	1300	7.96	2868	10.26
V	Plant protection chemicals	1150	7.04	3450	12.35
VI	Irrigation	800	4.90	3400	12.17
VII	Miscellaneous	600	3.68	600	2.15
	Total	16325	100.00	27943	100.00

Table 7. Comparative performance and profitability of groundnut and Bt cotton

Sl. No.	Parameter	Groundnut	Bt cotton
I	Yield		
	i. Main product (kg/ha)	1860	2850
	ii. Bye product (kg /ha)	3975	3600
II	Farm harvest price		
	i. Main product (Rs./kg)	16.25	24
	ii. Bye product (Rs./kg)	1.25	0.25
III	Gross monetary returns (Rs./ha)	35193.8	69300
IV	BCR	2.16	2.48
V	Net returns (Rs./ha)	18868.8	41357
VI	Increase in net returns (%)	-	119.183
VII	Increase in gross returns (%)	-	96.91

The other important reasons seem to be the differences in the price fetched by groundnut and cotton and the increasing incidence of insect-pests and diseases in cotton over the years. Whenever the prices of groundnut were low, the area of cotton increased in the following year and vice-versa. The prestige associated with the adoption of new technology and the pressures from the peers are the other important reasons for the adoption of Bt cotton. The fodder value of groundnut may also act as deterrent for further decrease in area under groundnut and may even cause the reverse shift in favour of groundnut. The important social, economic, technological and infrastructure constraints for the shift from groundnut are given in table 8.

Table 8. Farmers' perceptions for shifting from groundnut to Bt cotton

Sl. No.	Perception	Rank
I Social		
1.	Pressure from peers (most of the other farmers were doing so)	II
2.	Growing Bt cotton enhances the prestige in the community	V
3.	Farmers faith in potential of Bt cotton for improving the income	VI
4.	Bt cotton is less prone to risks than groundnut	XIV
5.	Bt cotton is less labour intensive than groundnut	XXI
6.	Bt is more compatible with the existing resources/implements	XV
7.	Need for economic achievements to improve the standard of living	VII
8.	The fodder-value of straw	XXV
II Economic		
9.	Higher returns from Bt cotton compared to groundnut	I
10.	Good marketing opportunities for Bt cotton compared to groundnut	VIII
11.	Easy availability of credit for Bt cotton compared to groundnut	XXIV
12.	Higher market prices for Bt cotton compared to groundnut	IX
13.	Lower cost of cultivation compared to groundnut	XXIV
14.	Lower investment on control of pests and diseases in Bt cotton compared to groundnut	IXX
15.	Easy availability of seeds of Bt cotton seed compared to groundnut	XVI
16.	Lower cost of seeds of Bt cotton compared to groundnut	X
III Technological		
17.	Lower yield of groundnut	II
18.	Higher incidence of pest and diseases in groundnut	XXII
19.	Greater suitability of soils for Bt cotton than for groundnut	XII
20.	The weather conditions are more favourable for Bt cotton than groundnut	XII
21.	Adequate knowledge on cultivation of Bt cotton	XIII
22.	Greater ease of picking of cotton compared to harvesting/picking of groundnut	XXIII
23.	Persuasion by extension agencies	XXVI
IV Administrative/Infrastructure		
24.	Timely availability of seed of Bt cotton seed compared to groundnut	IV
25.	Timely availability of skilled labour for Bt cotton than of groundnut	XVIII
26.	Easy marketability of Bt cotton than of groundnut	XVII

Training programmes organized at DGR, Junagadh

Sl. No.	Date	Title	Participants	Sponsor
1.	26.03.2009 to 27.03.2009	Training-cum-exposure visit	02 agricultural officers and 20 farmers from Vishakapatnam, Andhra Pradesh	Agricultural Technology Management Agency, Jaisalmer, Rajasthan.
2.	16.03.2009 to 20.03.2009	Groundnut production technology	03 scientists from KVK, Jaisalmer and 25 farmers from 12 villages of Jaisalmer, Rajasthan	Agricultural Technology Management Agency, Jaisalmer, Rajasthan.
3.	12.11.2008 to 19.11.2008	Model training course on Improved package of practices for realizing higher yields through groundnut based intercropping system	12 agricultural officers of five states viz., Andhra Pradesh, Gujarat, Karnataka, Maharashtra and Tamil Nadu	Directorate of Extension, GOI, New Delhi
4.	20.10.2008 to 26.10.2008	Improved groundnut production technology	15 officers of Orrisa Tribal Empowerment and Livelihood Programme (OTELP) Orissa	Govt. of Orissa
5.	1.10.2008 to 05.10.2008	Improved package of practices of groundnut farmers from Kadapa, Andhra Pradesh	02 agricultural officers and 22	Agricultural Technology Management Agency, Jaisalmer, Rajasthan.
6.	17.09.2008 to 23.09.2008	Low cost technologies for improving groundnut production	26 farmers from Orissa	ISOPOM, GOI, New Delhi
7.	03.06.2008 to 07.06.2008	Groundnut production technology	28 farmers from Orissa	ISOPOM, GOI, New Delhi

PROJECT 14: BREEDING FOR LARGE-SEEDED AND CONFECTIONERY TYPE GROUNDNUT

(CHUNI LAL, HARIPRASANNA, K. (up to 23rd August, 2008), **RADHAKRISHNAN T., J. B. MISRA AND VINOD KUMAR)**

Hybridization

During *kharif* 2008, ten crosses were attempted to incorporate large seed size coupled with high yield. Advanced breeding lines from NRCG, ICRISAT, and BARC were used in hybridization programme. Pollination was attempted on 4231 buds and 515 probable hybrid pods were harvested with a success rate of only 12.17%.

Raising F_1s and identification of true hybrids

Sixteen crosses generated in *kharif* 2007 were raised along with parents and the true hybrids were identified and their pods were harvested individually for further advancement. Four crosses were rejected being doubtful; thirty single plants were identified from the remaining crosses that confirmed hybridity.

Selection and generation advancement

The F_2 generations of 11 crosses were sown and true F_2s (segregating) were identified. In this generation also one cross, which did not show segregation, was rejected. The remaining crosses were bulk-harvested cross-wise for further advancement. Fifteen crosses in F_3 were sown and the progenies were harvested in bulk, after rejecting four inferior cross combinations. Twenty crosses in F_4 generation were advanced without making any selection and out of these five were rejected due to poor combination of traits. Similarly three crosses were advanced from F_5 to F_6 generation. Phenotypic selections were carried out in F_6 generations where the material had stabilized. In this generation, in 11 cross combinations, seven Virginia type and one Spanish type advanced breeding cultures were dentified. In M_6 generation three selections were made into next generation from among the 10 sown elections.

Table 1. Crosses advanced and selections made during the year

Generation	Crosses Sown	Crosses Rejected	Selections Sown	Selections Made
F_1	16	4	-	30 SPP*
F_2	11	1	-	-
F_3	15	4	-	-
F_4	20	5	-	-
F_5	3	0	-	-
F_6	11	4	-	7 Virginia and 1 Spanish adv. lines
M_6	0	0	10	3

SPP, single plant progenies

Multiplication and maintenance

Forty-two advanced breeding lines were multiplied and 66 cultures (4 Spanish, 62 Virginia) were maintained. Four advanced breeding lines (PBS Nos.29077, 29078 and 29080, and ICGV 99101) were multiplied for seed enhancement.

Station trials

Two yield evaluation trials were conducted under this project during the period under report. The performance was poor during *kharif* season because of unfavourable weather conditions. In both the trials observations on pod and kernel yields, and related traits were recorded.

Preliminary yield trial of advanced breeding lines

Seventy seven test entries which included eight germplasm lines and seven advanced breeding cultures from ICRISAT, 41 germplasm lines from NRCG and 19 advanced breeding cultures developed under this project, were tested in a preliminary evaluation trial in a RBD with only two replications (as the seed available was limited). The ANOVA indicated significant differences due to genotypes for all the traits studied. The variety M 13 ranked first among the checks for pod (1232 kg/ha) and kernel (846 kg/ha) yields, and only one test entry NRCG 3324 could out perform this check variety for these traits (pod yield, 1828 kg/ha; kernel yield, 1205 kg/ha). M 13 also was the best check for SMK (63%), but no test entry recorded significant higher SMK over this check though the highest one was recorded in NRCG 12167 (72 %). BAU 13 toped for HKW (51 g) and HSMK (57 g). Only PBS 29128 recorded HKW (62 g) and HSMK (70 g), which were significantly higher than those, recorded in BAU 13. No test entry could surpass significantly the shelling outturn 72% recorded in GG 20 (best check for SP). Though two advanced breeding cultures of ICRISAT, namely ICGV 89104 and ICGV 89104 recorded 73 and 74 per cent shelling, respectively.

Large seeded yield evaluation trial

Single year of evaluation

In *kharif* 2008 twenty-six advanced breeding lines comprising 17 lines developed under this project and the remaining nine (ICGV Nos.) received from the ICRISAT, were evaluated along with four check varieties recommended for zone II. The highest pod (1783 kg/ha) and kernel (1220 kg/ha) yields were recorded in ICGV 97079, as compared to the ones recorded in the best check variety M 13 (1388 kg/ha and 944 kg/ha pod and kernel yields, respectively). Though the yields obtained in ICGV 97079 were higher, but statistically at par with the check varieties. For physical quality traits only two genotypes, PBS 29079 B for HKW (64 g) and HSMK (71), and PBS 29124 for SMK (79%), were found to possess significant superiority over the best check variety BAU 13 (HKW, 53g; HSMK, 61 g, and SMK 62%). No test entry could surpass the best check variety GG 20 for shelling outturn. PBS 29122 was the earliest (19 DAS) in completing 50% flowering on plot basis, but very poor yielder (528 kg/ha).

Two years of evaluation

Twelve advanced breeding lines six each developed under this project and received from the ICRISAT were evaluated along with two check varieties GG 20 and M 13, in *kharif* season of years 2007

and 2008. Analysis of pooled data across two years indicated that differences due to genotypes were highly significant for all the traits studied except for SMK. Except for days to 50% flowering, SMK and shelling percentage, differences due to years were also significant for the studied traits. Only for days to flowering and HKW, four (PBS 29067, ICGV 90208, ICGV 97051 and ICGV 97061) and seven (PBS 29067, PBS 29069, PBS 29079 A, PBS 29079 B, ICGV 89214, ICGV 91089 and ICGV 97061) test entries, respectively recorded significant performances for these two traits over the best check varieties GG 20 for days to 50% flowering (28 DAS) and M 13 for HKW (44 g). No test entry was found statistically superior over the best check variety for rest of the studied traits. The highest pod (1661 kg/ha) and kernel (1084 kg/ha) yields were recorded in ICGV 97051, but were at par with the check variety GG 20 which recorded 1570 kg pods and 1137 kg kernels/ha.

Evaluation of Spanish germplasm lines under summer growing conditions

Twenty-nine germplasm lines of Spanish groundnut along with one check variety TKG 19 were evaluated in a RBD with two replications in summer 2008. Observations on phenological and yie traits were recorded. ANOVA revealed significant differences due to genotypes for all these traits. C comparison of mean values of germplasm lines tested with the check variety TKG 19A, it was observ that no line was statistically superior over the check variety for days to flower initiation and 50 flowering. NRCG 11982 was the only germplasm line observed to record higher pod (3572 kg/ha) a kernel (2136 kg/ha) yields over the check variety, which gave 2721 kg and 1742 kg pod, and ker yields, respectively. No germplasm line surpassed the check variety significantly for SP, HSM a SMK. However, highest values for these traits were recorded in NRCG 11669 (SP=73%), NRCG 119 (HSM=51g) and NRCG 11867 (SMK=86%)

PROJECT 15: MULTIPLICATION AND UTILIZATION OF WILD *Arachis* GENE POOL FOR IMPROVEMENT OF GROUNDNUT

(S. K. BERA, P. C. NAUTIYAL, A. L. SINGH, RADHAKRISHNAN T, CHUNI LAL, T. V. PRASAD AND VINOD KUMAR)

Hybridization

Hybridizations were done in the field during rainy season. Ten BC4F1, 5 BC3F1, 5 BC2F1 progenies were used as male parents in further back crossing with elite cultivars. Besides crosses were made for transferring stem rot resistance from pre-breeding genotype, NRCG CS-19 and also large kernel size from pre-breeding genotypes, NRCG CS-281 and NRCG CS-148 to elite cultivars. Cross wise probable cross-pods were harvested and stored for sowing in next rainy season.

Evaluation of breeding lines

Initial evaluation trial (IVT)

On the basis of pod yield and reactions to major diseases evaluated in field during rainy season stable breeding lines were selected. Thirty-nine genotypes along with 3 checks were sown under augmented design in 3 blocks. Each genotype was sown in 3 lines of 3 m bed following the recommended crop management practices. Genotypes were characterized for physio-morphological traits at different crop stages. Pod yield of eleven genotypes was significantly higher than that of the best check TKG 19A (68.3g/10 plants). Highest pod yield was observed in NRCG CS-360 (134 g/10 plants) followed by NRCG CS-376, NRCG CS-366 and NRCG CS-359. Hundred-kernel mass (HKM) of genotypes NRCG CS-384, NRCG CS-385 and NRCG CS-387 was at par with check TKG 19A (39.9g). Excess rain could be one of the possible reasons for less shelling turnover and low percent of sound mature kernels observed in majority of the genotype.

Advance evaluation trial (AVT)

Promising breeding lines selected on the basis of performance in IVT were further evaluated under AVT during rainy season. Twenty-two genotypes and 3 checks were sown in randomized block design with 3 replications. Each genotype was grown in 5 lines of 3-meter long bed following recommended crop management practices. None of the 22 genotypes significantly surpassed the pod yield of the best check GG 20 (82.0 g/10 plants). In general shelling outturn was low in all genotypes and was in the range of 42-66% including that of check. There was no significant difference in hundred-kernel mass between any of the test entries and the check TKG 19A (37.3 g).

In a separate trial, during summer season 63 promising mutants of GG 2 were evaluated under replicated trial. Each mutant was sown in 3 lines of 5-meter long bed following recommended crop management practices. Ten out of 12 genotypes recorded significantly higher pod yield than GG 2 (160.2 g/10 plants) beside giving significantly higher shelling outturn, HKM and biological yield (BY). The differences between and the best check and genotypes for the values of sound mature kernel (SMK), SPAD chlorophyll meter reading (SCMR) and specific leaf area (SLA) were, however, not significant.

This indicated that pod yield, shelling turnover, BY and HKM were affected more by the mutagens used in the experiment. Mutants with higher SCMR and lower SLA seemed to be tolerant to abiotc stresses like salinity and drought. Compared to parent (GG 2) and elite cultivar (GG 20), the mutants NRCG CS-389, NRCG CS-394, NRCG CS-407 and NRCG CS-401 were promising for their significantly higher pod yield and the related traits over the parent (GG 2) as well as elite cultivar (GG 20).

Confirmation of resistance to late leaf spot, PBND and stem rot of breeding lines at hot spot

Multiple disease resistant (MDR) lines selected based on evaluation over 2 years at Junagadh were further evaluated for resistance to late leaf spot, PBND and Stem rot at RRS, Raichur. Scoring for LLS ranged between 3 to 7 in 0-9 scale. Three entries *viz.*, NRCGCS-108, NRCGCS-109 and NRCGCS-206 recorded a score of 3 for LLS against maximum score of 7 in local check (KRG 1). Further, PBND incidence ranged between 2.0% (NRCG CS-244) to 61.90% (NRCG CS-206). Among them, five entries *viz.*, NRCG CS-215, NRCG CS-241, NRCG CS-244, NRCG CS-245 and NRCG CS-260 were highly resistant to PBND by recording less than 5% incidence. The natural incidence of stem rot ranged between 2.1% (NRCG CS-221 and NRCG CS-108) to 24% (NRCG CS-102). Further fourteen entries *viz.*, NRCG CS-108, NRCG CS-109, NRCG CS-113, NRCG CS-128, NRCG CS-130, NRCG CS-132, NRCG CS-148, NRCG CS-149, NRCG CS-155, NRCG CS-159, NRCG CS-159, NRCG CS-221, NRCG CS-241 and NRCG CS-244 were found promising by recording less than 5% incidence.

Characterization of wild species against abiotic stresses

Screening for SLA and SCMR

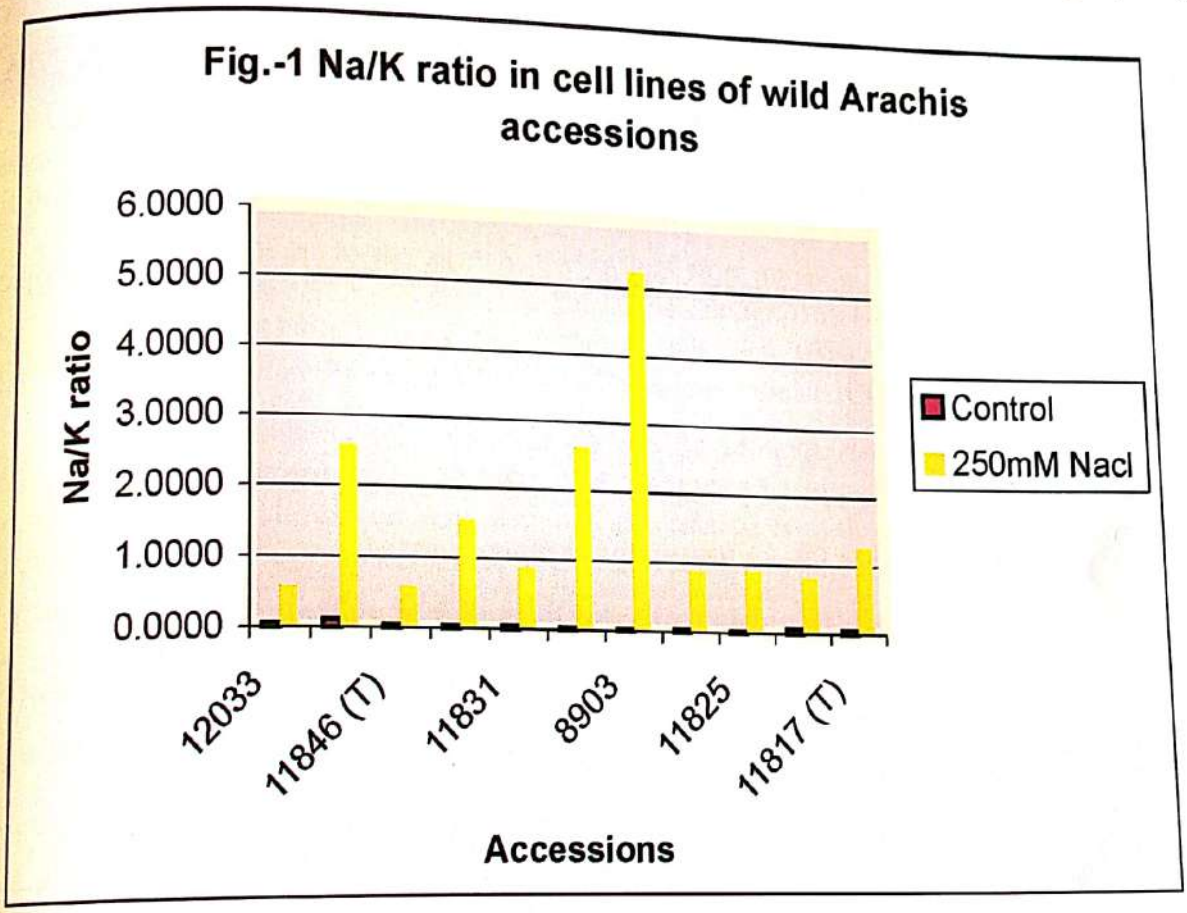
Wild species were characterized for traits (SLA and SCMR) associated to drought during rainy season. SLA ranged from 103.2 to 492.4 and SCMR ranged from 13.2-41.4 in 145 accessions evaluated. Seven accessions out of 87 low SLA lines registered significantly lower SLA than population mean. Three (NRCG 11811, 11831 and 12035) among 7 accessions recorded significantly higher SCMR. Accessions NRCG 11811 (*A. stenophylla*), 11831(*A. glabrata*) and 12035 (*A. appresipilla*) with lower SLA as well as higher SCMR could be used as tolerant parent for water limited stress.

Screening for tolerance to salinity

In vitro screening

Callus induced from leaves of 11 wild accessions were screened *in vitro* under NaCl induced salinity stress. Callus was sub cultured in MS medium with 50, 100, 150, 200 and 250mM NaCl concentration and allowed to grow up to one month. Fresh callus wt, dry callus wt, chlorophyll content, sodium and potassium uptake were recorded after one month of culture. SDS page analysis was done in calli of 11 accessions cultured both in control as well as 250mM NaCl treatment. The calli of four accessions were promising as calli showed very profuse growth and was dark green in colour under 250mM NaCl. These tolerant accessions showed over expression of specific stress induced protein(s) under induced stress condition which were either absent or very low under control condition indicating that these accessions have constitutive genetic make up for sustaining under stress condition by signaling specific metabolic pathway(s). Salinity tolerant cell lines of NRCG 12033, 11846, 11821 and 11817 also maintained equal relative water content (RWC) both in control and 250mM salt concentration and recorded lower plant stress index (PSI) under 250mM NaCl stress suggesting their

tolerance to salinity stress. Beside sodium and potassium uptake ratio in plants was used for screening salt tolerant genotypes in other crop plants. The sodium and potassium uptake ratio was low in calli of most of the accessions except 11832, 8189 and 8903 (Figure 1). The low Na/K uptake ratio of accessions 11846, 11821 and 11817 support their tolerance to NaCl induced salt stress. However, accession 11832 showed comparatively higher Na/K ratio though it showed healthy callus growth, low PSI, higher chlorophyll content. It is evident from the initial experimentation that more than one parameter may be considered for *in vitro* selection of salt tolerant genotypes in groundnut than rather taking any single parameter as selection criteria.



Screening of working collection under hot spot and laboratory conditions

Hundred and thirty-five working collections were sown in single row of 5-meter long bed under rice fallow at CSSRI Regional Station, Canning Town, West Bengal during first week of February 2008. Irrigation was provided with pond water as and when required. Delayed germination was observed in all genotypes under study. The soil pH of the experimental plot was 16dSm^{-1} during sowing. Germination was recorded after 25 days of sowing which ranged from 0-50%. Plant started drying from third weak after germination due to gradual increase in soil salinity from 16dSm^{-1} to 50 dS^{-1} m during sowing period from 15th February to 9th April. Genotypes recorded 52 to 100 % mortality at 60 days after sowing. None of the germplasm could survive beyond 70 days. However, 8 breeding lines and one released variety TAG 24 showed 9-47% plant stand beyond 60 days. Maximum plant stand was recorded in NRCG CS 317 followed by TAG 24. All genotypes died gradually between 70-80 days after sowing without any pod yield. Profuse flowering and at drying stage 2-5 immature pods per plant were observed in these genotypes. Two genotypes CS 317 and TAG 24 may have some physiological mechanism, which helps to sustain up to 70 days under high soil salinity condition.

In a separate laboratory experiment, 9 advanced lines selected based on preliminary screening wa further tested for tolerance to NaCl induced salinity. All genotypes showed delayed germination unde salt stress condition. Seven out of nine genotypes confirmed their tolerance to salinity by recordin more than 80% germination and survived up to 3 weeks under salt stress. Two genotypes NRCG CS 1 and NRCG CS 84 were promising because of their higher fresh shoot and root biomass accumulatio under stress condition. This technique could be used effectively in groundnut for screening seedlir tolerance to salinity under laboratory condition.

PROJECT 16: ECONOMICS OF GROUNDNUT CULTIVATION IN MAJO GROWINGAREAS

(G. GOVINDRAJ)

This project was under suspended animation for the period of this report as the PI of the project w on study leave.

PROJECT 17: BREEDING FOR IMPROVED FODDER QUALITY TRAITS IN GROUNDNUT

(A. L. RATHNAKUMAR, CHUNI LAL, P. C. NAUTIYAL, J. B. MISRA AND R. S. JAT)

Evaluation of cuttings from the established crops of the promising wild species to target environments

After four years of their establishment under wasteland conditions, ten wild accessions of *Arachis* (six rhizomatous and four seed forming) were evaluated for eight fodder quality traits in November 2008 (Table 1). Crude protein content (N content X 6.25) in these species varied from 10.8% (*A. magna,* NRCG 12032) to 17.0% (*A. glabrata,* ICG 8902). Rumen microbes require a minimum of 1.0-1.2% nitrogen (6.25-7.50% crude protein) in the fodder to effectively degrade it. Among the accessions evaluated as high as 17.0% crude protein content has been observed even under wasteland conditions, indicating potentials of these species as a source of green or dry fodder.

The palatability of the fodder as measured by leaf:stem ratio and sugar content indicated that the leaf:stem ratio varied between 1:1.2 (*A. rigonii*) to 1:2.4 (*A. magna*) and total sugar content ranged from 1.13% (*A. glabarata*, ICG 8902) to 3.22% (*A. magna*, NRCG 12039). Crude fibre content was in the range of 22.94% (*A. rigoni*, NRCG 12032) to 31.17% (*A. hagenbekii*, ICG 8188).

Nutrients important for lactation like Ca and Fe contents ranged from 1.86% (*A.* spp.; PI 468363) to 2.85% (*A. marginata;* ICG 8903) and 4600 ppm (*A.* spp., PI 468363) to 8200 ppm (*A. magna,* NRCG 12039). The ash content, which is also related, with the mineral contents of the plants was in the range of 10.14% (*A.* spp.; PI 468363) to 12.11% (*A. magna,* NRCG 12039).

Table 1. Proximate composition of foliage of some promising wild *Arachis* species

Sr. No.	Species and accession number	Component (%)							
		CP	Sugars		EE	CF	Ash (minerals)		
			TS	RS			Total	Ca	Fe
1	*A. rigonii* (NRCG 11795)	13.56	1.98	1.64	2.86	27.6	10.51	1.94	0.69
2	*A. rigonii* (NRCG 12032)	11.11	1.91	1.90	2.56	22.9	10.45	2.45	0.48
3	*A. hagenbekii* (ICG 8188)	11.12	1.22	1.19	3.19	31.2	11.72	2.30	0.80
4	*A. magna* (NRCG 12039)	10.76	3.22	2.97	2.34	30.2	12.11	2.56	0.82
5	*A. prostrata* (ICG 8189)	14.17	1.25	1.55	2.37	27.3	10.68	2.12	0.65
6	*A. marginata* (ICG 8903)	16.79	1.24	1.51	3.15	26.0	10.94	2.85	0.66
7	*A. glabarata* (ICG 8902)	16.92	1.13	1.27	3.10	28.8	11.33	2.76	0.67
8	*A. glabarata* (NRCG 11818)	16.76	1.38	1.15	2.47	28.7	11.94	2.56	0.52
9	*A. appersipila* (NRCG 12035)	14.84	2.44	2.17	2.69	29.2	10.16	2.25	0.48
10	*A. spp.* (PI 468363)	14.38	1.97	1.55	3.66	30.8	10.14	1.86	0.46
	Minimum	10.76	1.13	1.15	2.34	22.9	10.14	1.86	0.46
	Maximum	16.92	3.22	2.97	3.66	31.2	12.11	2.85	0.82
	Mean	12.67	1.86	1.74	2.80	28.1	10.87	2.36	0.62

CP=crude protein; TS= total sugars; RS = reducing sugars; EE= ether extract

The average dry matter yield (Table 2) was in the range of 1.1 t/ha (*A. rigonii*, NRCG 12035) to 3.8 t/ha (*A. glabrata*, NRCG 11818). All the three rhizomatous species yielded above 3.0 t/ha of biomass per season in two cuttings in addition to yield of rhizomes (about 1.5 t/ha), which act as a soil binder and thus indicating the suitability of these species for high rainfall regions and slopes to prevent soil erosion.

Table 2. Total biomass and rhizome production and leaf to twig ratio of some promising wild *Arachis* species

Species and accession number	Yield of biomass (t/ha)		Leaf-twig ratio
	Fodder*	Rhizome	
A. appressipila (NRCG 12035)	1.8	**	1:1.6
A. rigonii (NRCG 12035)	1.1	**	1:1.2
A. magna (NRCG 12039)	1.6	**	1: 2.4
A. marginata (ICG 8903)	3.2	1.84	1:2.3
A. prostrata (ICG 8189)	3.6	1.72	1:1.3
A. glabrata (NRCG 11818)	3.8	1.92	1:1.3
CD (P=0.05)	**1.48**	**0.23**	-
CV (%)	**9.77**	**8.3**	-

*Four cuttings in six months; mean of two years; ** non-rhizomatous species

Variation in fodder quality in Indian groundnut varieties

Ninety Indian groundnut varieties were evaluated for seven fodder quality traits, *viz.*, crude protein (CP), neutral detergent fibre (NDF), acid detergent fibre (ADF), acid detergent lignin (ADL), total sugars (TS), metabolizable energy (ME), and *in vitro* organic matter digestibility (IVOMD) by using NIR technique at the International Livestock Research Institute, ICRISAT, Patancheru.

The statistical parameters of the seven fodder quality traits are given in Table 3. As can be seen from the figures given in table 3, for all the traits significant and wide variations were observed. The crude protein content was low in variety J 11 while it was high in the variety MH 1. The NDF value was low in M 13 while it was high in J 11; and ADF was low in TG 42 while it was high in Kadiri 3. Further ADL was low in TG 42 while it was high in Kadiri 5; the sugar content was high in VRI 2 and low in RG 41; ME and IVOMD were high in TG 22 but both were low in M 13.

Table 3. Mean, range and variability for seven fodder quality traits in 90 Indian groundnut varieties

Parameter	CP (%)	NDF (%)	ADF (%)	ADL (%)	TS (%)	ME (MJ/kg)	IVOMD (%)
Mean	11.3	51.2	34.1	8.1	4.7	7.9	55.5
Range	7.5-19.9	25.9-72.4	17.7-61.0	3.3-13.2	1.5-8.2	3.7-9.4	26.0-65.8
SED	0.21	3.0	3.4	0.8	0.6	9.4	2.1
CD (P=0.05)	0.43	6.0	6.7	1.5	1.2	0.6	4.1
CV (%)	15.1	7.6	12.6	12.0	16.0	4.7	4.7

able 4. The top five varieties in decreasing order of contents of their fodder quality traits

Trait	Varieties in decreasing order of content (%)				
CP	MH 1	TG 42	ALR 1	ICGS 11	S 206
NDF	M 13	Kadiri 3	S 206	TG 42	ALR 1
ADF	TG 42	M 13	S 206	TG 22	SG 84
ADL	RG 141	TPG 41	BG 1	TG 42	M 13
TS	VRI 2	BG 2	RS 1	TMV 2	LGN 2
ME	TG 22	ALR 1	TMV 2	VRI 3	VRI 2
IVOMD	TG 22	TMV 2	S 206	ICGV 86590	VRI 3

On the basis of the results of analysis for seven quality traits, among the 90 varieties evaluated, G 22 and M 13 were found to be promising for at least three traits each while VRI 2 for at least two aits. These varieties can be used as donors for improvement in fodder quality.

elationship among the fodder quality traits

Correlation and regression analyses were performed to understand the relationship among arious fodder quality traits (Table 5), using the data generated with 771 genotypes comprising 681 dvanced breeding lines and 90 varieties of groundnut. The studies indicated that there existed a gnificant inverse relationship between nitrogen and the three fibre-fractions on the one hand and a gnificant positive relationship between the nitrogen content and another three traits *viz*., total sugars, etabolizable energy and *in vitro* organic matter digestibility on the other hand.

The three fibre fractions i.e. the neutral detergent fibre, the acid detergent fibre and the acid etergent lignin were positively correlated with each other while their relationship was negative and gnificant with total sugars, metabolizable energy and *in vitro* organic matter digestibility.

Thus the results indicated that the selection for nitrogen content alone is very likely to bring bout simultaneous selection for improvement in metabolizable energy and *in vitro* digestibility of rganic matter.

able 5. Correlation matrix for different fodder quality traits

Fodder quality traits	Nitrogen content	NDF	ADF	ADL	Sugars	ME	IVOMD
NDF	-0.93**	1.00	-	-	-	-	-
ADF	-0.94**	0.94**	1.00	-	-	-	-
ADL	-0.71**	0.73**	0.84**	1.00	-	-	-
Sugars	0.13*	-0.15*	-0.28**	-0.29**	1.00	-	-
ME	0.61**	-0.66**	-0.75**	-0.74**	0.70**	1.00	-
IVOMD	0.79**	-0.82**	-0.88**	-0.79**	0.55**	0.96**	1.00

NDF= Neutral detergent; ADF= Acid detergent fibre; ADL= Acid detergent lignin; ME= Metabolizable energy; IVOMD= *in vitro* dry matter digestibility

Regression analysis

Regression analysis was performed to obtain coefficients of determinants and also to predict the strength of relationship between various pairs of fodder quality traits (Table 6). The regression coefficients worked out between nitrogen and the two traits namely metabolizable energy and *in vitro* organic matter digestibility were positive highly significant.

Table 6. Regression co-efficient and co-efficient of prediction between nitrogen content and the fodder quality traits

Versus	b*i*	R^2	SE
Nitrogen with NDF	-0.82**	0.68	1.24
Nitrogen with ADF	-0.77**	0.59	1.41
Nitrogen with ADL	-0.83**	0.69	1.24
Nitrogen with total sugars	0.87**	0.77	1.07
Nitrogen with ME	0.95**	0.90	0.70
Nitrogen with IVOMD	0.95**	0.91	0.65

The results indicated that more than 90% of the obsered variation between nitrogen content and ME and nitrogen content and IVOMD could be explained on the basis of respective R^2values. This indicates a very high lavel of predictability or reliability of these three traits. The associations between nitrogen content and all the three fibre fractions studied were negative and significave.

Thus, traits as coutents of nitrogen and fibre fractions and value of IVOMD of groundnut fodder could be cased to predict pertineut live stock responses such as digestible organic matter ritake with very high accuracy.

To understand the genetics of fodder quality traits through Six Generation Mean Analysis model, crosses to produce F_1s, back crosses (BC_1s and BC_2s) were effected involving parents with contrasting fodder quality traits. The hybrid pods were harvested cross-wise and preserved for further evaluation.

PROJECT 18: CONSTRUCTION OF DIGITAL LIBRARY OF RELEASED VARIETIES, WILD SPECIES, PEST, DISEASES AND NUTRIENT DISORDERS OF GROUNDNUT IN INDIA

(V. V. SUMANTHKUMAR)

This project was under suspended animation for the period of this report as the PI of the project was on study leave.

ALL INDIA COORDINATED RESEARCH PROJECT ON GROUNDNUT

The year 2008-09 had been quite eventful for AICRP-Groundnut. During this year decision was en by the ICAR to wind up four centers *viz*., Digraj (in Maharashtra), Anand (in Gujarat), Chiplima Orissa), and Jhargram (in West Bengal) and in lieu open four new centers *viz*., Ratnagiri (in harashtra), Vyara (in Gujarat), Bhubaneshwar (in Orissa) and Mohanpur (in West Bengal). It was wever, decided to implement the decision by the end of June 2009.

Two meetings of the scientists working under AICRP-Groundnut were organized. The *kharif* oundnut Workshop was organized at the JAU, Junagadh on 24-26 April, 2008 at JAU, Junagadh and nual Group Meeting of Groundnut Research Workers for *rabi*-summer was organized at BSKKV, poli, Ratnagiri on 15-16 October, 2008. During the year six new groundnut varieties were identified the duly constituted varietal identification committees. At the workshop held at Junagadh, four rieties *viz*., R 2001-2 for Zone IV (Orissa, Jharkhand, West Bengal, and NEH States) and Zone V mil Nadu, Andhra Pradesh, Karnataka, Southern Maharashtra); VG 9816 for Zone V (Tamil Nadu, dhra Pradesh, Karnataka, Southern Maharashtra); ICHG 00440 for all India; and ICR 48 for jasthan and Gujarat (for end-of-season drought) were identified for cultivation in *kharif* season. At Group meeting held at Dapoli, two varieties *viz*., K 1319 and R 2001-3, both for Zone IIIa harashtra and Karnataka) were identified for cultivation in *rabi*-summer.

A sum of Rs. 270 lakhs was allocated to AICRP-G for the year 2008-09 out of which an penditure of Rs 268 lakhs was incurred.

mary of the progress of research and other activities

abi-summer 2008

Although the sowing time for the experiments planned for *Rabi*-summer falls in the fiscal year 007-08, the crop is by and large harvested in the fiscal year 2008-09. Hence the results are included in e report of 2008-09. The summary of the progress of work for the last *rabi*-summer season (2007-08) given below:

CROP IMPROVEMENT

.1 Maintenance and evaluation of groundnut germplasm

Thirty-one wild species and 1153 Spanish bunch germplasm lines were multiplied at six ICRP-G centres (Chinthamani, Anand, Jalgaon, Digraj, Rahuri, Bhavanisagar) during *rabi*-summer 007-08.

About 1000 germplasm accessions were screened at hotspots for major insect pests and diseases hat limit groundnut production. A few promising accessions, tolerant of the PBND, PSND, stem rot, ollar rot and thrips have been identified. These accessions, which have shown promise against the two mportant viral diseases, are now being immunologically screened at NBPGR, Hyderabad for confirmation of tolerance.

1.2 Hybridisation and selection

For developing high yielding groundnut cultivars possessing earliness, fresh seed dormancy, and tolerance of major biotic stresses, 107 crosses were effected at various AICRP-G centres during *rabi*-summer 2007-08. A few back-crosses and three-way and multiple crosses were also made to incorporate earliness and foliar disease resistance into well adapted genetic backgrounds.

1.3 Interspecific hybridisation

Various segregating generations of objective specific crosses were advanced to the next filial generations during *rabi*-summer 2007-08. Amongst 212 crosses which were advanced, about two-thirds (152 crosses) were in early generation and one third in the advanced generation. Among the selections made, a large number (1364) of single plant selections were made in early generation (upto F_4) and fewer (226) were in advanced generation.

Ten interspecific crosses were also made at the Vridhachalam centre to introgress the novel genes from wild species for enhancing tolerance of foliar fungal and viral diseases and sucking pests. In these crosses, the seed setting ranged from 11.9% {TAG 24 x (*A. pintoi x A. helodes*)} to 24.8% {(ICGV 91279 x (*A. duranensis x A. stenosperma*)}. Further, the selections made earlier were also advanced to respective higher filial generations. Thus a total of 386 selections were made.

Twenty-six promising interspecific derivatives developed at Vridhachalam were screened for Late Leaf Spot (LLS) and rust during *rabi*-summer season of 2007-08. For LLS, the disease pressure was optimum (the susceptible varieties VRI 2 and TMV 7 recorded a disease score of 8.0 on 1-9 scale), while in case of rust it was below optimum. For LLS, the promising resistant/ tolerant cultures identified were VG 0514, VG 0523, VG 0455 (all 3.2); VG 0520, VG 0104, VG 0241 (all 3.5; and VG 0105 (3.6). For rust, three genotypes viz. VG 0523 (2.5), VG 0514 (2.8) and VG 0455 (3.0) showed promise. These new sources of resistance/tolerance may be used in crop improvement programme

1.4 Selections from NRCG and ICRISAT breeding materials

Sharing of segregating and advanced breeding materials for effecting location specific selections by NRCG and ICRISAT has resulted in identification and selection of promising genotypes in different filial generations at various AICRP-G centres for earliness, fresh seed dormancy, large seed size, major soil borne, foliar and viral diseases, and insect pests. One genotype has entered state varietal trial at Chinthamani; 12 are in preliminary yield trials and among the advanced generations, 26 promising selections were made at different centres.

From ICRISAT breeding materials, 42 selections for yield, earliness, foliar diseases and large seeds were made at advanced generations; thirty-three genotypes are in comparative yield trials with local checks and 67 are in different yield evaluation trials at different centres. Two genotypes (ALG 234 and ALG 06320), selected from ICRISAT breeding materials at Aliyarnagar, are on the verge of release in Tamil Nadu.

1.5 Promising genotypes in pipeline

Two varieties, VRI Gn 6 (VG 9816) and TMV Gn 13 were released for the state of Tamil Nadu by Vridhachalam centre for both *kharif* and *rabi*-irrigated conditions. Several other genotypes are either on the verge of release or at different stages of yields evaluation at various AICRP-G centres.

1.6 Varietal evaluation

A three-tier system comprising Initial Varietal Trial (IVT) Stage I, Initial Varietal Trial (IVT)-Stage II, and Advanced Varietal Trial (AVT) was adopted for evaluation of promising entries of different centres. The details are given below.

1.6.1 IVT Stage-I

Nineteen new Spanish bunch entries were evaluated at all the 22 test locations across the four

zones. The evaluation of same set of entries/trials would be repeated during ensuing *rabi*-summer season to understand their performance over two years and across the locations.

1.6.2 Initial Varietal Trial (IVT-I & IVT-II, Pooled)

Fifteen entries were tested for two years in all the four zones. The entry, ICGV 00350, with high pod (2958 kg/ha) and kernel (1959 kg/ha) yields, significantly out yielded the best check TAG 24 and hence promoted to AVT in zone IIIb.

1.6.3 Advanced Varietal Trial

This trial was conducted in three zones (Zone IIIa, IIIb and Zone IV). There were three entries (K 1319, R 2001-2 and R 2001-3) in Zone IIIa; two (K 1319 and VG 0107) in Zone IIIb and four (R 2001-2, R 2001-3, UG 3 and JALW 30) in Zone IV.

Over three years, in zone IIIa, two entries, K 1319 (3721 and 2540 kg/ha of pod and kernel yields) and R 2001-3 (3694 and 2492 kg/ha of pod and kernel yields) exhibited yield superiority over the best check of the zone i.e. TAG 24 (3171 and 2189 kg/ha of pod and kernel yields). These two entries also showed tolerance of stem rot, foliar fungal diseases and PBND. Hence, these two entries were identified in zone IIIa.

In zone IIIb, entry VG 0107, across different stages of testing over three years, registered an increase in pod and kernel yields of 31.8% and 36.0% over TAG 24 (NC) and 18.5% and 21.3% over R 8808 (ZC), respectively. In addition, this entry also exhibited tolerance of foliar fungal diseases and PBND and hence, this entry was proposed for identification in zone IIIb.

1.7. Breeder seed production during 2007-08

For the year 2007-08, indents of 8043.61q breeder seed comprising 62 groundnut varieties were received from DAC. Based on the availability of nucleus/breeder seed stage I, a production target of 9231.50q was assigned among 19 groundnut breeder seed producing centres/agencies.
However, during *kharif* 2007, a total of only 2561.15q breeder seed could be produced. Therefore, to mitigate the shortfall, a contingency plan was drawn and a compensatory breeder seed production programme was lunched during *rabi*-summer 2007-08 season and in this season a total of 6195.50q of breeder seed was produced. Thus during 2007-08, a total of 8756.65q breeder seed was produced with a surplus of 713q.

2. CROP PRODUCTION

2.1 Survey of agronomic practices

The survey revealed that a majority of farmers continued to grow old or some local cultivars. Application of herbicides, micronutrients and bio-fertilizers are not in practice, though use of gypsum is catching up. Use of a lower seed rate than recommended rate results low plant density at many centres. Heavy incidence of PSND and PBND was reported at Kadiri centre.

2.2 Water and nutrient management in polythene-mulch

Polythene mulching on 'paired rows-bed furrow' with irrigation either at 0.8 or 0.6 IW/CPE ratio and 100% recommended doses of fertilizers + seed treatment (*Rhizobium* and Phosphorous Solubilzing Bacteria) recorded the highest gross and net return at Digraj and Jhargram.

2. 3 Effect of different maturity duration rice cultivars on the productivity of groundnut in rice groundnut sequence cropping system

Short duration (90-100 days) rice cultivars followed by criss-cross sowing of groundnut in the rice-groundnut cropping system was found to be most optimum at Jhargram.

2.4 Integrated nutrient management in rice-groundnut cropping system

Recommended doses of nitrogen and phosphorus to rice and recommended doses of nitrogen and phosphorus + *Rhizobium II* (IGR 6) to groundnut recorded the highest yield and economic returns of groundnut at Jhargram.

2.5 Management of micronutrient nutrition

Soil application of $FeSO_4$ at 20 kg/ha at Jalgaon and 30 kg/ha at Junagadh and application of $ZnSO_4$ at 20 kg/ha at Jhargram, and 30 kg/ha + boron 2 kg/ha (seed treatment) at Vridhachalam produced highest groundnut yields and gross returns.

2.6 Application of organic manure, biofertilizers and biopesticides

Application of poultry manure + biofertilizers + biopesticides at Rahuri, Vriddhachalam and Aliyarnagar; FYM + recommended doses of fertilizers (25:75:25) at Dharwad and Kadiri; and FYM + biopesticides (neem cake @ 500 kg ha^{-1} + *Trichoderma* seed treatment @ 5 g kg^{-1} + Neem Seed Kernel Extract 2%) at Junagadh were found effective in increasing groundnut yields.

2.7 Evaluation of post emergence herbicides

Use of fluchloralin 0.9 kg a.i. /ha + hand weeding at 45 DAS (Aliyarnagar) and pendimethalin 1.0 kg a.i./ha + hand weeding at 30-35 DAS (Rahuri, Jhargram and Kadiri) were found to be effective in controlling the weeds. Pendimethalin 1.0 kg a.i./ha + quizalofop ethyl 50 g ai/ha (Jagtial, Ratnagiri and Junagadh) and pendimethalin 1.0 kg a.i/ha + imazethapyr 50 g a.i/ha (Vriddhachalam) were found to be the best herbicide treatments.

3. Crop Protection

3.1 Disease situation

At Dharwad, foliar diseases like late leaf spot (LLS) and rust were moderate. At other centers these diseases were not severe. Incidences of soil borne diseases were low at Dharwad, Junagadh, Kadiri, Raichur and Vridhachalam. Incidence of PBND was high at Raichur (up to 41% at harvest).

3.2 Disease Resistance

Disease	Entries	Location
PBND	ICG 76, ICG-442, ICG-1668, ICG-9802, CS-107 and ICG-10185 (<5% incidence as against 33.3 % in susceptible check, KRG- 1	Raichur
PSND	P1 268573 (1.0%) as against the highest incidence of 27% in NCAC 520	Kadiri
Rust & LLS	GPBD 4, VG 0107, K 1319	Aliyar Nagar
Rust & LLS	INS-I-2006-4, INS-I-2006-5, 1NS-I-2006-9, INS-I-2006-1 1, and INS-I-2006-12	Dharwad
Stem rot	INS-I-2007-3, INS-I-2007-l 1, JALW 30 and INS-II-2006-17 showed moderate resistance (<10% incidence as against 36% in check)	Jalgaon

3.3.1 Management of stem rot (*Sclerotium rolfsii*)

At Junagadh, the pooled data of three years revealed that soil drenching with *Trichoderma viride* 30 DAS was significantly superior in reducing stem rot disease and thereby increasing the pod yield, this was followed by seed treatment with *T. viride* and soil application of *T. viride* with castor cake. The highest ICBR (1:37) was obtained when *T. viride* was applied as seed treatment and this was followed by *T. viride* as soil drenching at 30 DAS (1:20).

At Raichur, the results of three years, indicated that soil drenching with *Trichoderma* (2.5 kg/ha) was highly effective in controlling stem rot with a mean least incidence of stem rot of 3.46% at harvest coupled with highest mean yield of 2425 kg/ha. The next best was the seed treatment with *Trichoderma* (4 g/kg seed) with mean stem rot incidence of 4.37% and mean pod yield of 2137 kg/ha.

At Vriddhachalam soil application of *Trichoderma* (2.5 kg/ha) along with 50 kg castor cake at the time of sowing gave significantly higher initial and final plant stands, and yield and with significantly low incidence of stem rot (4.6%) as compared to control (10.5%)

3.3.2 Management of dry root rot (*Rhizoctonia bataticola*)

At Raichur, seed treatment with Mancozeb (4 g/kg seed) recorded the least disease incidence (2.58 per cent) and highest pod yield (2445 kg/ha) and this was followed by seed treatment with *Pseudomonas fluorescens* + soil application of *Pseudomonas fluorescens* (disease incidence of 2.11% and pod yield of 2450 kg/ha).

Among the various treatments tried at Vriddhachalam and Kadiri, seed treatment with *Trichoderma* (4 g/kg seed) + soil application of *Trichoderma* (2.5 kg/h) recorded significantly higher initial and final plant stands besides higher pod yield and lower dry root rot incidence (4.5%, and 5.2% respectively) over the control (12.0% and 16% respectively) with ICBR of 1: 3.2 at Kadiri.

3.3.3 Isolation and identification of plant parasitic nematodes

Twenty soil samples were collected from different groundnut fields of Junagadh district. Thirteen nematodes were identified from these samples, out of which *Tylenchorhynchus sp. Helicotylenchus sp. and Hoplolaimus sp.* were the predominant ones.

3.4 Insect pests

3.4.1 Insect pest situation

- At Dharwad, highest infestations of *Spodoptera* (25%) and *Helicoverpa* (12%) were observe during pod formation stage.
- At Jalgaon, thrips damage was in the range of 1.3-24.2%. The incidences of *Spodoptera* and le miner were 2.3-24% and 0.2-14.3%, respectively.
- At Jagtial, damages due to thrips (45%), jassids (75%) and *Spodoptera* (35%) were high duri vegetative stage.
- At Raichur, high activities of leaf miner and thrips were observed during pod formation a vegetative stages.
- At Vriddhachalam, the incidence of tobacco caterpillar was noted

3.4.2 Host resistance against Insect pests

Insect pest	Promising genotypes	Centre
Spodoptera litura	INS-I-2007-13, Dh-86, INS- I-2006-5, Dh- 101, 9-2-29, Dh-86, R-2001-2 and AIS-2007-I	Dharwad
	INS-I-2007-2 and 5, ALSVT-2007-5, AIS-2007-1, INS-I-2006-3, AIS-2006-7 and 9	Vriddhachalam
	INS-I-2007-2, 3, 4, 5, 10,11, 12, 13, 14, INS-II-20061, 2, 4, 5, 8, 9, 12, 13, 14, 15, 16, 17, AIS-2007-2, 3, 4, 6, 7, 8, 10 AIS-II-2006-1, 2, 4, 5, 9, 11, 12, 13, 14, ALSVT-I-2007-1, 2, 3, 6	Jalgaon
Thrips	INS-I-2007-2, 3, 4, 5, 8, 10, 11, 13, INS-II-2006-7, 8, 9, 10, 11, 12, 13, 14, 15, 16 AIS-2007-1, 2, 3, 4, 6, and AIS-II-2006-1, 2, 6, 9, 10, 11, 12, 13, ALSVT-I-2007-1, 2, 3, 6	Jalgaon
	INS-I-2007-10, INS-I-2007-3, GG-6, AIS-2007-2 and AIS-2007-8	Junagadh
	INS-I-2007, INS-I-2007-7 & 6 INS-I-2006-18, INS-I-2006-15,13 & 7, AIS-2006-5, 2 and 14	Kadiri
Helicoverpa	AIS-2007-2, INS-I-2007-4, AIS-2007-1 and AIS-2007-6	Junagadh
Thrips, jassids and *Spodoptera*	INS-2007-08, 10 and AIS 2007- 1 and 7	Jagtial

3.4.4 Integrated management of defoliators

At Vriddhachalam, the IPM module consisting of seed treatment with *T. viride* (4 g/kg seed), trap crop castor (200 g/ha randomly sown), pheromone traps for *Spodoptera* and leaf miner (12 traps/ha for each) bird perches (50/ha), NSKE 5% spray twice, need based chemical spray (Quinalphos, 2ml/lit) significantly lowered the incidences of *S. litura* (5.3-7.8 %) and leaf miner (4.4-6.2 %) compared to control (16.0-29.8% and 8.1-9.0% incidence of *S. ltiura* and leaf miner, respectively). This treatment also recorded higher yield and favourable CBR.

3.4.5 Biological control of *S. litura* with *Nomuraea rileyi*

At Vriddhachalam, application of *N. rileyi* @ 2gm/lit with NSKE 5% gave better control of *Spodoptera litura* than the other treatments. This treatment recorded higher yield and CBR than those of control.

4. FRONTLINE DEMONSTRATIONS - RABI/SUMMER 2007-08

A total of 253 FLDs were conducted at 14 centers during *rabi*-summer 2007-08 in the major groundnut growing states like Andhra Pradesh, Gujarat, Maharashtra, Karnataka, Tamil Nadu and in states like Rajasthan, West Bengal and Tripura. The components of FLDs conducted were, Improved Variety, Integrated Nutrient Management, Plant Growth Promoting Rhizobacteria, Integrated Pest

Management, Integrated Weed Management and Irrigation Management. The FLDs over the centres and components indicated that highest mean pod yield of 3074 kg/ha was recorded at Udaipur centre with Improved Variety compared to 2510 kg/ha of the local variety and the lowest mean pod yield of 1976 kg/ha was recorded at Aliyarnagar centre compared to 1640 kg/ha of local variety.

The FLDs on improved variety has shown that the highest mean pod yield of 3074 kg/ha was realized at Udaipur centre with TAG 24 compared to 2274 kg/ha of local variety. The lowest yield of 1458 kg/ha was realized at Raichur centre with R-2001-03 compared to 1078 kg/ha with local variety. There was 22% increase in mean pod yield with improved variety over the local variety. Over the local variety, the highest increase in pod yield of 42% was recorded at Raichur centre and the lowest of 8% at Vriddachalam.

Under the FLDs on integrated nutrient management, the highest mean pod yield of 3021 kg/ha was realized at Jagtial over farmers practice (2274 kg/ha) Through INM the highest and lowest increase in yields recorded were 20% at Aliyarnagar and 11% at Jalgaon.

The highest mean pod yield of 2731 kg/ha was realized at Jhargram with the application of plant growth promoting Rhizobacteria compared to 2493 kg/ha with farmers' practice. The improved practices recorded 15% increase in pod yield across the centres compared to farmers' practice.

The integrated pest management gave an increase in pod yield by 11% at Jagtial and 8% at Vriddhachalam over farmer's practice. The integrated weed management at Jagtial increased the pod yield by 12.2% over farmers' practice.

The Gross Monetary Returns (GMR) increased by each of the components of FLDs. The increase in GMR ranged from 7 to 64% under FLDs. The highest increase in GMR of 64.4% over farmers practice was recorded at Digraj with improved variety and lowest increase of 7.6% at Jagtial centre with integrated pest management.

The GMR ranged from Rs. 31,912 to 84,280/ha with improved variety at Raichur and Anand, respectively. The net returns ranged from Rs. 13,879 to Rs. 61,770/ha with improved variety at Raichur and Anand respectively. The benefit cost ratio (BCR) ranged from 1.18 to 3.70 under FLDs at Bhavanisagar and Anand centres respectively.

***Kharif* - 2008**

The major accomplishments of AICRP on Groundnnut during *kharif* 2008 are as follows:

1.0 CROP IMPROVEMENT

1.1 Maintenance, Evaluation and Utilization of Germplasm

Forty-nine wild accessions and 4298 groundnut germplasm and advanced breeding line belonging to four habit groups were maintained during *kharif* 2008 at nine centers located in the state of Rajasthan, Gujarat, Maharashtra, Madhya Pradesh, Karnataka, Andhra Pradesh, and Tamil Nad The germplasm included 1140 new accessions acquired from NRCG, ICRISAT and some loc collections.

1.2 Hybridization and Selection

1.2.1 Inter/intra varietal hybridization

To develop high yielding groundnut cultivars possessing resistance to various biotic and abio stresses for *kharif* season, hybridization programme was taken up at 15 AICRP-G centres.

During *kharif*-2008, by involving different cultivars/advanced breeding lines, germplasm accessions, 218 new crosses were effected.

Among the various parents used in hybridization programme, the parents, which were used widely amongst the AICRP-G centers, included TG 37A (for high yield, earliness and compact fruiting). For tolerance of foliar diseases like ELS, LLS and rust the variety GPBD 4 has been used. ICGV 860312 has been used for incorporating tolerance of PBND.

Segregating and advanced generation populations of inter and intra varietal crosses effected during the previous *kharif* seasons at 16 AICRP-G centres were advanced to their respective next filial generations during *kharif* 2008. A large number of single plant/line or progeny bulks were selected.

1.2.2 Interspecific hybridization and selections

Nine interspecific crosses made at Vridhachalam during the previous *kharif* season involving the cultivated and agronomically superior varieties with various wild species were raised in *kharif*-2008 to isolate the true F_1s. In all, eight amphidiploids (developed earlier and being maintained at this centre) have been used for production of these crosses.

At different filial generations of the interspecific crosses, 257 promising selections were made. Corrective breeding approach has also been followed through back cross breeding in a few crosses to rectify/incorporate productive traits from the adapted varieties.

1.3 Evaluation of promising selections made at various AICRP-G centres

There are 92 promising selections currently under different stages of evaluation at various AICRP-G centers. A few of these are also under multi location evaluation both *rabi*-summer as well as in *kharif*.

1.3.1 Selection from NRCG breeding material

Altogether, segregating and advanced generation breeding materials belonging to 35 crosses were supplied to 10 AICRP-G centres during *kharif* 2008. These crosses were made with the objective of incorporating earliness, water use efficiency, drought tolerance, iron-deficiency induced chlorosis tolerance, fresh seed dormancy, collar rot tolerance and *A. flavus* tolerance and also resistance to foliar fungal diseases into broad based cultivars/genetic back grounds.

From the available breeding material, 35 crosses supplied to five centres during the last *kharif* seasons, 219 promising location specific selections were made at five centres.

1.4 Varietal Evaluations

A three-tier system of evaluation namely Initial Varietal Trial (IVT) Stage-I, Initial Varietal Trial (IVT) Stage-II and Advanced Varietal Trial (AVT) was adopted.

1.4.1 IVT Stage-I

Nineteen Spanish type and 16 Virginia type genotypes along with the check varieties were evaluated in all the five zones- at 29 and at 23 AICRP-G centres respectively. Only the recently released varieties or pre-release varieties were for the respective zones and were used as the check varieties.

1.4.2 Initial Varietal Trial (IVT I & II) Pooled

Sixteen Spanish bunch and Virginia genotypes were tested for two years in all the five and four zones respectively. Among Spanish bunch types, none could be promoted to AVT owing to their poor performance in relation to the best check varieties. Under Virginia group in zone I (comprising Rajasthan, Uttar Pradesh, and Ludhiana) one entry, HNG 123 recorded significant higher pod (2630 kg/ha) and kernel (1744 kg/ha) yields over HNG 10, the best check for this zone.

1.4.3 Advanced Varietal Trial

Two Spanish bunch genotypes, PBS 12160 and GPBD 5 recorded 10% higher kernel yield in their order of merit over the best check variety OG 52-1 across different stages of testing over three years. These genotypes also exhibited tolerance of foliar diseases. Hence, these two entries were proposed for identification for zone IV (Orissa, Jharkhand, West Bengal and Manipur).Under the Virginia group, two entries, HNG 69 and CSMG 2003-19, gave 10% higher kernel yield over the various checks and have also been found tolerant of soil borne diseases (collar and stem rot). These two entries were proposed for identification.

1.5. Breeder seed production

During *kharif* 2008, DAC indent for 22897.20 q pods (58 groundnut varieties) was received. However, on the basis of availability of nucleus/breeder seed stage-I, a production target of 9065.10 q. was assigned to the 20 breeder seed producing centres. During *kharif* 2008, against this allocation, only a quantity of 2552.45q breeder seed could be produced. Hence a compensatory programme was undertaken during *rabi*-summer 2008-09, to meet the short fall and a total of 4992q was produced. The total quantity of breeder seed produced during 2008 was 7544.45 q.

2.0 CROP PRODUCTION

1. Survey of agronomic practices in the farmers' field

A low rate of adoption was indicated for improved varieties, herbicides, gypsum, micronutrients and kind of fertilizers. Due to erratic and in certain areas excessive rainfall during *kharif* 2008, the yield was adversely affected.

2. Evaluation of groundnut cultivars for late sown condition

Delayed sowing after onset of monsoon caused a reduction in pod yield by 32-61 %. The varieties VRI-6 and VRI-7 at Virddhachalam; Vemana at Kadiri; JL-501 at Jalgaon; Chintamani-2 at Chintamani; and GG-5 at Junagadh however, were not affected much by delayed sowing.

3. Micronutrient management in groundnut

Among eleven treatments evaluated, the soil application of zinc sulphate @ 10 kg/ha at Chiplima; 30 kg/ha at Digraj; zinc sulphate @ 10 kg/ha + boric acid @ 6 kg/ha at Chintamani recorded the highest pod yield whereas application of boric acid @ 12 kg/ha was the best at Mainpuri.

4. Intercropping of groundnut with cotton

The highest groundnut equivalent yield in cotton (hybrid or Bt) + groundnut intercropping was obtained at 1:3 row ratio at Dharwad and Junagadh and at 1:1 ratio at Jalgaon.

5. Effect of consortia of microorganisms on the growth and yield of groundnut

The application of consortia of beneficial micro-organisms increased the pod yield by 13-15%.

Application of 100% RDF with non-fluorescent pseudomonads (at Dharwad, Virddhachalam and Durgapura) and with PGPR + PSM + *Rhizobium* (at Jalgaon, Aliyarnagar and Kadiri) improved nodulation and yield.

6. Evaluation of post emergence herbicide in rain fed groundnut

At Chintamani, Ratnagiri and Dharwad, application of quizalofop ethyl @ 50 g a.i./ha and at Durgapura, Junagadh, Jalgaon, Khargone and Virddhachalam, application of imazethapyr @ 50 g a.i./ha were found the most effective post emergence herbicides.

7. Effect of bio regulators on productivity of rain fed groundnut

Foliar application of thiourea @ 500 ppm at Ratnagiri and Digraj; and @ 1000 ppm at Junagadh, Kadiri and Dharwad improved the pod yield and economic returns. Application of thioglycollic acid @ 200 ppm, however gave the maximum yields only at Durgapura.

8. Nutrient management in hybrid Bt Cotton + groundnut intercropping system

The results of one-year experiments revealed that Bt cotton and groundnut (1:5 rows, respectively) recorded highest pod and kernel yields at Dharwad but such a response was not observed at Durgapura.

9. Development of package of practices for organic groundnut

Application of FYM (7.5t/ha) duly inoculated with biofertilizers and supplemented with biopesticides improved yield at Durgapura. While at Aliyarnagar, application of inoculated FYM and foliar spray of 'panchgavya' (3%) improved both the pod yield and the returns. However, such a response was not observed at Kadiri and Virddhachalam

10. Agronomic management of AVT entries

The evaluation entries in AVT for their agronomic traits revealed that the Spanish entries R-2003-3, HNG-69, CTMG-1 and CSMG2001-02 performed well under 150% RDF with and spacing of 30 cm X15 cm respectively at Virddhachalam, Hanumangarh, Chintamani and Jhargram. At Mohanpur, however, the entries AVK2008-03 (Virginia) and AVK2008-02 (Spanish) showed good performance.

3.0 Crop Protection

3.1 Disease situation

- Among the *foliar fungal diseases,* ELS was moderate while LLS and rust intensity was high at Dharwad, Jalgaon, Junagadh and Raichur. Severity of ELS was high at Kadiri and Hanumangadh. The rust intensity was low at Kadiri and Vriddhachalam.
- Among the *seed and seedling diseases*, stem rot and collar rot incidence was low to moderate (<15%) at Dharwad, Jalgaon, Junagadh and Hanumangadh during the crop growth. Maximum incidence of stem rot reached up to 18-30% at Kadiri and Raichur. Dry root rot was observed up to 10% at Hanumangadh, Kadiri and Vriddhachalam.
- Among the *viral diseases,* the incidence of PBND was low (up to 6%) in farmers' fields at Dharwad, Hanumangadh and Jalgaon and was not noticed at Junagadh. At RARS, Raichur PBND incidence ranged from 25-37% and less (2-19%) in farmers' fields. The incidence of PSND was 1-22 % at Kadiri.

3.2 Disease Resistance

Disease	Genotypes	Hot spot location
Early leaf spot (ELS)	ISK-I-2008-12 and 16; IVK-I-2008-1, 12, 13 and 16; ISK-I-2007-12, AVK-I-2007-2, 4; LSVT-I-2007-2, 3 - grade =2 as against highest 6	Kadiri
	IVK-I-2008-12, IVK-I-2008-13; IVK-II-2007-1, IVK-II-2007-5 and IVK-II-2007-8; ISK-I-2008-9 and ISK-I-2008-21; ISK-II-2007-3 and ISK-II-2007-10; LSVT-I-2008-6 and LSVT-I-2008-12 ; LSVT-II-2007-5 ; AVK-2008-8 ; AVK-2008-9 ; ASK-2008-2 ; ALSVT-2008-4; ADR - grade 1 as against highest grade 5-6	Hanumangarh

3.2 Disease Resistance

Disease	Genotypes	Hot spot location
Stem rot	ISK-I-2008-1, IVK-I-2008-7, AVK-I-2008-5, ALSVT-I-2008-1 - less than 5%	Kadiri
	IVK-I-08-18 and LSVT-I-08-13; LSVT-II-07-8, IVT-VG-I-1 - zero incidence as against 16.4% in GG 20 and highest 52.5%	Junagadh
	ISK-I-2008-12 and ISK-I-2008-20 <10% as against 39% in the check, JL24 LGN-163, ICGV-99105, LGN-140, LGN-142, LGN-145 <10% stem rot disease as against 40% in check, JL 24	Latur
Collar rot	IVK-I-2008-7 and IVK-I-2008-15; IVK-II-2007-7; ISK-I-2008-9 and ISK-I-2008-13, ISK-I-2008-18 and ISK-I-2008- 21; LSVT-I-2008-4 and LSVT-I-2008-12; ALSVT-2008-5; ADRVT-2008-4 and ADRVT-2008-7 - zero incidence as against highest 23-27%	Hanumangarh
Late leaf spot (LLS)	ISK-I-2008-1, ISK-I-2008-2, ISK-I-2008-12, ISK-I-2008-16, ISK-I-2008-17, ISK-I-2008-18 and ISK-I-2008-20; IVK-I-2008-1, IVK-I-2008-2, IVK-I-2008-3, IVK-I-2008-7, IVK-I-2008-11, IVK-I-2008-12, IVK-I-2008-15 and IVK-I-2008-16; ASK-I-2008-4, AVK-I-2008-1 and AVK-I-2008-2 ; ASK-I-2008-4, AVK-I-2008-1 and AVK-I-2008-2; LSVT-I-2008-7, LSVT-I-2008-8 and ALSVT-I-2008-2 -moderately resistant (grade 3-4)	Jalgaon

Disease	Genotypes	Hot spot location
	ISK-II-2007-7, ISK-II-2007-13 and ISK-II-2007-22; IVK-II-2007-2, IVK-II-2007-3, IVK-II-2007-4, IVK-II-2007-6, IVK-II-2007-11 and IVK-II-2007-18; AVK-II-2007-1, 2; LSVT-I-2007-2, 3 and ALSVT-II-2007-3 -moderately resistant (grade 3-4)	
	ICGV lines viz. 86325, 86699, 86707, 87194, 90267, 91172, 9186, 86590, ICGS-44, TG-3, TG-29, CO-2, B-95, RHRG-1, RHRG-11, RHRG-16 < 3.0 grade	
	RHRG-S-06083, RHRG-S-06090, RHRG-S-06092, LGN-117 and LGN-140 - up to grade 3	
	ISK-I-2008-19, -20 and AVK-2008-1; Germplasm lines ICG-1668, -5779, -10886, -12988, -7221, -12921, NRCG-11611, -13004, -13172 and CS-205; NRCG CS-108, CS-109 and CS-206; PBS-15011, PBS-22042, PBS-16033 and PBS-22046 < 3 grade against 7-8 grade in KRG-1 (Check)	Raichur
Rust	IVK-I-2007-06, IVK-I-2008-08 and ISK-I-2008-11 LSVT-I-08-6	Latur Junagadh
LLS + Rust	LSVT-I-2008-5, LSVT-I-2008-7 and LSVT-I-2008-11; ISK-I-2008-12 and ISK-I-2008-20; ISK-I-2007-23; ASK-2008-5 and ASK-2008-6; ALSVT-2008-5 - moderately resistant	
	ALSVT-2008-5 - resistant	Dharwad
PBND	AVK-2008-10; ICG-1415, ICG-5745 and NRCG CS-107; CS-215, CS-241, CS-244, CS-245 and CS-260; PBS-16033 less than 5% as against highest 30.8-64.30%	Raichur
PSND	ISK-I-2007-10, IVK-I-2007-8 -2.5 to 3.5% as against highest 23.6%	Kadiri

recorded lowest collar rot incidence and highest pod yield which were at par with seed treatment with Tubeconazole. Pooled data of two years revealed that seed treatment with Tubeconazole was very effective in controlling collar rot incidence with significantly higher pod yield.

3.3.2 Integrated management of major diseases of groundnut

At Dharwad, Hanumangadh, Jalgaon, Kadiri and Latur, the integrated treatments T_5 *viz.*, soil application of Trichoderma (4.0 kg/ha) + neem cake (250 kg/ha) + two spray of Hexaconazole (1ml/L) were found very effective against foliar diseases of groundnut and significantly increased yield. Stem rot was also significantly low in this treatment. At Junagadh the lowest incidence of collar rot was observed in plot where Tebuconazole was applied as seed treatment while seed treatment with *Trichoderma* @10 g/kg + two spray of Hexaconazole @ 1 ml/L was found significantly superior in reducing stem rot. At Kadiri, lowest dry root rot incidence was recorded in seed treatment with Mancozeb (3 g/kg) + two foliar sprays with Hexaconazole (2 ml/L). At Vriddhachalam, minimum root rot incidence was recorded in the treatment T_5. The lowest incidence of LLS and rust were recorded in T_2 Seed treatment with Mancozeb (3 g/kg) + 2 sprays of Hexaconazole (1ml/L) at Kadiri and Vriddhachalam.

4 Insect pests

4.1 Insect pest situation

- At Dharwad, hairy caterpillar and *Spodoptera litura* incidence was highest (25 to 40%) during maturity phase
- At Jalgaon, the larval infestation of *Spodoptera litura* ranged from 1.2 to 20 % during flowering to pod formation stage and incidence of thrips was in the range of 5-33 %.
- At Jagtial, the percent leaves damaged by thrips was high during vegetative stage (75%) and jassids (100%) and aphids (20%) infestation was high during pod formation stage.
- At Kadiri, severe incidence of leaf miner (73%) was observed at Bathalapalli mandal.
- At Raichur, maximum larval population of leaf miner (108 larvae/plant) was recorded during last week of September.

3.4.2 Host resistance against insect pests

Insect pest	Promising genotypes	Centre
Spodoptera litura	ISK -I-2008-2 ISK -I-2007-23 LSVT-I-2008-14, 15, ASK-I-2008-1, 2 IVK-I-2008-8, 12, 15, 16 and 18 ADRVT-2008-3 and ADRVT-2008-5, ALSVT-2008-2, GPBD-6	Dharwad
Spodoptera litura	ISK-2007-12, 23,8 & 22	Jagtial
Spodoptera litura	ISK-I-2008-18, IVK-I-2007-1 & 9 ISK-II-2007-4, 6, 8, 11, 12 ASK-II-2007-1, 2, 3, 4, 8, 10, IVK-II-2007-8, LSVT-I-2008-4, LSVT-II-2007-2, ADRVT-II-2008-1, ALSVT-I-2008-4, RHRG -1, ASJ-1	Jalgaon
Thrips	ISK-2007-8, 12 & 22 IVK-I-2008-12 IVK-I-2007-2, 5,7,10	Jagtial
Jassids	ISK-2007-8, IVK-I-2008-10 & 18 IVK-2007-7, 8 & 10	Jagtial

Insect pest	Promising genotypes	Centre
Thrips, jassids and *Spodoptera litura*	ISK-I-2008-11 and 12	Jagtial
Thrips	ISK-I-2008-1213,16, LSVT-I-2008-9, LSVT-I-2007-1, 2 and IVK-I-2007-10	Junagadh
Jassids	ISK-I-2008-1, ADRVT-2008-4, ALSVT-2008-3, ALSVT-2008-5 and IVK-I-2008-18 IVK-I-2007-3, ISK-I-2007-12, IVK-I-2007-1,6 and Dhiraj-101	Junagadh
Thrips	ISK-I-2008-2 ASK-2008-1 IVK-2008-7, 10,11,14,18, LSVT-I-2008-5,6,11,12,15, LSVT-I-2008-6 ALVST-I-2008-1,2,3,4,5 ISK-I-2008-1, 4, 8, 15, 22, 23 ASK-2007-2 and IVK-I-2007-1	Kadiri
Thrips and leaf miner		Kadiri
Jassids and thrips	ISK-I-08-8, 13, 10, 19, 20 and LGN-2	Latur
Thrips	ISK-I-08-21, IVK-I-08-2 and AVK-08-8	Ludhiana
Leaf miner	CSMG-84-1, ALR-1, GG-13, NRCG-7472, NRCG-6155, RS-1, DSG-1 and Dh-8	Raichur
Leaf miner	IVK-1-2008-12, AVT-1-2008-5, 10, ASK- 2007-2, ISK-2007-23 and ALSVT-2008-12	Vriddhachalam
Leaf miner	CSMG-84-1, ALR-1, GG-13, NRCG-7472, NRCG-6155, RS-1, DSG-1 and Dh-8	Raichur
Leaf miner	IVK-1-2008-12, AVT-1-2008-5, 10, ASK- 2007-2, ISK-2007-23 and ALSVT-2008-12	Vriddhachalam

3.4.3 Demonstrations of IPM modules on the field of research farm

At Dharwad, the IPM module evaluated gave higher yield, gross return and lower cost of cultivation than in farmers practice and higher activity of natural enemies were observed in IPM module over farmers practice.

At Junagadh, comparatively low incidence of thrips jassids, *Helicoverpa* and *Spodoptera* and higher pod yield was observed in IPM practices than farmer's practice.

At Kadiri, at 30 DAS the thrips incidence was low (5.3%) in IPM plot as compared to the farmer method (11.2%), because of the seed treatment with imidacloprid. Yields of Red gram was high 486kgs/ha. in IPM plot than the farmer method (207 kg/ha.).

At Vriddhachalam, significantly lower incidence of leaf miner (3.4- 6.8 %) and favourable CBR ratio in IPM modules was observed as compared to control 16 18.4 %.

Monitoring of *Spodoptera* and leaf miner male moths using pheromone traps

Centre	Peak period (Standard week)
Spodoptera litura	
Dharwad and Jalgaon	36th
Junagadh	37th
Raichur	34th, 51st and 52nd
Jagtial	37th and 38th
Latur	36th
Kadiri	41st
Leaf miner	
Latur	36th
Vriddhachalam	36th and 37th
Helicoverpa	
Latur	39th

4.5 Evaluation of new molecules for the control of *Spodoptera*/GLM

Pest and Centre	Best treatment	Second best treatment
Spodoptera litura		
Dharwad	Emamectin benzoate 0.2 g/lit	Spinosad @ 0.018 %
Jagtial	Spinosad @ 0.018 %	Thiodicarb 0.075%
Latur	Spinosad @ 0.018 %	Chlorpyriphos
Jalgaon	Novaluron	Spinosad @ 0.018 %
GLM		
Raichur	Profenophos 50 EC @ 2ml/lit	Spinosad 0.3 ml/lit

6 Population dynamics of thrips fauna and PSND/PBND incidence on groundnut

At Jagtial, thrips incidence was high (18/10 terminal thrips) with 70 % foliage damage with only 10% PBND incidence. The thrips species were *Caliothrips indicus* and *Scirtothrips dorsalis*.

At Raichur, species complexity of thrips fauna indicated the prevalence of *Thrips palmi* and *ıkliniella schultzei* as the predominant species. *Scirtothrips dorsalis* and *Caliothrips indicus* were d in minor proportions.

3.4.7 Testing of new insecticides (seed dressers & foliar sprays) against sucking pests on groundnut

Centre	Best treatment	Second best treatment
Jagtial	Thiamethoxam @ 1g /kg	Monocrotophos @ 1.60 ml/ litre
Junagadh (thrips)	Thiamethoxam @ 1g /kg	Dimethoate 30 EC @ 2 ml/litre
Junagadh (jassids)	Imidacloprid 70WS @ 2g/kg	Dimethoate 30 EC @ 2 ml/litre

4.0 Front Line Demonstrations

The FLDs were conducted at sixteen centres during *kharif* 2007 in the major groundnut growing states such as Andhra Pradesh, Gujarat, Karnataka, Madhya Pradesh, Manipur, Maharashtra, Orissa, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh and West Bengal with the objective of demonstrating on farmers fields the productivity potential and profitability of the latest improved varieties and production technologies vis-à-vis prevailing farmers practice.

A total of 428 FLDs were conducted against the allotted 584 FLDs on different aspects of improved technology such as Improved Variety, Integrated Nutrient Management, Integrated Pest Management, Integrated Disease Management, Integrated Weed Management, Plant Growth Promoting Rhizobacteria and groundnut based intercropping system.

- The FLDs over the centres and component technologies indicated that the pod yield ranged from 448 to 4438 kg/ha with improved practice as compared to 420 to 3250 kg/ha with farmers practice. The pod yield increased by 22% compared to farmers practice. One of the farmers realized highest pod yield of 4438 kg/ha under Groundnut + Bt cotton intercropping at Junagadh. The haulm yield ranged from 1300 to 5000 kg/ha with improved practice as compared to 1080 to 5000 kg/ha with farmers practice. The haulm yield increased by 13% as compared to farmers practice. One of the farmer achieved highest haulm yield of 5500 kg/ha at Ludhiana centre with improved variety SG 99.

- The average cost of cultivation ranged from Rs 12615/ha with improved variety at Junagadh centre to Rs.31867/ha with INM at Durgapura whereas it ranged from Rs 11058 to Rs 30925/ha under farmers practices. The average gross monetary returns (GMR) ranged from Rs 18624 to Rs 939789/ha with improved practice compared to Rs.15540 to Rs 62300/ha with farmers practice. The GMR increased by 24% with the improved practice as compared to farmers practice. One of the farmer at Junagadh realized highest GMR of Rs 1,18,281/ha under groundnut + Bt cotton intercropping with net returns of Rs.96371/ha. The average net returns ranged from Rs 5882 to Rs 69017/ha with the adoption of the improved practice compared to Rs 4108 to Rs.37041/ha with farmers practice. The net returns increased by 38% as compared to farmers practice. The ICBR ranged from less than a rupee to more than Rs16.

EXTERNALLY FUNDED PROJECTS BAGGED DURING 2008-09

1. **Diversity analysis of *Bacillus* and other predominant genera in extreme environments and its utilization in agriculture**

   Funding agency: NAIP

   PI: Dr. K. K. Pal

   Date of start: 16 January 2009

   Likely date of completion: 31 March 2012

   Total budget: Rs. 437.51 lakhs

   DGR component: Rs. 68.27 lakhs

2. **Over expression of PR 10 gene cloned from salt stress tolerant cell lines of *A. hypogaea* in groundnut cultivars for abiotic stress tolerance**

   Funding agency: DBT

   PI: Dr. S. K. Bera

   Date of start: 22 January 2009

   Likely date of completion: January 2012

   Total budget: Rs. 31.99 lakhs

   DGR component: Rs.18.54 lakhs

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Meetings/Trainings Attended

Dr. Vinod Kumar

- National Seminar on "Non-biological Contaminants (Mycotoxins, Pesticides, Heavy-metals & Dioxins) in Food, Feed and their Safety Standards" held at the India International Centre, New Delhi from 23rd -24th September 2008.
- National Seminar on "Innovative Extension Strategies for Agricultural Development and Rural Prosperity" held at RAU, Pusa (Bihar) from December 18-20, 2008.
- International Conference on "Grain Legumes: Quality Improvement, Value Addition and Trade" held at IIPR, Kanpur from December 14th -16th February 2009.
- Annual *Kharif* Groundnut Workshop held at JAU, Junagadh from 23rd-25th April 2008.
- Annual *Rabi*/Summer Groundnut workshop held at Dapoli, during October 15-16, 2008.

Dr. Radhakrishnan T.

- DBT meeting for member secretaries and DBT nominees for IBSC, at Bangalore on 23 January 2009.
- Workshop on allele mining in crops and livestock, at the NASC complex, N. Delhi on 30 January 2009.
- Project workshop of ISOPOM funded projects on FPRE and Seed systems, at ICRISAT during 3-5 December 2008.
- 3rd International Conference for Peanut Genomics and Biotechnology on Advances in *Arachis* through Genomics and Biotechnology (AAGB-2008) ICRISAT, Hyderabad (AP), India; 4-8 November 2008.
- 4th World Congress on Conservation Agriculture, New Delhi. February 4-7, 2009.

Dr. G. D. Satish Kumar

- Three day training programme on "Survey instruments and their implementation" at ICRISAT, Patancheru, Hyderabad during 4- 6th February 2009.
- 5th National Extension Education Congress-2009 on "Extension perspective in Changing Environment" during March 5-07, 2009 at Chandra Shekhar Azad University of Agriculture and Technology, Kanpur and presented a paper on "Impact assessment of improved technologies through sustainable livelihood approach - A case study of groundnut (*Arachis hypogaea* L.)".

- *Rabi*/summer 'Groundnut researchers group meeting' organized by Konkan Krishi Vidyapeet, Dapoli, Maharashtra during 15-16th October, 2008 and presented the summary report of Frontline Demonstrations (FLDs) conducted during *rabi*/summer 2008 and planned the technical programme for *rabi*/summer 2009 under AICRP- G.
- *kharif* 'Groundnut researchers group meeting' organized by Junagadh Agricultural University, Junagadh during 24-26th April, 2008 and presented the summary report of Frontline Demonstrations (FLDs) conducted during *kharif* 2007 and planned the technical programme for *kharif* 2008 under AICRP- G.
- Ninth International Conference on Dryland Development: Sustainable Development in the Drylands - Meeting the Challenge of Global Climate Change held at Bibliotheca Alexandrina, Alexandria, Egypt and presented a paper on Farmers' perceptions of crop diversification for sustainable production.

Dr. Chuni Lal

- 4th World Congress on Conservation Agriculture, 4-7 February 2009, New Delhi, India.

Dr. T. V. Prasad

- National Seminar on "Pheromone Technologies: Development and Commercialization for Strengthening Eco -friendly Agriculture in India" 25- 26 September, 2008, Chennai.

Dr. P. C. Nautiyal

- 3 day conference on "Resource Capture by Crop: Integrated Approaches" at *University of Nottingham, Sutton Bonington Campus, UK,* 10-12 September, 2008.
- Symposium on underutilized, indigenous and traditional crops: Agronomy and water use, 18 and 19 January 2009. *University of Stellenbosch, South Africa.*

Dr. K. K. Pal

- 49th Annual Conference of Association of Microbiologists of India and International symposium on microbial biotechnology, diversity, genomics and metagenomics, , Nov. 18-20, 2008, University of Delhi, N. Delhi.
- 4th World Congress on Conservation Agriculture, Feb. 4-7, 2009, N. Delhi.

Dr. R. Dey

- International Conference on Grain Legumes: Quality Improvement, Value Addition and Trade, Feb. 14-16, 2009, Kanpur.
- 4th World Congress on Conservation Agriculture, Feb. 4-7, 2009, N. Delhi.

Dr. A. L. Singh

- National Seminar on "Sustainable Management of Acidic Soils for Higher Crop Productivity" College of Horticulture and Forestry, CAU Pasighat, Arunachal Pradesh from 22-24 September, 2008.

- Golden Jubilee conference on the "Challenges and Emerging Strategies for improving Plant productivity" Indian Society for Plant Physiology and IARI, New Delhi November 12-14, 2008.
- National Seminar on "Developments in Soil Science- 2008" 73rd Annual Convention of Indian soc. Soil science, 27-30 Nov 2008 UAS Bangalore, India.

Dr. S. K. Bera

- Golden jubilee conference on challenges and emerging strategies for improving plant productivity, 12-14 Nov, 2008, IARI, New Delhi.
- 4th World Congress on Conservation Agriculture, Feb. 4-7, 2009, New Delhi.

Dr. A. L. Rathnakumar

- Third International Conference of the Peanut Research Community on Advances in *Arachis* through Genomics and Biotechnology (AAGB-2008), 4-8 November, 2008, ICRISAT, Hyderabad.

List of employees (as on 31.3.2009)

Sl.No.	Name	Designation
1.	Dr. J. B. Misra	Director
2.	Dr. I.K.Girdhar	Principal Scientist
3.	Dr. P. C. Nautiyal	Principal Scientist
4.	Dr. A. L. Singh	Principal Scientist
5.	Dr. T. Radhakrishnan	Principal Scientist
6.	Dr. A. L. Rathnakumar	Senior Scientist
7.	Dr. Chuni Lal	Senior Scientist
8.	Dr. S. K. Bera	Senior Scientist
9.	Dr. K. K. Pal	Senior Scientist
10.	Dr. Rinku Dey	Senior Scientist
11.	Dr. G. D. Satish Kumar	Senior Scientist
12.	Dr. Vinod Kumar	Scientist (SS)
13.	Dr. T.V. Prasad	Scientist (SS)
14.	Shri G. Govind Raj	Scientist
15.	Shri V. V. Sumanth Kumar	Scientist
16.	Dr. Ram Swaroop Jat	Scientist
17.	Shri Har Narayan Meena	Scientist
18.	Shri Manjunatha	Scientist
19.	Dr. R. S.Tomar	Farm Superintendent (T6)
20.	Sh. C. P.Singh	TechnicalOfficer T6
21.	Ms. S. M.Chauhan	TechnicalOfficer T(7-8)
22.	Sh. V. K. Sojitra	Technical Officer T6
23.	Sh. H. B. Lalwani	Technical Officer T6
24.	Sh. D. M. Bhatt	Technical Officer T(7-8)
25.	Dr. D. L. Parmar	Technical Officer T(7-8)
26.	Sh. H. M. Hingrajia	Technical Officer T6
27.	Sh. N. R. Ghetia	Technical Officer T(7-8)
28.	Sh. P. V. Zala	Technical Officer T6
29.	Sh. Ranvir Singh	Technical Officer T6
30.	Dr. S. D. Savaliya	Technical Officer T6
31.	Smt. Veena Girdhar	Technical Officer T6
32.	Sh. V. G. Koradia	Technical Officer T6

Sl.No.	Name	Designation
33.	Sh. P. K. Bhalodia	Technical Officer T6
34.	Sh. H. K. Gor	Technical Officer T6
35.	Dr. J. R. Dobaria	Technical Officer T6
36.	Dr. M. V. Gedia	Technical Officer T6
37.	Sh. P. R. Naik	Technical Officer T6
38.	Mrs. V. S. Chaudhary	Technical Officer T5
39.	Sh. Virendra Singh	Technical Officer T6
40.	Sh. B. M. Chikani	Technical Officer T5
41.	Sh. D. R. Bhatt	Technical Officer T5
42.	Sh. R. D. Padvi	Technical Officer T5
43.	Sh. Suraj Pal Singh	Technical Officer T5
44.	Sh. V. K. Jain	Technical Officer T5
45.	Sh. H. V. Patel	Technical Assistant T-4
46.	Sh. Prabhu Dayal	Technical Assistant, T-4
47.	Sh. C. B. Patel	Driver, T-4
48.	Sh. J. G. Kalariya	Driver, T-4
49.	Sh. K. H. Koradia	Technical Assistant T-4
50.	Sh. A. M. Vakharia	T.A.T-3
51.	Sh. G. J. Solanki	Electrician T-3
52.	Sh. P. B. Garchar	Technical Assistant T-3
53.	Sh. Sugad Singh	Driver, T-3
54.	Sh. N. M. Safi	Tractor Driver, T-2
55.	Sh. B. M. Solanki	Driver, T-2
56.	Sh. G. G. Bhalani	T.A.T-2
57.	Sh. Pitabas Das	AAO
58.	Sh. J. B. Bhatt	Senior Stenographer & PA
59.	Mrs. Rosamma Joseph	Stenographer
60.	Sh. Y. S. Karia	Stenographer
61.	Sh. L. V. Tilwani	Assistant
62.	Mrs. S. Venugopalan	Assistant
63.	Mrs. M. N. Vaghasia	UDC
64.	Sh. R. D. Nagwadia	Security Supervisor
65.	Sh. M. B. Kher	UDC
66.	Sh. C. G. Makawana	

Sl.No.	Name	Designation
67.	Sh. H. S. Mistry	LDC
68.	Sh. P. N. Solanki	LDC
69.	Sh. N. M. Pandia	SSS
70.	Sh. D. M. Sachania	SSS
71.	Sh. R. B. Chawada	SSS
72.	Sh. B. K. Baria	SSS
73.	Sh. C. N. Jethawa	SSS
74.	Sh. R. V. Purohit	SSS
75.	Sh. M. B. Shaikh	SSS
76.	Sh. K. T. Kapadia	SSS
77.	Sh. J . G. Agrawat	SSS
78.	Sh. V. N. Koditar	SSS
79.	Sh. R. P. Sondarwa	SSS
80.	Sh. G. S. Mori	SSS
81.	Sh. V. M. Chawda	SSS
82.	Mrs. D. S. Sarvaiya	SSS
83.	Sh. N. G. Vadher	SSS
84.	Sh. A. D. Makawana	SSS
85.	Sh. P. M. Solanki	SSS
86.	Sh. B. J. Dabhi	SSS
87.	Sh. C.G.Moradia	SSS

Category-wise position of sanctioned and in-position strength of staff at DGR

Category of staff	Sanctioned	Filled	SC	ST	OBC
Scientific	39	18	01	02	04
Technical	40	39	05	05	05
Admn.	13	11	02	00	03
Supporting	19	19	05	03	07
Total	111		13	10	19

DEPARTMENTAL PROMOTION COMMITTEE

Sl. No.	Name of incumbent	Designation	Promoted to the post	Date of promotion
1.	Dr. G.D. Satish Kumar	Scientist (SS)	Sr. Scientist	30.11.2008
2.	Shri B.M. Chikani	Technical Officer, T-5 Officer, T-6	Technical	01.01.2009
3.	Smt V.S. Chaudhary	Technical Officer, T-5 Officer, T-6	Technical	01.01.2009

APPOINTMENT

Shri C.G. Moradia as Messenger w.e.f. 17.9.2008 on compassionate ground.

TRANSFER AND DEPUTATION

Dr. V. Muralidharan, Director, NRCG, Junagadh repatriated to TNAU, Coimbatore w.e.f. 31.5.2008

Shri R.T. Thakar, Assistant on deputation to NRCMAP, Anand w.e.f. 12.9.2008

RETIREMENT

Shri Joseph John, Administrative Officer voluntarily retired w.e.f. 1.2.2009

FINANCE AND ACCOUNTS

EXPENDITURE STATEMENT FOR THE YEAR 2008-09

NRCG-Main Unit

Rupees in lakhs

Sr. No.	Budget Head	Non Plan			Plan		
		BE	RE	Expenditure	BE	RE	Expenditure
1	Estt. Charges	218.00	260.00	317.18	0.00	0.00	0.00
2	O.T.A.	0.10	0.10		0.00	0.00	0.00
3	Wages	16.00	20.50	27.56	0.00	0.00	0.00
4	T.A.	4.50	5.50	5.00	15.00	15.00	15.00
5	HRD	0.00	0.00	0.00	0.00	0.25	0.00
6	Other Charges including Equipment/Vehicles	25.40	40.00	45.33	145.00	175.00	145.04
7	Works	11.00	45.00	14.00	40.00	56.00	31.4
	Total	275.00	371.10	409.07	200.00	246.25	191.5

AICRP-G

Rupees in lakhs

Sr. No.	Budget Head	Plan		
		BE	RE	Expenditure
1	Estt. Charges	229.50	229.50	228.86
2	O.T.A.	27.60	27.60	26.25
3	T. A.	6.90	6.90	6.56
4	Non-recurring	-	-	-
5	HRD	-	-	-
6	Need based research	6.0	6.0	6.42
Total		270.00	270.00	268.09

FARM SERVICES

The requirements of agricultural labourers both unskilled and semi-skilled were fulfilled as per needs of field experiments and other day to day work of farm. Bullock pairs were hired as and when required for inter-culture operations. All out efforts were made to keep tractors, farm implements, submersible pumps, etc. in good working conditions. One tractor and other 62 unserviceable or obsolete items were disposed off. Two new tractor trolleys and one water-tanker were acquired. A sum of Rs. 2,72,643/- was generated through sale of farm produce. About 30 hectares of farm land cleared of wild bushes and at several places land shaping was done by hiring earthmovers.

GENERAL INFORMATION

Institute Management Committee

Chairman

Dr. J.B. Misra, Director, DGR, Junagadh

Members

1. Dr. R.A. Sherasiya, Director of Agriculture (Gujarat), Krishi Bhavan, Sector 10-A, Gandhinagar
2. Shri S. Kosalaraman, IAS, Commissioner of Agriculture, Chepauk, Chennai 600 005
3. Dr. N.C. Patel, Principal and Dean, College of Agriculture Engineering & Technology, JAU, Junagadh-362 001
4. Shri Madhubhai K. Mankad, Progressive Farmer, Krishi Vigyan Kendra, Gundala Road, At. Sadau, Tal. Mundra, Kutch - 370 421
5. Shri Haridasbhai Bikhabhai Zala, Progressive Farmer, Post at: Vadhavi, Dist. Junagadh
6. Om Prakash Nagar, Finance & Accounts Officer, Central Arid Zone Research Institute (CAZRI), Light Industrial Area, Jodhpur 342 003
7. Dr. V. S. Bhatia, Principal Scientist, Directorate of Soybean Research, Khandwa Road, Indore 452 001
8. Dr. D. Kumar, Principal Scientist & Project Coordinator (Arid Legumes), Central Arid Zone Research Institute, Jodhpur 342 003
9. Dr. C. Chattopadhyay, Head, Division of Crop Protection, Indian Institute of Pulses Research, Kanpur 208 024
10. Dr. D.B. Kuchchadia, Director of Research, Junagadh Agricultrual University, Junagadh- 362 001
11. Dr. T. Radhakrishnan, Principal Scientist, DGR, Junagadh- 362 001

Member Secretary

Administrative Officer (ex officio), DGR, Junagadh

The 9th IMC meeting was held on 20th February 2009.

Research Advisory Committee

Chairman

Dr. C. Kempanna, Ex-DDG(CS), 82 II Main, III Cross, Ganga Nagar Layout

Bangalore 560 032

Members

1. Dr. S.N. Nigam, Principal Scientist (Groundnut), ICRISAT, Patancheru P.O., Hyderabad 502 324
2. Dr. M. Rangaswamy, Formar Director, School of Genetics (TNAU), "Vanvas", 9 Professors Colony, Velandipalayam, Coimbatore 641 025
3. Dr. M.P. Sahu, Director of Research (Agri), Rajasthan Agril. University, Bikaner 334 006
4. Dr. Ashok Mishra, Ex-Principal, College of Agriculture, JAU; Biotech Lab, Jain Irrigation Systems, Agri park, Jain Hills, P.O. Box-72, Shirsoli Road, Jalgaon 425 001
5. Director, DGR, Junagadh-362 001
6. Dr. V.D. Patil, Assistant Director General (O & P), Indian Council of Agricultural Research (ICAR), Krishi Bhavan, New Delhi 110 114
7. Shri Madhubhai K. Mankad, Progressive Farmer, Krishi Vigyan Kendra, Gundala Road, At. Sadau, Tal. Mundra (Kutch) 370 421
8. Shri Haridasbhai Bikhabhai Zala, Progressive Farmer, Post at: Vadhavi, Dist. Junagadh

Member Secretary

Dr. P.C. Nautiyal, Principal Scientist, DGR, Junagadh-362 001

Institute Research Council

Chairman: Dr. J.B. Misra, Director,

Members: All scientists of DGR

Member Secretary: Dr. Rinku Dey, Senior Scientist

The *kharif* IRC Meeting for the year 2008 (51st IRC meeting) was held from 12 to 13 June, 2008 and the summer IRC Meeting for 2009 (52nd IRC meeting) was held from 19 to 20 January, 2009.

Quinquennial Review Team (QRT)

Chairman

Prof. J. H. Kulkarni, Vice Chancellor, University of Agricultural Sciences, Dharwad - 580 005

Members

1. Dr. Subbrathnam, Ex-Professor of Entomology, Agri Biotech Foundation, A.P. Netherlands Biotechnology Programme, ATIC Building, ARI Campus, N G Ranga Agricultural University, Rajendranagar, Hyderabad-500 030
2. Prof. N. Shankaran, Ex-Professor of Agronomy, TNAU, Coimbatore, 52/101, Gopal Layout, Ponnayarajapuram, Coimbatore-641 001

3. Dr. Ashok Mishra, Ex-Principal, College of Agriculture, JAU, Junagadh; Jain Research & Development, Jain Irrigation Systems Ltd, Agripark, Jain Hills, PO Box 72, Shirsoli Road, Jalgaon-425 001
4. Dr. M. Sudarshan Reddy, Dean of Agriculture, N G Ranga Agricultural University, Rajendranagar, Hyderabad-500 030
5. Prof. M. V. C. Gowda, Professor of Genetics and Plant Breeding, UAS, Dharwad-580 005

Member Secretary

Dr. T. Radhakrishnan, Principal Scientist, DGR, Junagadh

The 5th Meeting of QRT was held from 19 to 20 September, 2008.

Institute Joint Staff Council

Chairman- Dr. J.B. Misra, Director, NRCG

Members: Staff side

1. Sh. C.N. Jethawa, Secretary-IJSC
2. Sh. Y.S. Karia, Member-CJSC
3. Mrs.M.N. Vaghasia, Member
4. Sh. D.R. Bhatt, Member
5. Sh. Sugad Singh, Member
6. Sh. B.K. Bariya, Member

Members: Office side

1. Dr. P.C. Nautiyal, Principal Scientist
2. Dr. Rinku Dey, Senior Scientist
3. Dr. Chunilal, Senior Scientist
4. Shri C.P. Singh, Technical Officer T-6
5. Administrative Officer
6. Finance and Accounts Officer

Directorate of Groundnut Research
PO Box No. 5, Ivnagar Road
Junagadh-362 001, Gujarat, India

Phones

Director	:	0285-2673382 (Direct) 2672550 (Telefax) 0285-2675831(Residence)
EPABX	:	0285-2672461 2673041
Administrative Officer	:	0285-2672843
Guest House	:	0285-2673629
FAX	:	0285-2672550
Telegram	:	GNUTSEARCH
Email	:	director@nrcg.res.in
URL	:	http://www.nrcg.res.in