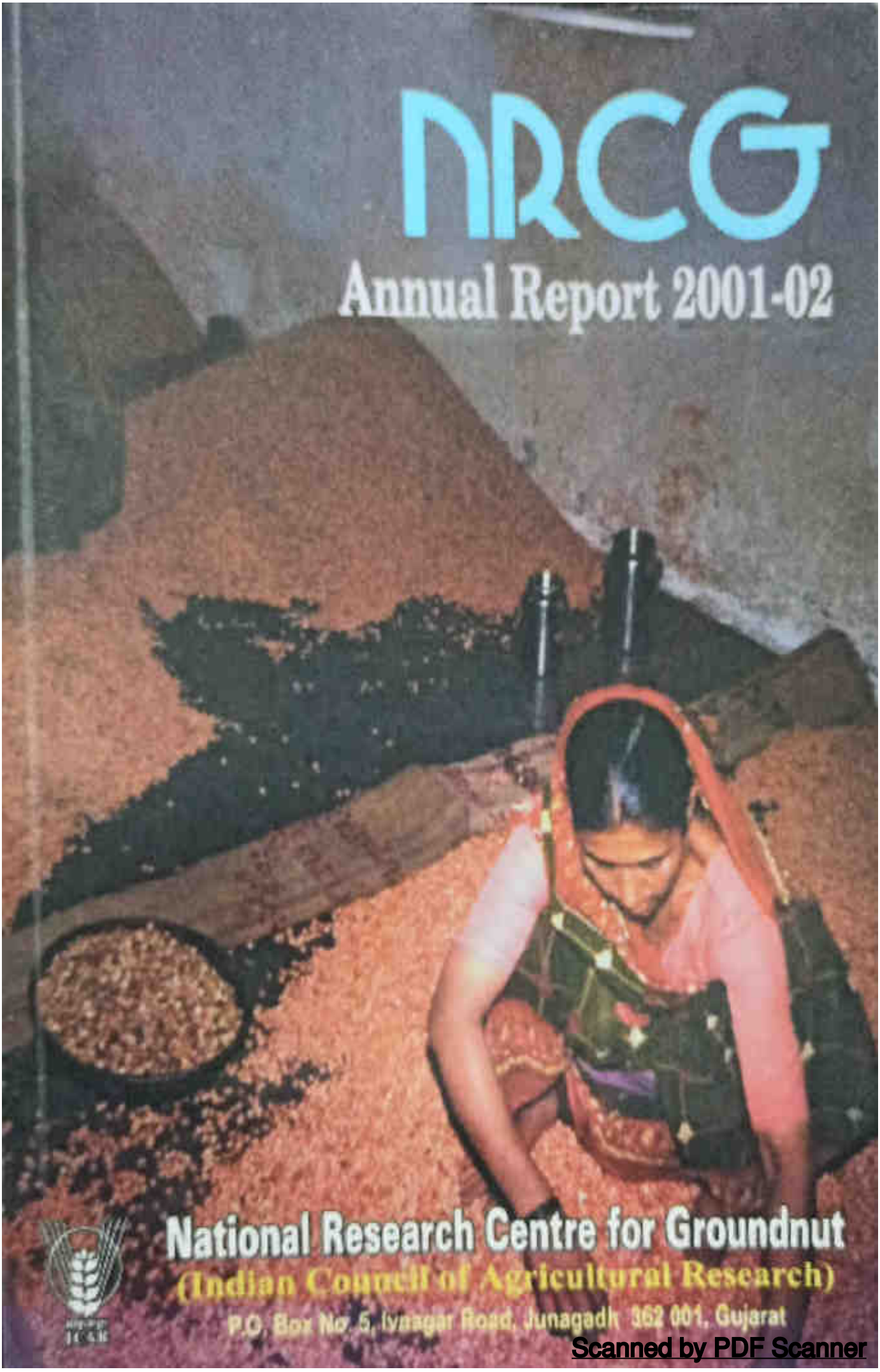

ANNUAL REPORT

2001-02

ICAR

National Research Centre for Groundnut

(Indian Council of Agricultural Research)

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PREFACE

During the year 2001-02, the research at the National Research Centre for Groundnut took a big leap as the institute projects as well as projects funded through external agencies delivered envisaged outputs in the areas of basic, strategic and applied research. Our scientists identified 46 late leafspot resistant cultures from our advanced breeding lines. As a part of our mandate, segregating materials of eight crosses from F3 to F5 generations were sent to 12 AICRP(G) centres for further utilization. We could explain the mechanism of soil-moisture deficit tolerance as a function of epicuticular wax load as well as leaf thickness in addition to already identified parameters. Research on DNA fingerprinting has picked up pace to meet the challenges of the IPR regime. The crop production scientists have identified calcium- and phosphorus-efficient genotypes. The long term nutrient dynamics studies started yielding results to understand and refine the production systems. The IPM technology developed so far is being refined based on the feed back from the end-users. Also, some useful and cost-effective technologies in value addition and biocontrol research have been developed and are being assessed for their marketability.

Human resource development was given a special thrust at all the strata for optimum utilization of the manpower. Extension activities at the centre took a new dimension with the joining of the specialist scientist and programmes were worked out to assess the impact of the technologies transferred by the centre as well as AICRPG system.

We feel that we are moving ahead in a right direction to achieve its mandate. Any valuable suggestions are always welcome for a mid-course correction of our programmes, where required.

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

(M S Basu)
Director

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प्रजनन के सम्बन्ध में विभिन्न उद्देश्यों को प्राप्त करने हेतु 44 नये संकर बनाने के लिए प्रयास किया गया ।

विभिन्न पीढ़ियों की प्रजननिक लाइनों को अग्रिम पीढ़ियों हेतु अग्रसारित किया गया । विभिन्न वांछनीय गुणों के लिए इन लाइनों में से 31 को F_4, 208 को F_5 तथा 34 को F_6 पीढ़ियों में से चयनित किया गया । खरीफ 2001 में कुल 762 अग्रिम पंक्ति के प्रजननिक कल्चरों को बहुगुणित किया गया ।

स्पैनिश किस्मों के उत्पादकता परीक्षण में स्थानीक चेक GG2 तथा गिरनार 1 की तुलना में तीन कल्चर PBS 12018, 13018 व 12092 बेहतर पाये गये । इसी प्रकार वर्जीनियां बन्च किस्मों के उपज परीक्षण में राष्ट्रीय चेक Kadiri 3 की तुलना में तीन कल्चरों PBS 24038, 24030 एवं 24022 को बेहतर पाया गया।

परिवन्य सड़न प्रतिरोधकता के आनुवांशिक अध्ययन में एसपर्जिलस नाइजर के उपनिवेशन के लिए बीजों के 12 में से 7 मामलों ने प्रभाविकता दर्शायी और 3 ने आंशिक प्रभाविकता दर्शायी ।

डायलेल मैटिंग डिजायन (diallel mating design) में लौह की कमी से जनित हरिमहीनता की पैत्रिकता के अध्ययन के लिए संकर बनाये गये । इस अध्ययन में क्लोरोफिल की मात्रा को नियन्त्रित करने वाले जीनों में यौगिक जीन प्रतिक्रिया पायी गयी । क्लोरोफिल के लिए उच्च gca प्रभाव के आधार पर पैत्रिकों में से PBS 21063 की पहिचान एक सामान्य अच्छे कम्बाइनर के रुप में की गयी ।

प्रक्षेत्रीय परिस्थितियों में पछेती पर्णचब्बा (LLS) के लिए अग्रिम प्रजननिक लाइनें छांटी गयी । इन कल्चरों में 46 कल्चर LLS के प्रति प्रतिरोधक व 23 मध्यम प्रतिरोधक पाये गये ।

अगेतीपन तथा (77DAS) के लिए 392 कल्चरों की छंटाई की गयी जिनमे से 7 कल्चरों PBS 23008, PBS 12120, PBS 11048, PBS 14037, PBS 11067, PBS 14027 तथा PBS 14013 के दानों में 90 प्रतिशत से अधिक परिपक्व भार पाया गया ।

नमी की कमी के दबाव के संदर्भ में बाह्यत्वचीय मोम स्तर (EWL) के अध्ययन से प्रदर्शित हुआ कि (1) फसल की उम्र बढ़ने के साथ-साथ सिंचित व पानी ही कमी दोनों की परिस्थितियों में EWL बढ़ता है तथा (2) पानी की कमी के दबाव की दशा में EWL में सार्थक वृद्धि होती है ।

हमारे उद्देश्यों के एक भाग के रुप में F_3 से F_5 पीढ़ियों के 8 संकरों के अलगीकृत पदार्थ (Segregating material) को अग्रिम चयन हेतु AICORPO के 12 केन्द्रों पर भेजा गया ।

अग्रिम पीढ़ी की तीन प्रजननिक लाइनों यथा: PBS Nos. 24001, 29017 तथा 30008 को NBPGR नई दिल्ली में पंजीकृत कराया गया ।

आइ. पी. एम. (IPM) के चार मॉडलों का परीक्षण किया गया जिनमें से एक मॉडल, जिसमें आवश्यकतानुसार टीपोल में 2% नीम का कच्चा तेल + फेरोमोन प्रपंच (ट्रैप) + ट्रैप फसलें (अरहर एवं अरण्डी) समाहित थे,ने नाशीकीटों का प्रभावी ढंग से दमन किया । जब नीम के कच्चे तेल का प्रयोग किया गया उस समय जैसिड की कीट संख्या कृत्रिम कीटनाशियों के उपचार में कीट संख्या के बराबर ही थी । इससे सुझाव मिला कि कृत्रिम कीटनाशियों के बजाय नीम का कच्चा तेल प्रयोग किया जाय जो कि पर्यावरणीय हितैषी है और जैसिड के प्रबन्धन में प्रभावी व उपयुक्त है ।

प्रयोगशाला में मूंगफली के थ्रिप्स (*Caliothrips indicus*) का विस्तृत जैवीय अध्ययन किया गया । वयस्क में 4 इस्टारों का रिकार्ड दर्ज किया गया । वयस्क नर की आयु 10.3 दिन पायी जब कि मादा की आयु 13.8 दिन पायी गयी । अण्डे देने की सीमा 2-59 अण्डे/मादा पायी गयी जब कि औसत 25 अण्डे रहा ।

पौलीविनायल की चादर का उपयोग करके ट्रैप्स विनिर्मित किए गये जो कि व्यवसायिक तौर पर पेस्ट कन्ट्रोल इण्डिया में स्टिक ट्रैप के नाम से उपलब्ध हैं । इनमें से चार छिद्र वाले ट्रैपों से अधिकतम नर (25.6/ ट्रैप/दिन) पकड़े जा सके हैं ।

फलियों के सुखाने की पद्धति ने अंकुरण, भण्डारण क्षमता तथा पौध ओज को प्रभावित किया। हालांकि सुखाने की पद्धति का महत्व खरीफ की अपेक्षा गर्मी में फलियों के सुखाने की विधि पर अधिक निर्भर है ।

खेत में सुखाने का तरीका तथा तापक्रम (नियन्त्रित परिस्थितियों में) बीजों में प्रोटीन बैण्ड पैटर्न को भी प्रभावित करता है । जननद्रव्य की प्रविष्टियों व प्रजातियों के Oil stability index (SI) में भिन्नता पायी गयी है ।

बीजों के विभिन्न परिपक्वता वर्गों के अंकुरित बीजों में पानी सोखने के पैटर्न व पौध ओज में भिन्नता पाई गयी ।

मूंगफली के दानों के पूर्ण विकास व उच्च गुणवत्ता के लिए छोटे दानों वाली मूंगफली की अपेक्षा बड़े दानों वाली प्रजातियों हेतु कैल्शियम की अधिक मात्रा की आवश्यकता पायी गयी । बड़े दानों वाली मूंगफली के लिए बालू संवर्धक में किए गये प्रयोग में कैल्शियम की उत्तम खुराक 100 मि.ग्रा०/लीटर तथा पोटाश की 100 मि.ग्रा०/लीटर पाई गयी ।

मूंगफली के बहुत से जीन प्ररूपों की छंटनी की गयी तथा निम्न जीन प्ररूपों को पोषक तत्व दक्ष पाया गया ।

फास्फोरस दक्ष : NRCG Ac 7085-1, 6919, 1308, GG5 एवं SG 84.
कैल्शियम दक्ष : NRCG Ac 7085-1, 6155 तथा ICGHNG 88448.

कार्बनिक पदार्थों के विभिन्न स्रोतों का मूल्यांकन किया गया और मूंगफली के लिए जैव-उर्वरकों के साथ गोबर की खाद तथा अरण्डी/नीम की खली को अधिक उत्तम पाया गया ।

मूंगफली के वर्जीनिया व स्पैनिश वर्गों के क्रमशः 11 व 20 जीन प्ररूपों के साथ बाजरा, अरहर व अरण्डी की अन्तरशस्यीय कम्पैटिबिलिटी के अध्ययन से संकेत मिला कि बाजरा के साथ अन्तरशस्यन करने से मूंगफली के उत्पादन में 32% की कमी की अपेक्षा अरहर/अरण्डी के साथ अन्तरशस्यन करने पर मूंगफली के उत्पादन में अधिक कमी (43-53%) पायी गयी ।

अन्तरशस्यीय प्रणाली के कारण वर्जीनिया में से GG20, B 95 एवं M 335 तथा स्पैनिश में से J11, VRI3 एवं ICGS 44 जीन प्ररूपों ने फली उत्पादन में कमी को अन्य की अपेक्षा कम दर्शाया ।

नत्रजन की संपूर्ण मात्रा को दो बार में देने की संस्तुति की अपेक्षा मूंगफली+बाजरा के अन्तरशस्यन में बाजरा में संस्तुति नत्रजन की 1/4 मात्रा को जब आधारीय रूप में तथा शेष मात्रा को चार बराबर किस्तों में खड़ी फसल में दिया गया तो मृदा में NO_3 (नत्रजन) की मात्रा में कमी (13.12 मि.ग्रा०/लीटर) आयी और कुल उत्पादकता (LER) में वृद्धि हुई ।

मूंगफली पर आधारित शस्य प्रणाली में पोषक तत्वों की गतिकी (dynamics) पर किए जा रहे दीर्घकालिक अध्ययन, जो कि 1998 से प्रारम्भ हुआ, में पाया गया कि मूंगफली-गेहूँ-मूंग की क्रमबद्ध फसल प्रणाली में मूंगफली का फली उत्पादन अधिकतम हुआ । हालांकि अध्ययन की जा रही अन्य फसल प्रणालियों की अपेक्षा अरहर के साथ मूंगफली की फसल प्रणाली ने उपलब्ध नत्रजन की उच्च मात्रा (60.39 मि.ग्रा०/लीटर) को बरकरार रखा तथा नत्रजन स्थिरीकारक सूक्ष्म जीवों की क्रियाशीलता को मृदा में [50.2 x 10^4 colony forming unit (cfu)/g] बढ़ाया ।

मृदा नमी संरक्षण के स्व-स्थाने (in-situ) अध्ययन में अन्तर पंक्ति जल संचयन [Inter Row Water Harvesting (IRWH)] पद्धति ने अधिकतम जल उपयोग क्षमता-WUE (5.65/kg/ha/mm) के साथ-साथ अधिकतम फली उत्पादन दिया तथा कन्ट्रोल (नमी संरक्षण उपचार के बिना) की अपेक्षा इसमें अधिक BCR (2.53) पाया गया।

मूंगफली+अरहर तथा मूंगफली+अरण्डी की अन्तरशस्यीय प्रणाली में "उपज-पानी" के सम्बन्ध पर अध्ययन से संकेत मिला है कि दोनों ही प्रणालियों में प्रक्षेत्र क्षमता के 70% पर नमी की कमी का स्थानापन्न करने पर जल उपयोग क्षमता (WUE) का उच्च परिणाम प्राप्त किया जा सकेगा तथा पानी की उपलब्ध उतनी ही मात्रा से 0.40 है० अतिरिक्त क्षेत्र को सिंचित किया जा सकेगा ।

पर्ण झिल्ली की तापीय टिकाऊपन की क्षमता को उच्च तापीय सहनशीलता के रुप में मानकीकृत किया गया । किस्म ICGS 76 को उच्च ताप सहनशील पाया गया ।

पत्ती में पानी के उपयुक्त स्तर को बनाये रखने का पत्ती की मोटाई के साथ सम्बन्ध पाया गया ।

चार वर्षों की कुल प्रगति के आधार पर उत्तर-पूर्वी क्षेत्रों हेतु मूंगफली की हॉल में विमोचित प्रजातियों का औसत फली उत्पादन राष्ट्रीय औसत से अधिक रहा । उत्तर-पूर्वी क्षेत्रो के लिए ICGS 76, ICGV 86590 तथा TKG 19 A किस्में सर्वाधिक उपयुक्त पाई गयी, इसलिए इन्हें वहां के लिए संस्तुति किया गया है ।

कम pH की परिस्थितियों के अन्तर्गत मूंगफली के 100 जीनप्ररुपों की छंटनी की गयी और तीन वर्षों के अध्ययन के आधार पर एल्यूमिनियम विषाक्तता तथा अम्लीय मृदा के प्रति सहिष्णु व संवेदनशील जो जीन प्ररुप पाये गये वह इस प्रकार हैं।

सहिष्णु : ICG 813, 1001, 1021, 1048, 1056, 1064, 1355, 3606, 10964, 11183.
संवेदन शील : ICG 2120, 4407, 6727, 6855, 7288, 7600, 7787, 7821, 10580, 11748.

उत्तर-पूर्वी राज्यों में ब्रैडीराइजोबियम और पी. एस. एम. के साथ फॉस्फेटिक उर्वरक एवं चूना की उत्कृष्ट प्रतिक्रिया पाई गयी जिसने इनके उपयोग को आवश्यक बना दिया है । चूना 2 टन/है०+50 कि०ग्रा०/है० फॉस्फोरस+ब्रैडीराइजोबियम एवं चूना+फॉस्फोरस+पी. एस. एम. के प्रयोग से कन्ट्रोल की अपेक्षा क्रमशः 40-51% तथा 49-50% तक फली उत्पादन बढ़ सकता है । यद्यपि चूना+फॉस्फोरस (50 कि०ग्रा०/है०)+ब्रैडीराइजोबियम+पी. एस. एम. के प्रयोग ने कन्ट्रोल की अपेक्षा सर्वाधिक 67% फली उत्पादन दिया ।

मूंगफली में चूना तथा गोबर की खाद परोक्ष एवं अपरोक्ष रुप से एल्यूमिनियम की विषाक्तता को कम करते हैं तथा उपज बढ़ाते हैं ।

लगातार दो वर्षों तक मूंगफली के 31 जीन प्ररुपों की उनकी एल्यूमिनियम विषाक्तता की सहिष्णुता के लिए बालू संवर्धक में छंटनी की गयी और NRCG 7599, 1038, 3489 तथा 6919 जीन प्ररुपों को सहिष्णु और GG4, GG5 तथा GG20 को संवेदनशील पाया गया ।

मूंगफली की सात सौ सत्तर (770) नई प्रविष्टियों को विभिन्न स्त्रोतों से प्राप्त किया गया ।

जूनागढ़ से 663 तथा ओ. आर. एस. भुवनेश्वर से 339 प्रविष्टियों को विभिन्न मांगकर्ताओं के पास भेजा गया ।

विभिन्न स्त्रोतों से प्राप्त की गयीं प्रविष्टियों में से 1799 प्रविष्टियों का उनके विशिष्ट गुणों की पहिचान हेतु आकारकीय गुणों के लिए लक्षण निश्चयन किया गया । सूचनाओं को आंकड़ों के आधार पर प्रलेखित किया गया ।
कुल 7508 जननद्रव्य प्रविष्टियों का कार्यसाधक व आधारीय एकत्रीकरण के रुप में रख रखाव किया जा रहा है ।

मूंगफली की आठ प्रजातियों में नमी की मात्रा तथा धूप में सुखाने की अवधि में नमी की गिरावट जानने के लिए एक अध्ययन किया गया। खुदाई के तुरन्त बाद फलियों में नमी की मात्रा 30.6% से 38.2% पाई गयी । विभिन्न प्रजातियों की फलियों, दानों, एवं छिलके में तथा सुखाने की अवधि में नमी के ह्रास में सार्थक भिन्नता पायी गयी ।

मूंगफली की विभोचित 21 अन्य प्रजातियों के एक समूह का तना, पत्ती, पुष्प, फल तथा बीजों के गुणों के लिए लक्षण निश्चयन किया गया और पाया गया कि अधिकतर गुणों ने ओवरलैपिंग भिन्नता दर्शायी ।

एरेचिस की जंगली प्रजातियों को पात्र में संरक्षण करने के एक अध्ययन से संकेत मिला है कि स्वस्थ प्ररोहों के उपसंवर्धन अन्तराल को बढ़ाने के लिए कल्चर मीडिया के साथ 2% मैनीटोल को पूरक के रुप में उपयोग करने पर एक जैसी धीमी वृद्धि होती है ।

नर बन्ध्य उत्परिवर्तियों x उर्वर नर जननद्रव्यों के संकरों के F2 पीढ़ी के अध्ययन से संकेत मिला है कि नर बंध्यता, पूर्णतः जीनों की प्रणाली द्वारा नियंत्रित होती है जो कि पृथक्कीकरण पैटर्न पर निर्भर करता है जिसमें एक से चार जीन दिखते है और यह उपयोग किए गये नर वितृ पर निर्भर करता है ।

F_1 बीजों का ई. एम. एस. (EMS) उपचार F_1 M_1 पीढ़ी में पर्याप्त भिन्नता पैदा कर सकता है ।

एरेचिस की जंगली किस्मों की 51 प्रविष्टियों का पुष्प आकारकीय तथा 29 प्रविष्टियों का फलियों के गुणों के लिए लक्षण निश्चयन किया गया ।

तेरह फलियों वाली जंगली एरेचिस प्रजाति की 28 प्रविष्टियों का फलियों के गुणों जैसे कि फली की चोंच, फली की जालीय रचना (रेटीकुलेशन), फली की लम्बाई आदि के लिए लक्षण निश्चयन किया गया ।

तीन अन्तर्जातीय संकरों के क्रोमोसोमों का व्यक्तिगत विश्लेषण किया गया ।

इस विशिष्ट क्रास में क्रोमोसोमों के एनाफेज पृथकीकरण से संकेत मिला है कि ब्रिज की उपस्थिति के कारण संकरो में विपरीत heterozygosity का संभावित योगदान है।

उपयुक्त प्राइमर संयोजकों की पहिचान के क्रम में, जो कि पॉलीमारफिज्म की खोज कर सकते हों, चार प्रवृत्ति वर्गों में से प्रत्येक में से 3 किस्मों का चयन करके उनका परीक्षण किया गया जिसके लिए 64 प्राइमर संयोजकों का उपयोग किया गया ।

चौसठ प्राइमर जोड़ों, जिनका परीक्षण किया गया, ने बैंडिंग पैटर्न में भिन्नता दर्शायी जिनमें शून्य से लेकर 76 बैण्ड पाये गये ।

प्राइमर जोड़ो ने 10% से अधिक पॉलीमारफिज्म दर्शाया । ऊपर से पांच जोड़े जो कि घटते हुए क्रम में इस प्रकार हैं : Eco RI-AAC + Mse I - CAG (P3), EcoRI - ACG + Mse I - CAC (P50), Eco RI - AGC + Mse I - CAT (P52) तथा Eco RI - AGG + Mse I - CTG (P63) ।

चारों किस्मों में P52 प्राइमर जोड़े ने औसतन अधिकतम पोलीमारोफज्म दर्शाया ।

हालांकि प्राइमर जोड़ो के पॉलीमारफिज्म में सार्थक भिन्नता नहीं पायी गयी ।

मूंगफली में, फिंगर प्रिंट बनाने में यह निष्कर्ष निकाला गया कि न्यूनतम 10 पौधों को सामिल करना होगा ।

खरीफ 2000 में उगाये जननद्रव्यों में पाया गया कि तेल व प्रोटीन की मात्रा के बीच उच्च, सार्थक व विपरीत ($r=-0.37$) सम्बन्ध है ।

सांक्सलेट विधि के विकल्प हेतु अरैचिलाइपोमीटर (Arachilipometer) के मॉडल में सुधार से पाया गया कि इसमें वह सभी क्षमतायें है जो कि साधारण, किफायती व त्वरित हैं ।

मूंगफली के बड़े दानों एवं कन्फेक्सनरी गुणों के लिए कई संकर बनाये गये और उनका प्रजननिक अध्ययन किया गया ।

मूंगफली में नर गैमिटोफाइट के माध्यम से रुपान्तरण की क्षमता के अध्ययन के लिए प्रयोग किये गये और पाया गया कि कणों के बम्बार्डमेंट के द्वारा 30% परागकणों ने गस जीनों की उपस्थिति दर्शायी ।

मूंगफली के आठ जननद्रव्यों के छिलकों का औसत संगठन के लिए विश्लेषण किया गया ।

सैक्रोमाइसेस सेरेविसी तथा साइट्रिक अम्ल के द्वारा एसपर्जिलस नाइजर का उपयोग करके मूंगफली के छिलकों पर सूक्ष्मजीवीय प्रक्रिया से एल्कोहल प्राप्त करने में आरम्भिक प्रयोग सफल रहे ।

SUMMARY

- Forty-four fresh crosses were attempted to meet different breeding objectives.
- Breeding materials in different filial generations were advanced further. From this material, thirty-one selections were made in F_4, 208 in F_5 and 34 in F_6 generations for different desirable traits. A total of 762 advanced breeding cultures were multiplied during kharif 2001.
- Three cultures, PBS 12018, 13018, 12092 were found to be superior over local checks GG2 and Girnar 1 in yield evaluation trials of Spanish bunch cultivars. Similarly three cultures, PBS 24038, 24030 and 24022 were superior over the national check Kadiri 3 in Virginia bunch yield evaluation trials.
- In a study on inheritance of collar rot resistance, out of 12 crosses 7 crosses showed dominance and three crosses showed partial dominance for seed colonization of *Aspergillus niger*.
- To study the genetics of iron deficiency chlorosis crosses were made in a diallel mating design. In this study additive gene action was found to govern chlorophyll content. The parent PBS 21063 was identified as good general combiner based on its higher gca effects for chlorophyll.
- Advanced breeding cultures were screened for Late Leaf Spot (LLS) under field condition. Of these cultures 46 culture were found to be resistant and 23 moderately resistant to LLS.
- Out of 392 advanced cultures screened for earliness (77DAS), 7 cultures, which showed more than 90 per cent mature kernel weight, were PBS 28008, PBS 12120, PBS 11048, PBS 14037, PBS 11067, PBS 14027 and PBS 14013.
- The study of epicuticular wax level (EWL) in relation to moisture deficit stress demonstrated that i) with increase in the age of crop EWL increases under both irrigated and water deficit conditions and ii) under condition of water deficit-stress EWL increases significantly.
- As a part of our mandate, segregating materials of eight crosses from F_3 to F_5 generations were sent to 12 AICRP(G) centres for further selections.
- Three advanced breeding cultures viz., PBS Nos. 24004, 29017 and 30008 were registered with NBPGR, New Delhi.
- Four IPM modules were tried, among them, the modules which comprised 2% Crude Neem Oil in Teepol (need based) + Pheromone traps + Trap crops (red gram and castor) have suppressed the pests effectively. The jassid population when crude neem oil was used was on par with synthetic pesticides treatment, suggesting that instead of synthetic pesticide, crude neem oil, which was eco-friendly and effective may be suitable for the management of jassids
- A detailed biology of groundnut thrips (*Caliothrips indicus*) was studied under laboratory. There were four instars we could record with an adult. The total longevity of adult male

was 10.3 days compared to 13.8 days for female. The fecundity ranged from 2-59 eggs per female with an average of 25 eggs

- Traps were fabricated using polyvinyl sheet and the commercially available sticka trap from Pest Control India. Among them four holes could trap the maximum number of males (25.6/trap/day).
- Pod drying methods influenced germinability, storability and seedling vigour; however, effects of drying methods were more marked in seed processed during summer season than in *kharif*.
- Drying methods (in the field) and temperatures (under controlled conditions) also influenced seed protein band patterns.
- Oil stability index (SI) varied in germplasm accessions, and cultivars.
- Water up take pattern and seedling vigour, varied in germinating seed of various maturity groups.
- Large seeded groundnut cultivars had higher requirement of Ca than the small seeded one for full development of seed of the best quality. In sand culture experiment the best dose was100 mg/L K and 200 mg/L Ca for large-seeded groundnut.
- Several groundnut genotypes were screened and the nutrient efficient genotypes were:
  - P-efficient : NRCG Ac 7085-1, 6919, 1308, 3498 GG 5, and SG 84
  - Ca-efficient : NRCG Ac. 7085-1, 6155, and ICGHNG 88448.
- Various organic sources were evaluated and FYM, caster/neem cakes, together with biofertilizers were most promising for groundnut.
- Studies on compatibility of groundnut genotypes (Virginia 11, Spanish 20) with intercrops (pearl millet, pigeon pea and castor) indicated that reduction in pod yield was more with pigeon pea /castor (43-53%) than with pearl millet (32%). Genotypes, GG20, B 95 and M 335 among Virginia and J 11, VRI 3 and ICGS 44 among Spanish showed less reduction in pod yield due to intercropping system
- Application of one fourth of recommended nitrogen dose of pearl millet as basal and remaining in 4 equal splits as top dressing reduced NO_3 N (13.12 mg/L) in the soil and increased total productivity (LER 1.43) of groundnut + pearl millet intercropping system as compared to the recommended practice of applying full nitrogen in two splits.
- In a long term study initiated during 1998 on nutrient dynamics in groundnut based cropping systems, pod yield of groundnut was the maximum under sequential cropping of groundnut-wheat-green gram. However, intercropping of groundnut with pigeon pea maintained higher available nitrogen (60.39 mg/L) along with enhanced activity of N fixer microbes (50.2 x 10^4 colony forming unit (cfu)/g of soil) than rest of the cropping systems studied.
- In a study on *in-situ* soil moisture conservation, Inter Row Water Harvesting (IRWH) gave the maximum pod yield (1797 kg/ha) along with highest water use efficiency (WUE) of

- A study was undertaken to know the moisture content and rate of depletion over a period of time under sun drying in eight cultivars of groundnut. The moisture content ranged from 30.6% to 38.2% in pods immediately after the harvest. Significant variation among cultivars in the initial moisture content in pods, kernels and shells and the rate at which moisture is lost during drying was observed.
- A further set of twenty-one released groundnut cultivars was characterized for stem, leaf, flower, fruit and seed traits showed overlapping variation for most of the traits.
- The studies on *in vitro* conservation of wild *Arachis* species indicated culture media supplemented with 2% mannitol could show uniform retarded growth with healthy shoots for enhancing the sub culturing intervals.
- The study on the F_2 generation of cross between Male sterile mutants x male fertile genotypes indicated that male sterility was governed by a complete system of genes depending on the segregation pattern showing one gene to four genes depending on the male parents used.
- EMS treatment of F_2 seed could induce substantial variation in the F_1M_1 generation
- Fifty three accessions of wild *Arachis* species were characterized for floral morphology and 29 accessions for pod traits.
- Twenty-eight accessions of 13 pod bearing wild *Arachis* species were characterized for pod traits viz., pod beak, pod reticulation pod length, pod width, seed length and seed width.
- The chromosomal analysis of the three inter specific hybrids were carried out individually.
- The anaphase segregation of chromosomes in this particular cross-indicated the probable involvement of inversion heterozygosity in the hybrid by showing the presence of bridges.
- In order to identify suitable primer combinations which can detect the polymorphism, three cultivars each belonging to the four habit groups were selected and tested for the polymorphism using the 64 primer combinations
- The sixty-four primer pairs tested showed different banding patterns which ranged from no bands to 76 scorable bands.
- The primer pairs showing more than 10% of polymorphism, ranked in the decreasing order and the five primer pairs from the top were Eco RI-AAC+Mse I-CAG (P3), Eco RI-ACG+Mse I-CAC (P50), Eco RI-AGC+Mse I-CAG (P51), Eco RI-AGC+Mse I-CAT (P52), and Eco RI-AGG+Mse I-CTG (P63).
- Primer pair P52 showed maximum mean polymorphism across the four cultivars.
- It was concluded that a minimum of 10 plants may have to be bulked for making fingerprints in groundnut.
- A highly significant inverse relationship ($r = -0.37^{**}$) was observed between oil and protein contents of genotypes grown in Kharif-2000.

5.65 kg/ha/mm and secured higher BCR (2.53) than the control (without moisture conservation treatment)

- Studies on yield-water relationship in groundnut+pigeon pea and groundnut+castor intercropping systems indicated that irrigation at 70% water deficit replenishment of field capacity in groundnut+pigeon pea or groundnut+castor would result in higher WUE and also would bring additional land area of 0.40 ha with same amount of water available for irrigation.
- Leaf membrane thermostability as a measure of high temperature tolerance was standardized. The cultivar ICGS 76 was found to be tolerant to high temperature.
- Leaf thickness was found to be associated with the maintenance of favourable leaf-water status.
- The mean pod yield of recently released groundnut cultivars, in NEH region, was more than the national average and based on the overall performance for four years ICGS 76, ICGV 86590 and TKG 19A were found to be most suitable for NEH Region.
- One hundred groundnut genotypes were screened under low pH condition and based on the studies conducted for three years the Al toxicity and acid soils tolerant and sensitive genotypes were as follows:
    - Tolerant : ICG 813, 1001, 1021, 1048, 1056, 1064, 1355, 3606, 10964, 11183.
    - Sensitive : ICG 2120, 4407, 6727, 6855, 7288, 7600, 7787, 7821, 10580, 11748.
- An excellent response of *Bradyrhizobium* and PSM was found with phosphatic fertilizer and lime in NEH region making their application essential. Application of lime (2t/ha) +50 kg/ha P + *Bradyrhizobium* and lime+P+PSM could increase 40-51% and 49-50 % pod yield over control, respectively. However, application of lime + P(50 kg/ha) + *Bradyrhizobium* + PSM showed maximum pod yield of 67% more over control.
- Lime and FYM reduced the direct and indirect effects of Al-toxicity in groundnut and increased the yield.
- Thirty one groundnut genotypes were screened under sand culture for their tolerance of Al-toxicity for consecutive two years and the genotypes NRCG 7599 and 1038, 3498 and, 6919 were found tolerant and GG 4 and GG 5 and GG 20 sensitive
- Seven hundred and seventy new accessions have been assembled from different sources.
- Six hundred and sixty three accessions were supplied to indenters from Junagadh and 339 from ORS, Bhubaneshwar
- One thousand seven hundred ninety nine accessions, procured from different sources were characterized for aro-morphological traits to identify special feature accessions in the collection. The information was documented in a database.
- A total of 7508 germplasm accessions are being maintained in the working and base collection

About the Institute

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

With the drafting of the perspective plan 'NRCG Vision-2000', the mandate of the Centre was reoriented to provide basic and strategic research support backstopping to the National Agricultural Research Systems on groundnut. Accordingly, the revised mandate is as follows.

- Conduct basic and strategic research to enhance production, productivity and quality of groundnut.
- Act as the national repository of working collection of groundnut germplasm and information on groundnut research.
- Establish relevant institutional linkages, offer consultancy and training, and
- Provide logistic support and coordination mechanism for generation of location specific technology through the All India Coordinated Research Project on Groundnut.

The research activities of the Centre are carried out by nine scientific sections: Genetic Resources, Plant Breeding, Genetics and Cytogenetics, Agronomy, Biochemistry, Plant Pathology, Entomology, Plant Physiology and Microbiology. Eleven research projects have been formulated to achieve the Centre's mandate during IX plan period and appropriaste strategies have been followed for the successful implementation of these projects. In addition, projects funded by external funding agencies are also being implemented at the Centre. the supporting sections of the Centre are: Library, Farm, Establishment and Audit & Accounts.

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

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

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

- The improved model of arachilipometer was found to have all the potential of providing a simple, economical and rapid alternative for Soxhlet method.
- Several crosses were made for studying genetics and also for breeding confectionery and bold-seeded groundnut.
- In the experiment conducted for studying the potential of male gametophyte mediated transformation of groundnut about 30% pollen grains expressed the gus gene introduced through particle bombardment.
- Proximate composition of groundnut shell of eight genotypes was analyzed.
- Preliminary experiments were successful in obtaining alcohol from the microbial processing of groundnut shell by employing *Saccharomyces cerevisiae* and citric acid by employing *Aspergillus niger*.

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

(P. MANIVEL (UP TO 15 03-2002) M.Y. SAMDUR, CHUNI LAL (FROM 16-03-2002), M.P. GHEWANDE, V. NANDAGOPAL, A.L. SINGH, P.C. NAUTIYAL)

Sub project 1: Breeding and genetic studies on biotic stresses in groundnut
Sub project 2: Breeding and genetic studies on abiotic stresses in groundnut

1 Hybridization

Forty-four crosses made for different purposes (Table 1) and 2371 probable hybrid pods were harvested with a mean success of 25.4% (Table 1).

Table 1. Fresh crosses made for different purposes

	Purpose of crosses	No. of crosses	F_1 pods harvested	Average % of Success
1	L X T for collar rot	20	1088	18.60
2	Reticulation for testing of multiple allele	5	242	33.02
3	Cold tolerance	2	302	41.26
4	Genetics of fresh seed dormancy	4	301	25.38
5	Genetics of A. flavus infection	2	162	30.92
6	Genetics of shelling percentage	2	63	11.75
7	Genetics of seed colour	3	183	30.05
8	Large seeded and cold tolerance	2	30	12.20
	Total	**44**	**2371**	**25.4**

2 Multiplication, generation advancement and selections

2.1.1 Multiplication

A total of 762 genotypes comprising of 148 stable mutants of Girnar 1, 288 advanced breeding cultures, 24 inter-specific derivatives, 10 germplasm, 15 international trial entries of ICRISAT, 192 water use efficiency entries 54 selections recieved from ICRISAT and 31 released cultivars were multiplied. Out of these 632 were selected for future use.

2.1.2 Generation advancement

The crosses made for different traits like high yield, late leaf spot (LLS) and rust resistance, collar rot resistance, multiple disease resistance, insect resistance, resistance/tolerance to Iron-deficiency chlorosis, cold tolerance, fresh seed dormancy, and inheritance studies were advanced to next generation. The details are given in the table 2.

Whether conditions at Junagadh during the year 2001

Month	TMax	T Min	Rh(M)	RH(E)	RH (avg)	WS	BSS	EVp	RF
April	39.6	23.1	65.2	16.0	40.6	7.3	10.3	10.8	0.0
may	37.8	26.3	77.2	40.8	59.0	11.7	9.3	10.0	1.0
june	33.8	26.1	85	62	73.2	11.2	5.0	6.3	9.2
july	29.1	24.9	95.3	86.4	90.9	7.9	0.8	2.4	7.6
Aug	29.59	24.49	92.32	79.42	85.9	5.24	2.65	2.65	6.46
Sept	33.09	24.24	87.03	60.03	73.5	4.93	6.29	4.54	3.56
Oct	36.12	27.93	78.71	41.29	60.0	3.93	8.12	5.31	0.53
Nov	35.61	24.34	54.37	19.90	37.1	2.66	9.35	5.25	0.00
Dec	32.7	13.76	60.6	21	40.8	3.1	9.26	8.36	0
Jan	31.5	14.2	47.3	19.2	33.3	5.3	9.6	6.2	0.0
Feb	33.4	16.3	60.4	23.1	41.8	6.1	9.4	6.4	0.0
March	35.7	18.3	47.3	11.3	29.3	6.3	10.0	9.1	0.0

Table 2. Status of segregating material as on kharif 2001

Generations	Number of crosses
F_2	75
F_3	21
F_4	53
F_5	49
F_6	11

2.1.3 Selections

Thirty-one selections in F_4, 208 in F_5 and 34 in F_6 generations were made for different desirable traits.

3 Evaluation

3.1 In-station trials

In two yield evaluation trials, one with Spanish and another with Virginia advanced breeding cultures were grown in 5 rows plot of 5 m length in RBD with three replications. The salient results are presented in table 3 and 4.

In Spanish trial, 15 cultures were evaluated along with four checks viz., JL 24 (national check), GG 2 and Girnar 1 (local check). Three cultures, PBS 12018, 13018, 12092 were superior over local check GG2 and Girnar 1 (Table 3). In Virginia trial, 13 cultures were evaluated along with check varieties, GG 20 (local check) and Kadiri 3 (national check). Three cultures, PBS 24038, 24030 and 24022 were superior over the national check Kadiri 3.

Table 3. Yield potential of advanced breeding cultures

Name of culture	Pod Yield kg/ha	Increse over check (%)		SP	HKW
Spanish		**GG2**	**Gir 1**		
PBS 12018	3568	23	21	70	53
PBS 13018	3134	8	6	73	47
PBS 12092	3041	5	3	75	34
Virginia		**K3**	**GG20**		
PBS 24038	3869	15	9	75	39
PBS 24030	3576	6	-	73	48
PBS 24022	3519	4	-	76	49

3.1.1 Evaluation of F_1 seeds for collar rot resistance

Four high yielding cultivars, GG 20 (moderate resistance), GAUG 10, R33-1 and JL 24 (susceptible) as female parents and three donar parents J 11 (resistant), ICG 899 and ICGV 87280 (moderate resistance) were used for the study. Twelve crosses were made during kharif 1999 and 2000. The hybrid pods were harvested and tested for dry seed resistance to *A. niger* under artificial inoculation condition. The percent seed colonization of GG 20, GAUG 10, R33 1, JL 24, J 11, ICG 899 and ICGV 87280 were 25.0, 44.8, 43.3, 35.7, 10.7, 23.3 and 28.3 respectively. In the cross GG 20 x J 11 the F_1 seeds were found to be resistant to *A. niger* as there was only 9.3 per cent seed colonization, thereby indicating dominant nature of inheritance for this trait. In the crosses GG 20 x ICG 899 and GG 20 x ICGV 87280 involving moderate resistant parents, their hybrids seeds showed moderate level of resistance. When the crosses were made between moderate level of resistance and susceptible parents GAUG 10 x ICG 899, R33-1 x ICG 899, JL 24 x ICG 899, GAUG 10 x ICGV 87280, R 33 1 x ICGV 87280 and JL 24 x ICGV 87280, their hybrid seeds showed moderate level of resistance to seed colonization. This indicated that moderate resistance is dominant over the susceptible. In three crosses GAUG 10 x J 11, R 33 1 x J 11 and JL 24 x J 11 partial dominance was observed as F1 were of intermediate type. Out of 12 crosses 7 crosses showed dominance and three crosses showed partial dominance for seed colonization.

3.1.2 Evaluation of F_1 hybrids for lime induced iron deficiency chlorosis

A total of 12 hybrids derived from full diallel involving 4 parents (PBS 14021, I 2, ICVG 86031 and PBS 21063) were evaluated in a replicated trial. Chlorophyll content was was measured on 50 days after sowing. GCA variance were highly significant for chlorophyll content indicating the importance of both additive gene action. The parents PBS 21063 was identified as good general combiners based on its higher gca effects (Table 6). Data on F_2 plant was also recorded for visual chlorotic rating.

Table 4. General and specific combining ability effects of diallel cross for lime induced iron deficiency chlorosis

Characters	Female\Male	I 2	PBS 14021	ICGV 86031	PBS 21063
Chlorophyll a	I2	-0.81	0.50	-0.14	0.01
Chlorophyll b		-0.34	0.06	-0.01	0.00
Total		-1.12	0.56	-0.15	0.03
Chlorophyll a	PBS 14021	0.55	0.12	-0.46	0.46
Chlorophyll b		-0.02	-0.03	-0.09	0.18
Total		0.52	0.10	-0.52	0.60
Chlorophyll a	ICGV 86031	-0.27	-0.74	-0.13	-0.07
Chlorophyll b		-0.08	-0.28	-0.01	-0.07
Total		-0.35	-1.02	-0.14	-0.21
Chlorophyll a	PBS 21063	0.97	0.21	0.27	0.83**
Chlorophyll b		0.34	-0.02	0.13	0.37**
Total		1.31	0.10	0.28	1.17**

** Significant at 1 per cent level

11049, PBS 12067, and PBS 12115) three cultivars (J 11, GG 2, and GAUG 1) and one germplasm accession NCAc 17090. Three leaflets each from 3rd to 5th (top to bottom) leaf were collected from 10 different plants of a genotype from each treatment and used immediately for determination epicuticular wax load (EWL).

The differences due to genotype and treatments as well as their interactions were highly significant and the values ranged from 0.653 to 2.878 mg dm^{-2}. On an average, the highest EWL was found in the genotype PBS 11049 (2.24 mg dm^{-2}), which while being statistically at par with GG 2 and PBS 11023 was higher than the remaining seven genotypes. The EWL of genotype PBS 11049, which ranked the highest in T-2 and T-4 was statistically at par with the genotypes that had highest EWL in T-1, T-3, T-5, T-6 and T-7. The highest average value of 2.878 mg dm^{-2} EWL was found in genotype GG 2 in T-7 while the lowest of 0.653 in PBS 20055 in T-1. Among the treatments received regular irrigation, the mean wax content 0.801, 0.1868, 2.33 and 2.243 mg dm^{-2}. Among the treatments T-1, T-2, T-3 and T-4, which all received normal irrigation and differed only in age of the crop at the time of sampling, the mean EWL was lowest in T-1 followed by T-2, T-4 and T-3 thereby indicating that the EWL increased with the increase in age of the crop under irrigated conditions. On any given day of sampling, a greater increase in EWL was observed in the treatments that were subjected to moisture deficit stress than those which were not. The differences were, however, significant only for 80 and 85-day old crop.

7 ACIAR-ICAR-ICRISAT collaborative experiment on "Development of water use efficient lines in groundnut"- Multi-location trial

A total of 204 entries (96 from empirical, 96 from trait selections, 8 parents and 4 checks cultivars) were evaluated in alpha design during summer 2001. Observations were made on initial plant population, SPAD reading and leaf area. Yield and related traits of the top ten entries are presented in table 1. There was no much difference for SPAD between the trait selections and empirical selections. Three entries selected at our center were figured in the top ten. The maximum shelling percent of 73.5% was observed in JUG 15 (selection form our centre).

Table 1. Yield performance of the top ten entries

Genotype	Cross	M	Pod weight (Kg/ha)	Kernel weight (Kg/ha)	SPAD	Shelling percent
ICR_20	(TAG 24 x ICGV 86031)	TRT	4049	2896	38.857	71.61
ICR_27	(ICGS 76 x CSMG 84-1)	EMP	4000	2623	38.93	64.86
ICR_10	(ICGS 44 x ICGS 76)	TRT	3851	2768	39.19	71.52
JAL_03	(ICGS 76 x CSMG 84-1)	TRT	3793	2686	41.06	71.37
JUG_15	(ICGS 76 x CSMG 84-1)	TRT	3736	2750	42.34	73.48
JAL_26	(ICGS 76 x CSMG 84-1)	EMP	3709	2311	41.97	62.38
JUG_28	(ICGS 76 x CSMG 84-1)	EMP	3662	2655	42.14	72.51
ICR_11	(ICGS 44 x ICGS 76)	TRT	3556	2452	41.24	68.93
ICR_40	(TAG 24 x ICGV 86031)	EMP	3519	2482	38.05	70.39
JUG_27	(ICGS 76 x CSMG 84-1)	EMP	3511	2436	35.83	69.54
GG 2 (LC)			2258	1645	37.98	67.74

M = Breeding method, EMP = Empirical selections, TRT = Trait selections

Diagonal values are gca effects, Upper diagonal is sca effects and below diagonal are reciprocal effects.

4 Screening

4.1 Screening for late leaf spot resistance

All the advanced breeding cultures were screened for the late leaf spot (LLS) under field condition on 1-9 scale during kharif 2001(Table 5). The maximum score 9 was noted in the mutant line PBS 30041.

Table 5. Advanced breeding lines with resistance and moderate resistance to LLS.

Moderately resistant (score 3-5)	Resistant (score<3)
PBS 11023,24005, 30102,29039, 24030, 11032, 11033, 11037, 11033, 11037, 11038, 11040, 12066, 12116, 12124, 18038, 18037, 21069, 21073, 21082, 22011, 22039, 22040, 29048 and 30139	PBS 11057, 11001, 11003, 11024, 11039, 11049, 11053, 11058, 11068, 11065, 12013, 12029, 12163, 18037, 19004, 21006, 21010, 21017, 21030, 21046, 21063, 21080, 21081, 22005, 22006, 22008, 22038, 23003, 23016, 23026, 23019, 23078, 23029, 23031, 23032, 24038, 24039, 29017, 29020, 29021, 29034, 29035, 29036, 29034, 29047, 29060, 30013, 30138

4.2 Screening of advanced breeding lines for earliness

A total of 392 advanced breeding cultures (Spanish, Virginia and mutants of Girnar 1) were screened for earliness at 77 days after sowing. In the culture PBS 14021 and 11048, pod maturity were 83.33 and 81.77 per cent respectively. The culture PBS 11048, 21062 and 14.037, showed percent mature pod weight 84.24, 74.80 and 71.82 respectively. The seven cultures, which showed more than 90 per cent mature kernel weight, were PBS 28008 (94.39), PBS 12120 (93.39), PBS 11048 (93.71), PBS 14037 (92.94), PBS 11067 (92.29), PBS 14027 (92.29) and PBS 14013 (91.55).

5 Genetics of flower colour, stem colour and testa colour

A female parent PBS 12013 with green stem, white testa colour and red flower was crossed with two male parents (PBS 11003 and 21062) both having pigmentation for three characters. Progeny of F_1 plant was pigmented indicating pigmentation was dominant over non-pigmentation.

6 Epicuticular wax content in relation to moisture deficit stress

The trial was conducted in summer season (February-June, 2001) in split plot design with three replications. With respect to stages of maturity and soil moisture availability the main plot treatments were: T-1, regular irrigation and sampling at 45 DAS; T-2, regular irrigation and sampling at 65 DAS; T-3, regular irrigation and sampling at 80 DAS; T-4, regular irrigation and sampling at 85 DAS; T-5, no irrigation beyond 45 DAS and sampling at 65 DAS; T-6, no irrigation beyond 45 DAS and sampling at 80 DAS; and T-7, no irrigation beyond 45 DAS and resumption of irrigation on 80 and 85 DAS followed by sampling. The genotypes (in subplots) comprised in addition to six advanced breeding lines (PBS 11023, Code 9, PBS 20055, PBS

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

(M.P.GHEWANDE, V.NANDAGOPAL, S.DESAI)

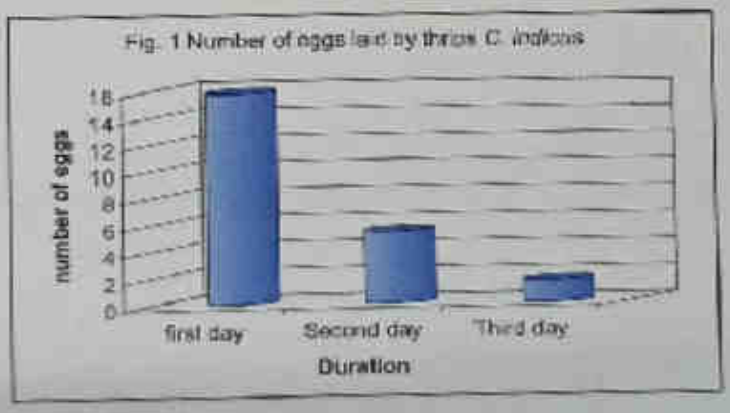
Subproject 1 : Integrated management of thrips and defoliators in groundnut using non-synthetic pesticides, Bio-control agents and cropping system approach

I Integrated Pest Management using non synthetic pesticides

The cv. GG 2 was sown in a 25 m rows of 5m length of 45 cm spacing between rows. Four IPM modules were tried and each were repeated 4 times. Groundnut was sown in three rows followed by either castor or pigeon pea. Among them, the modules which comprised 2% Crude Neem Oil (CNO) in Teepol (need based) + Pheromone traps + Trap crops (red gram and castor) have suppressed the pests effectively when crude neem oil was used, the jassids population was on par with synthetic pesticides treatment (Table 1) suggesting that instead of synthetic pesticide, crude neem oil, which is eco-friendly may be suitable for the management of jassids. This trend is not reflected in the thrips population (Table 2). The damage on leaves due to defoliating insects was higher (19.6%) in the farmers practice compared to 15.5 in the plot, where IPM module was implemented, however statistically they are on a par (Table 3). The reduction in the groundnut pod yield in the plots where IPM module was implemented, was due to the replacement of groundnut with pegionpea and castor; each one row after every three rows of groundnut. The yield was 870 kg/ha of pods in IPM module and 1482 kg/ha in farmers' practice, which is a mono cropping of groundnut (Table 4). The additional yields were from castor (792 kg/ha) and pegionpea (1545 kg/ha). The additional return (net return) due to extra inputs was Rs.27458/ha with ICBR 4.38 (Table 4 and 5).

The use of plant products against the oviposition of storage beetle, *C. serratus* was undertaken. When dry neem leaf powder (DNLP) at 5% was used, the oviposition was only 31 per 50 g of pods while in kernel it was 48 eggs.

A detailed biology of groundnut thrips *(Caliothrips indicus)* was studied under laboratory. There were four instars we could record with an adult. The total longevity of adult male was 10.3 days as compared to 13.8 days of female. The fecundity ranged from 2-59 eggs per female with an average of 25 eggs (Fig.1).



8 Supply of segregating material/advanced breeding lines to national system

Segregating materials of eight crosses from F_3 to F_5 generation were send to 12 AICRPG centres for further selections.

Table 7: Segregating materials send for AICRPG centres.

Sr. No.	Cross	Purpose	Generation	Quantity of pods
1	GG 3x ICGS 44	Seed viability	F_5	3.30kg
2	Girnar 1 x NRCG 7323	Fresh Seed Dormancy	F_5	4.25kg
3	GG2x PBS 190	Fresh Seed Dormancy	F_5	1.85kg
4	GG2x NRCG1339	Cold tolerance	F_5	1.40kg
5	ICGV 86325x Chico	Earlyness	F_5	1.10kg
6	ICGV 86325x Girnar 1	Earliness	F_5	2.10kg
7	GG2 x Kadiri 3		F_3	6.10kg
8	TAG 24x MH2	High reproductive efficiency	F_4	8.76

9 Registration of breeding lines

The following three advanced breeding cultures registered as germplasm at NBPGR, New Delhi.

Name	Special traits
PBS 24004	Resistance to lime induced iron deficiency chlorosis
PBS 29017	Large seeded and high yielding
PBS 30008	Narrow leaf mutant

Table 4. Yield (Kg/ha) and return (Rs/ha) in IPM

Module	Groundnut	Castor	Red gram	Gross return (Rs)
2% CNO in Teepol (need based) + Pheromone traps + Trap crops(red gram and castor)	827 575 (11495)	792 (15833)	1547 (27070)	54398
Control (Farmers' practice)	1482 1037 (20748)	------	------	20748
CD	235.85**			3654.46**

Table 5. Economics of IPM

Module	Basic Production Cost	Additional cost due to treatment	Total Cost of Cultivation	Gross return	Net return	Additional Net Return due to treatment	ICBR
2% CNO in Teepol (need based) + Pheromone traps + Trap crops (red gram and castor)	10200	6245	16445	54398	37953	27405	4.38
Control (Farmers' practice)	10200	----	10200	20748	10548	------	-----

2 Monitoring of the major insects

Under monitoring of major insect pest programme, aphid have started in large number from November and it has gone up 1162 aphids per trap during December. The leaf miner population showed its appearance by October and continued up to December with amaximum of 126 during November. Jassids and thrips were far below except in few weeks when they crossed ETL (Fig 2).

Table 1. Population of Jassid/ 5 sweeps in IPM

Module	First spray (30DAS)		Second spray (50 DAS)		Third spray (70 DAS)	
	Pre-	Post-	Pre-	Post-	Pre-	Post-
2% CNO in Teepol (need based)+ Pheromone traps + Trap crops (red gram and castor)	8.0	7.5	3.7	1.2	3.7	5.5
Control (Farmers' practice)	11.7	1.5	1.2	1.0	3.0	4.0
CD	NS	NS	2.53*	NS	NS	NS

Table 2. Population of Thrips/ 5 sweeps in IPM

Module	First spray (30DAS)		Second spray (50 DAS)		Third spray (70 DAS)	
	Pre-	Post-	Pre-	Post	Pre-	Post-
2% CNO in Teepol (need based)+ Pheromone traps + Trap crops (red gram and castor)	1.7	1.2	2.2	0.7	3.7	14.7
Control (Farmers' practice)	1.0	1.0	1.0	0.2	4.0	7.2
CD	NS	NS	NS	NS	NS	4.28*

Table 3. Per cent damage due to defoliator per leaf in IPM

Module	First spray (30DAS)		Second spray (50 DAS)		Third spray (70 DAS)	
	Pre-	Post-	Pre-	Post	Pre-	Pos
2% CNO in Teepol (need based)+ Pheromone traps + Trap crops (redgram and castor)	3.6	2.7	5.2	2.6	17.8	15.5
Control (Farmers' practice)	3.9	2.8	3.7	2.0	13.0	19.6
CD	NS	NS	2.0*	NS	NS	NS

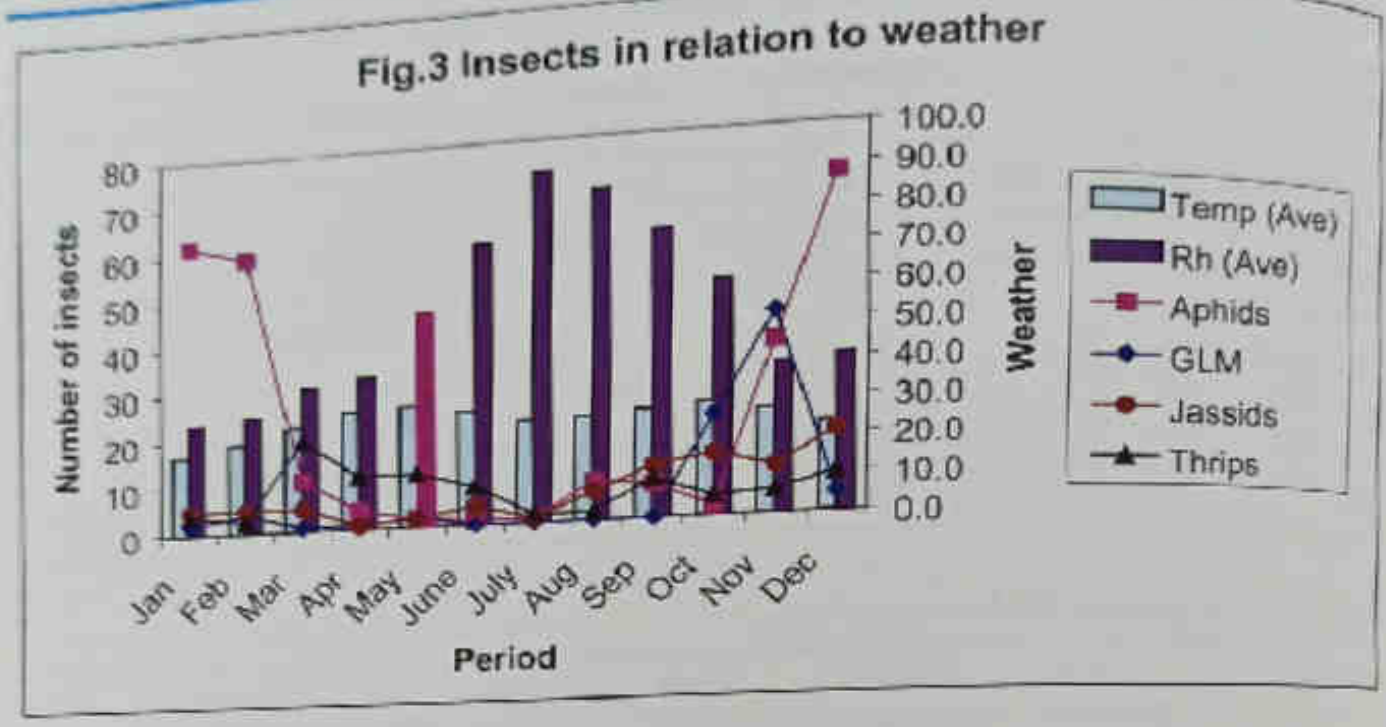


Fig.3 Insects in relation to weather

Sub project: 02 Integrated management of major diseases (ELS, LLS, Rust, Collar rot, stem rot, PBND)

1 Disease resistance

Sixty genotypes including released varieties, advanced breeding lines and germplasm accessions were evaluated against early leaf spot (ELS), late leaf spot (LLS) and Stem rot under field condition during Kharif 2001. Out of 60 genotypes, 11 genotypes viz, HNG (HPS) 2, GG 13, PBS 24030, PBS 20507, GS 19, PBS 11038, UF-70-103, TKG 19A, PBS 21063, Code 30, and B 95 showed resistant reaction to both ELS and LLS disease (3-4 grade on a 1-9 scale). Genotype, PBS 20501 was found to be resistant to LLS.

The incidence of stem rot ranged from 6.38% to 38.16%. Lowest incidence of stem rot (6.38%) was recorded in ALR 2 followed by PBS 29022 (6.46%) TG 48 (7.14%) as against 38.16% in PBS 21063 and 36.67% in Girnar 1.The highest pod yield of 550 g/ 5m row was recorded in Code 4 followed by PBS 12032 (383g/5m row) and PBS 11013 (365 g/5 m row) (Table 1). Also, 36 genotypes including some released varieties, advanced breeding lines and germplasm accessions were evaluated against stem rot under artificially inoculated sick soil condition in concrete blocks. The incidence of stem rot ranged from 7.69% to 95%. The minimum incidence of 7.69% was recorded in code 7 followed by NRCG 12213 (11.11%) and AHPS 2005 (13.89%) as against 95 % in JL 24 and 65% in GG-20 (Table 2). These 36 genotypes were also screened for resistance to Aflaroot, collar rot, ELS and LLS. The incidence of aflaroot and collar rot ranged from zero to 39.68% and zero to 17.39% respectively. Three genotypes viz, J11, NRCG 1086 and ICGV 86325 had no infection of aflaroot disease. Eight genotypes viz, AHPS 2001, Code 4, CODE 7, J 11, NRCG 4468, NRCG 4659, NRCG 12181 and NRCG 201 also had no incidence of collar rot. Six genotypes viz, AHPS 2006, CS 19, Code 7, NRCG 12215, NRCG 12181, NRCG 99 showed resistant reaction against ELS and LLS (3-4 grade). Seventy bold

seeded genotypes along with M 13 and GG 2 as susceptible checks and J 11 as resistant check were evaluated for resistance to *in-vitro* seed colonization by *Aspergillus flavus* and Aflatoxin production. The genotype NRCG 12121 (Nc 10277) recorded lowest seed colonization (16.67%) as against 100% in TG 47 and TG 48 indicating moderate level of resistance to *in-vitro* seed colonization by *A. flavus*. This genotype also supported relatively low Aflatoxin (300µg/kg) production.

Thirty genotypes in one set and twenty genotypes in another set (elite) along with a susceptible genotype (Kadiri 3) were evaluated at seedling stage (10 days old) for resistance to *Sclerotium rolfsii* under artificially inoculated condition. The mean seedling mortality of 20 elite genotypes after 10 days of inoculation ranged from 21.67% to 100%. The seedling mortality varied significantly among genotypes. The minimum seedling mortality of 21.67 was recorded in NRCGs 8201, 6222 and 5101. However, none of the genotypes was found resistant to stem rot pathogen at seedling stage. In the set of 30 elite genotypes, the seedling mortality ranged from 20 to 100%. It varied significantly among genotypes. The minimum seedling mortality of 20% was recorded in NRCG 1123 as against 45% in susceptible check and 100% in NRCG's 155 and 12178. As such none of the genotypes was found resistant to stem rot pathogen (Table 3).

A total of 32 genotypes including some released varieties and advanced breeding lines were evaluated against Peanut bud necrosis disease (PBND) under field during summer, 2002. The incidence of PBND ranged from zero to 11.62%. Six genotypes viz. PPS 7, J 11, ICGV 86325, PBS 24002, PPS 1-1 and TG 17 were found free from PBND infection. The pod yield (5 m. row) ranged from 80g /5m row to 490g /5 m row. The highest pod yield of 490g/ 5m was recorded in PBS 12074 which had 1.06% incidence of PBND followed by R 8808 (445g/5m row) and PBS 20501 (425g/5m row).

Also a total of 30 genotypes were evaluated against stem rot under sick soil condition in concrete blocks during summer 2002. The incidence of stem rot ranged from 15.84 to 87.50%. The minimum incidence of 15.84% was recorded in ALR 2 as against 87.50% in NRCG 12214 and 35.42% in GG 2 and 33.33 in GG 13.

Twenty-nine germplasm lines along with susceptible and resistant checks were screened for *in-vitro* dry seed resistance to *Aspergillus niger*. GG 13 showed resistant reation to *A. niger*. Six genotypes viz; NRCGs 1123, 2458, 2480, 190, 4485 and NRCG 8428 were found to be moderately resistant to collar rot pathogen (Table 4).

2 Disease management

2.1 Crop rotation

Six crop rotations viz. groundnut-wheat-groundnut, groundnut-groundnut-groundnut, groundnut-mustard-groundnut, groundnut-gram-groundnut, groundnut-maize-groundnut and groundnut-fallow-groundnut were tried for the management of major diseases during kharif 2001. The incidence of aflaroot, collar rot and stem rot was low during kharif 2001 and did not differ significantly among crop rotations tried. However, the intensity of LLS varied significantly among crop rotations. The incidence of aflaroot, collar rot and stem rot ranged

Table 1: Evaluation of some groundnut genotypes against stem rot under field condition during Kharif- 2001

Sr. No.	Genotype	Stem rot incidence (%)	Pod yield(g/5 m row)
1	HNG (HPS) 2	18.33	90
2	GG 13	14.25	280
3	PBS 24030	22.18	150
4	PBS 20507	16.54	250
5	PBS 11038	13.04	280
6	PBS 21063	38.16	92
7	UF 70-103	24.19	300
8	CS 19	17.06	140
9	TKG 19A	29.58	190
10	B95	25.08	90
11	Code 30	32.89	190
12	PBS 20501	19.90	285
13	ALR 2	6.38	250
14	PBS 29022	6.46	325
15	TG 48	7.14	50
16	Code 4	16.38	550
17	GG 2	9.82	218

from 1.17 to 2.90 %, 0.84 to 2.05 % and 2.53 to 4.97 % respectively. The minimum incidences of aflaroot (1.17%), collar rot (0.84%) and stem rot (2.53%) were recorded in groundnut-maize-groundnut, groundnut-gram-groundnut and groundnut-groundnut-groundnut rotation respectively.

The minimum intensity of LLS (23.83%) was recorded in groundnut-gram-groundnut rotation as against 31.83% in groundnut-fallow- groundnut. The highest pod yield of 1121kg/ha was recorded in groundnut-wheat-groundnut rotations followed by groundnut-gram-groundnut and groundnut-mustard-groundnut. The highest haulm yield of 2603 kg/ha was also recorded in groundnut-wheat-groundnut rotation.

2.2 Organic Soil Amendment

The plant products (straw, shells, Fresh leaves, cake) of castor, groundnut, karanj, neem, parthenium, wild sorghum and wheat were evaluated each @ 500 kg/ha as soil application in the furrow at the time of sowing for the management of major diseases during kharif 2001. The incidence of aflaroot, collar rot and stem rot did not differ significantly among treatments. However, the intensity of LLS varied significantly among treatments. The minimum incidence of aflaroot (0.81%), collar rot (0.91%) and stem rot (4.70%) was recorded in soil application of fresh leaves of wild sorghum, castor cake, and *Parthenium* fresh leaves each @ 500kg/ha as against 1.34%, 1.06% and 9.24% in control respectively. Soil application of fresh neem leaves @ 500kg/ha gave maximum control (57.69%) of LLS followed by neem seed kernel powder @ 500kg/ha and castor cake. Pod yield levels did not vary significantly among treatments. Soil application of *Parthenium* fresh leaves @ 500kg/ha gave maximum yield of 1375 kg/ha followed by neem seed kernel power.

2.3 Integrated disease management (IDM)

The components viz, seed treatment with *Trichoderma viride* @ 4 g/kg seed, soil application of *T. viride* @ 62.5 kg/ha, soil amendment with castor cake @ 500 kg/ha, groundnut intecropped with pearlmillet (3:1), foliar spray of aqueous extract of mustard cake @ 5% and foliar spray of fungicide mixture (Carbendazim 0.05% + Mancozeb 0.2%) were suitably integrated for the integrated management of diseases like aflaroot, collar rot, stem rot, ELS, LLS and rust during Kharif 2001. The incidence of rust and ELS was negligible. The incidence of aflaroot and stem rot did not vary significantly among treatments. However, the incidence of collar rot and the intensity of LLS varied significantly among treatments. The minimum incidence of aflaroot (0.57%) and minimum intensity of LLS (24.50%) was recorded in the treatment of seed treatment with *T. viride* @ 4 g/kg seed and soil application of castor cake @ 500 kg/ha as against 1.02% and 39% in control treatment respectively. The minimum incidence of collar rot (1.42%) was recorded in the seed treatment of *T. viride* + castor cake + soil application of *T. viride* + groundnut intercropped with pearlmillet. This combination of components was also found to be the next best for the control of LLS. No definite trend was observed for the control of stem rot. The pod and haulm yields varied significantly among the treatments. The highest pod yield of 1693 kg/ha was recorded in the treatment of foliar spray of Carbendazim 0.05% + Mancozeb 0.2% at 40, and 55 DAS followed by seed treatment with *T. viride* + soil application of castor cake in which minimum incidence of aflaroot and LLS was also recorded. The highest haulm yield of 2794 kg/ha was recorded in seed treatment with *T. viride*+ soil application of castor cake and *T. viride*.

Table 2 : Evaluation of some groundnut genotypes against stem rot under seek soil condition in concrete block during Kharif-2001

No.	Genotype	Stem rot Incidence (%)
1	AHPS 2001	73.63
2	AHPS 2002	37.05
3	AHPS 2003	59.83
4	AHPS 2004	63.23
5	AHPS 2005	13.89
6	AHPS 2006	76.34
7	Code 4	82.50
8	CS 19	17.07
9	CS 21	32.21
10	Code 5-3	23.07
11	Code 7	7.69
12	NRCG 8402	77.96
13	NRCG 4508	66.50
14	ICGV 87280	79.37
15	TG 45	61.16
16	Dh 8	72.36
17	TKG 19A	70.79
18	GAUG 10	64.86
19	R 8088	33.04
20	R 33-1	19.22
21	GG 13	57.88
22	J 11	63.64
23	JL 24	95.00
24	GG 20	85.00
	SEM ±	13.30
	C.D. at 5 %	38.81
	C.V. %	34.46

Table 3: Evaluation of some groundnut genotypes for resistance to stem rot pathogen at seedling stage under laboratory condition

Sr. No.	Genotype	Mean seedling mortality (%)
1	NRCG 995	76.66
2	NRCG 6453	51.66
3	NRCG 4508	93.33
4	NRCG 3648	100.00
5	NRCG 12229	55.00
6	NRCG 1637	53.33
7	NRCG 1634	58.33
8	NRCG 1123	20.00
9	NRCG 1086	33.33
10	NRCG 190	48.33
11	NRCG 184	58.33
12	NRCG 084	38.33
13	NRCG 018	64.00
14	NRCG 122197	70.00
15	NRCG 12197	80.00
16	NRCG 12213	66.66
17	NRCG 12214	85.00
18	NRCG 12215	72.11
19	NRCG 099	75.00
20	NRCG 155	100.00
21	NRCG 135	58.33
22	NRCG 201	93.33
23	NRCG 2291	75.00
24	NRCG 12189	66.66
25	NRCG 12187	68.33
26	NRCG 12181	100.00
27	NRCG 12179	86.66
28	NRCG 12178	100.00
29	NRCG 8462	53.33
30	NRCG 7306	48.33
31	Kadiri 3	45.00
	SEM±	16.10
	C.D. at 5 %	45.53
	C.V. (%)	41.70

Table 4 : Evaluation of some groundnut genotypes for resistance to collar rot pathogen (Aspergillus niger) under laboratory condition

Sr. No.	Genotype	% seed infection	% seed colonization
1	NRCG 1123	100	26.67
2	NRCG 4508	100	66.67
3	NRCG 2291	100	56.67
4	NRCG 1637	100	66.67
5	NRCG 2458	100	23.33
6	NRCG 99	100	46.67
7	NRCG 8402	100	83.33
8	NRCG 12178	96.67	90.00
9	NRCG 12214	100	73.33
10	NRCG 6255	100	63.33
11	NRCG 6453	100	93.33
12	NRCG 4532	100	93.33
13	NRCG 12181	100	73.33
14	NRCG 12215	100	76.67
15	NRCG 12195	100	56.67
16	NRCG 2480	83.33	20.00
17	NRCG 12221	100	53.33
18	NRCG 8201	100	56.67
19	NRCG 6213	93.33	56.67
20	NRCG 115	93.33	63.33
21	NRCG 84	100	73.33
22	NRCG 190	100	20.00
23	NRCG 6131	90	70.00
24	NRCG 6310	100	53.33
25	NRCG 184	100	66.67
26	NRCG 12187	86.67	60.00
27	NRCG 4468	100	46.67
28	NRCG 4485	100	23.33
29	NRCG 8428	96.67	23.33
30	J 11	24.07	11.48
31	GG 13	12.90	9.67
32	GG 2	90.0	66.67
	C.D. at 5%	2.94	5.84
	C.V. %	5.89	19.74

PROJECT 03. PHYSIOLOGY AND BIOCHEMISTRY OF SEED VIABILITY AND DORMANCY IN GROUNDNUT

(P.C. NAUTIYAL, J.B. MISRA)

1 Standardization of pod drying methods

Groundnut seed is prone to lose germinability mainly when harvested in the summer season and stored immediately before onset of monsoon until the next rabi or summer sowings. Therefore, the objective of this study was to maintain seed germinability and seedling vigour of groundnut harvested both in summer and *kharif* seasons by suitable drying method. Pods harvested in summer season were dried at 39, 50, 60, and 70°C in controlled conditions (off-plant), and by 10 different drying methods under field conditions (in-plant). Drying temperatures both under controlled and field conditions influenced germinability and seedling vigour markedly. Seed (in-shell) exposed to temperatures 60 and 70°C lost about 25% germination, immediately after drying. Pod dried by windrow and conventional methods lost about 50% germination, after 3 months storage, while pod dried by NRCG method retained >80% germination, even after 9 months storage. In addition, NRCG method helped in maintaining germinability and other seed qualities, when pod experienced rain during curing. It is suggested, that groundnut seed should not be exposed to temperatures >39°C during drying. Effect of drying methods on seed viability and seedling vigour and productivity of groundnut grown in *kharif* season is being studied, however; significant variation due to drying methods on seed germinability could not be noticed, even after 3 months storage.

Seed (in-shell) dried by various methods in the field and at three different temperatures (39, 50, and 60°C) in the laboratory showed significant variation in protein band pattern. Two protein bands of molecular weight between 116 and 170 kDa were found missing in the seed dried at 60°C, which was otherwise conspicuous in the seed dried at 50 and 39°C (ambient) temperatures. Seed dried by different methods such as DOR, NRCG, windrow, and shade also showed variation in protein band pattern (Fig. 1). Results of these studies indicated that drying methods influenced seed germinability and protein patterns. Thus seed remains physiologically active during the post-harvest curing/drying period, and possibility of the role of (late embryogenesis abundant proteins) LEAs in determining seed qualities including viability is still obscure.

2 Seed coat colouration and germinability

Twenty-five groundnut accessions including some cultivars varying in seed coat colouration studied for germination, seedling vigour, seed leachate and lipid profile, during both summer and *kharif* seasons. Wide genotypic variations existed both in total oil content and oelic and linolic (O/L) oil ratio or oil stability index (Table 1). Relationships between seed coat colouration *vs* germinability, and total lipid *vs* storability is being studied. Germinating seed of different maturity groups (mature, medium mature, and immature) and seed coat colouration and texture showed variation in their water up take pattern during germination.

Table 1. Groundnut germplasm accessions and cultivars showing a range of variation in total oil content and oil stability index (O/L ratio), cultivated at NRCG during *kharif* 2001.

Genotype	Oil content (%)	SI
NRCG 12285	43.3	4.1
NRCG 12298	45.3	1.1
NRCG 12905	43.0	1.4
NRCG 12685	49.5	1.1
NRCG 12255	42.8	1.3
BAU 13	46.3	3.5
CSMG 84-1	49.5	1.8
JSP 19	43.8	4.9

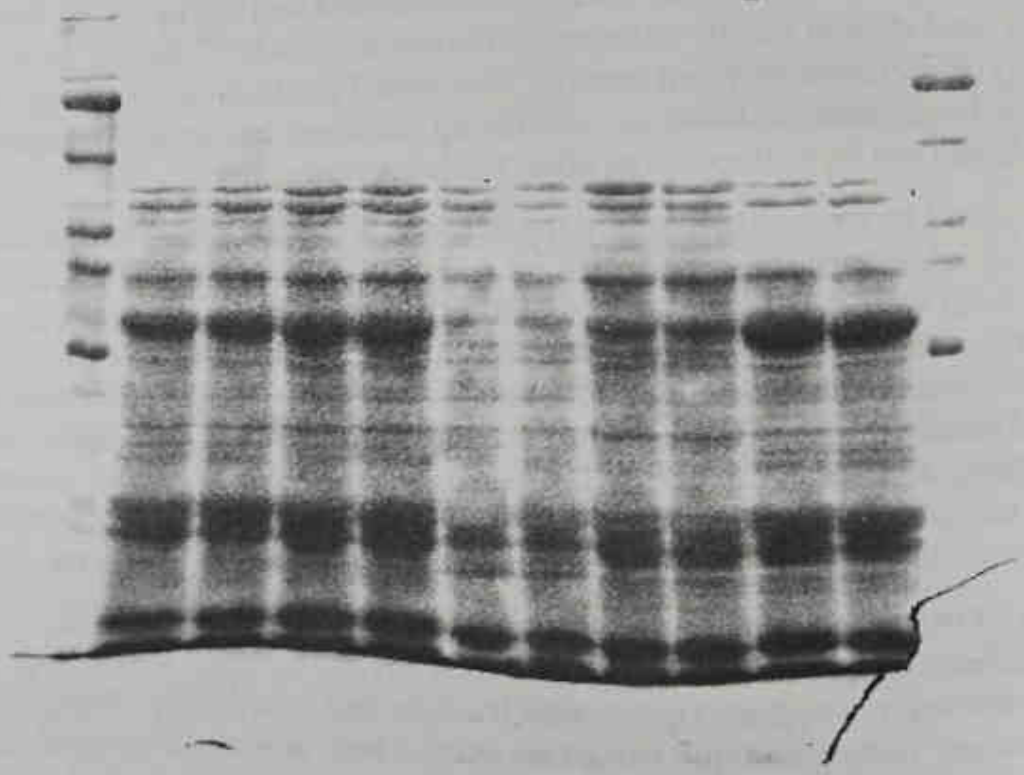


Fig 1. Electrophoretic pattern of seed protines from seeds dried by different drying methods.

PROJECT 04: INTEGRATED NUTRIENT MANAGEMENT IN GROUNDNUT

(K.K. PAL, RINKU DEY, A.L. SINGH, Y.C. JOSHI)

Sub-project 1: Development of biofertilizer packages for groundnut

1 Plant Growth Promoting Rhizobacteria (PGPR)

1.1 AICRP(G) trial

The application of plant growth promoting rhizobacteria as seed inoculant positively influenced the groundnut growth and yield and also enhanced the haulm yield, nodule number, pod number, shelling percentage and hundred kernel weight. Besides, it also improved the nutrient uptake. The increase in pod yield ranged from 17% to 20% because of the inoculation with PGPR (Table 1). Plant growth promoting rhizobacterial isolate, PGPR 4, proved to be the best culture in terms of pod and haulm yield. There was also an increase in the nodule dry weight and root length as a result of inoculation compared to control. PGPR 1 and PGPR 2 also enhanced the HKW significantly. The increase in nitrogen content in shoot ranged from 8%-18% in case of inoculated treatments while the increase in total phosphorus content of shoot ranged from 10% to 17.8% (Table 1).

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

As inoculation of single strain may sometimes fail to exhibit desired effect, consortia of compatible and competent strains of plant growth promoting rhizobacteria may contribute significantly in enhancing the growth parameters by expressing beneficial traits in a complimentary manner. Thus, two consortia viz. consortium A (mixture of four non-fluorescent pseudomonads) and consortium B (mixture of four fluorescent pseudomonads) comprising compatible strains of plant growth promoting rhizobacteria were developed and evaluated for their efficiency in enhancing the growth and yield of groundnut. It was found that seed bacterisation of consortium A significantly enhanced the pod and haulm yield, nodule dry weight, root length and HKW (Table 2). Seed bacterisation also enhanced the P and N content in shoot. Inoculation of consortium B also significantly enhanced the root length, HKW and nodule dry weight (Table 2). Similar results were also obtained with cultivar JL 24.

1.3 Evaluation of rhizosphere competence of PGPR on the basis of spontaneous rifampicin resistance marker

For studying the rhizosphere competence of the PGPR isolates, spontaneous rifampicin resistant mutants of six-plant growth promoting rhizobacteria (PGPR 1, PGPR 2, PGPR 4, PGPR 5, PGPR 7 and PGPR 8) were developed and tested in pots. Population densities of six PGPR mutants were evaluated in pots at different time intervals viz., 30, 45, 60, 75 DAS and at harvest. The population densities showed high variability based on the different colonization capabilities of the isolates. The population of PGPR 1 in the rhizosphere remained more or less constant while the rhizoplane population increased up to 60 DAS and thereafter declined (Fig 1). In case of PGPR 2, the rhizosphere population showed an increase up to 60 DAS thereafter

4.1.1.1.1 Table 2. Effect of PGPR consortia on the growth, yield and nutrient uptake of groundnut, cultivar GG2

Treatments*	PY (kg/ha)	HY (kg/ha)	NDW (mg/p)	RL/p (cm)	HKW	Shoot N (%)	Shoot P (%)
Control	2007	2860	59.85	113.55	38.67	1.620	0.123
Con A	2193	3183	87.40	17.00	43.51	1.773	0.141
Con B	2056	2875	73.30	17.45	41.66	1.653	0.136
CD (0.05)	**138**	**86**	**9.40**	**1.206**	**2.36**	**0.065**	**0.015**

*Con A: comprising four non-fluorescent pseudomonads
Con B: comprising four fluorescent pseudomonads

Table 3. Effect of VAM fungi on the growth, yield and nutrient uptake of groundnut in pots (Kharif, 2001)

Treatments	PY (g/p)	Root biomass (g/p)	Shoot biomass (g/p)	Colonization (%)	Phosphorus content (%)	
					Shoot	Kernel
Kadiri 3 (K3)	4.32	0.96	9.36	17	0.178	0.421
K 3 + G. *mosseae*	5.24	1.32	11.25	74	0.201	0.481
K3 + G. *margarita*	4.55	1.17	10.56	42	0.190	0.453
CD (0.05)	**0.56**	**0.21**	**1.42**	-	**0.016**	**0.036**
Gangapuri (G)	3.83	0.67	10.01	14	0.168	0.405
G + G. *mosseae*	4.79	0.98	12.13	64	0.196	0.466
G + G. *margarita*	3.97	0.76	10.96	40	0.182	0.432
CD (0.05)	**0.67**	**0.26**	**1.56**	-	**0.015**	**0.039**
JL24	4.24	0.89	9.65	16	0.172	0.412
JL24 + G. *mosseae*	4.82	0.86	10.32	38	0.182	0.426
JL24 + G. *margarita*	5.94	1.22	12.05	59	0.203	0.468
CD (0.05)	0.64	**0.21**	**1.35**	-	**0.022**	**0.036**

declined rapidly while the rhizoplane population increased up to 45 DAS and thereafter declined. In case of isolate PGPR4, the rhizosphere population built up till 45 DAS and thereafter slowly declined. However, the rhizoplane population steadily declined after 30 DAS. The population of PGPR 5 in the rhizosphere increased till 45 DAS then decreased at 60 DAS and then again increased rapidly till 75 DAS followed by rapid decline at harvest. The rhizoplane population (Fig 2.) of PGPR 5 increased only till 30 DAS followed by steady decline. The rhizosphere and rhizoplane population of PGPR 7 declined after 30 DAS. In case of PGPR 8, the rhizosphere population continuously declined after 30 DAS while the rhizoplane population increased up to 45 DAS and thereafter declined slowly. Overall assessment indicated that PGPR 7 was the best rhizoplane colonizer (Fig 2.) while PGPR 1 was the best rhizosphere colonizer (Fig 1).

2 Phosphate Solubilizing Microorganisms (PSMs)

Experiment conducted during kharif, 2001 in field indicated that seed treatment with PSM 3 and PSM 5 bacterial isolates resulted in significantly higher pod yield, plant biomass, P content in shoots and in kernels. These two cultures exhibited better performance than *Pseudomonas striata*.

3 Vesicular Arbuscular Mycorrhizae (VAM)

An experiment was conducted during kharif, 2001, with two VAM fungi viz., *Glomus mosseae* and *Gigaspora margarita* on three cultivars viz., Gangapuri (Valencia type), JL 24 (Spanish bunch) and Kadiri 3 (Virginia bunch). Inoculation with *Glomus mosseae* significantly increased VAM root colonization, pod yield, root and shoot biomass and uptake of P compared to control in cultivar Kadiri 3 and Gangapuri (Table 3). However, in cultivar JL 24, inoculation of *Gigaspora margarita* enhanced plant biomass and pod yield. However, maximum root colonisation was observed in cultivar Kadiri 3 with both the VAM fungi.

4 Supply of biofertilizers

Two bradyrhizobial isolates (TAL 1000 and NC 92) were supplied to NEH regions. Phosphate solubilizing bacterium, *Bacillus megaterium*, was supplied to IVLP villages. Four PGPR cultures were also supplied to Aliyarnagar, Dharwad, GAU(Junagadh), Chintamani, Jalgaon, Kadiri, Vriddhachalam for AICRP(G) trials.

Table 1. Effect of plant growth promoting rhizobacteria on the growth and yield of groundnut, cultivar JL24 (kharif, 01)

Treatments	PY (kg/ha)	HY (kg/ha)	NDW (mg/p)	RL/p (cm)	HKW (g)	Shoot N (%)	Shoot P (%)
Control	1367	3337	74.05	11.80	36.77	1.263	0.219
PGPR1	1608	3512	98.90	15.47	37.96	1.303	0.241
PGPR2	1605	3542	90.00	16.20	38.18	1.370	0.258
PGPR4	1644	3717	93.45	16.00	36.26	1.494	0.242
PGPR 1+2+4	1698	3522	90.30	15.75	35.97	1.450	0.248
CD (0.05)	88	196	13.56	1.34	0.89	0.101	0.017

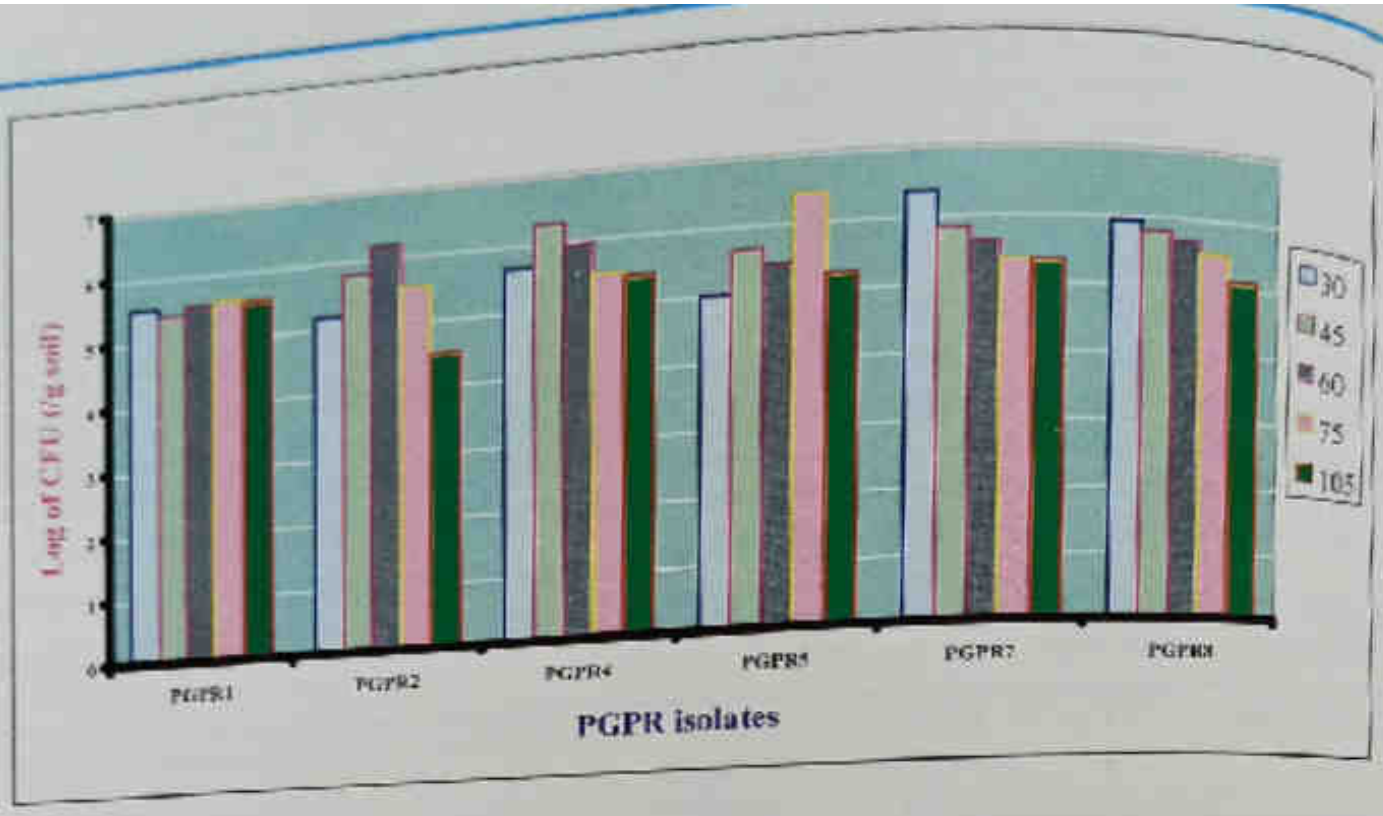


Fig 1. Population densities of different plant growth promoting rhizobacteria in the rhizosphere of groundnut, cultivar GG2, in pots, summer 2001

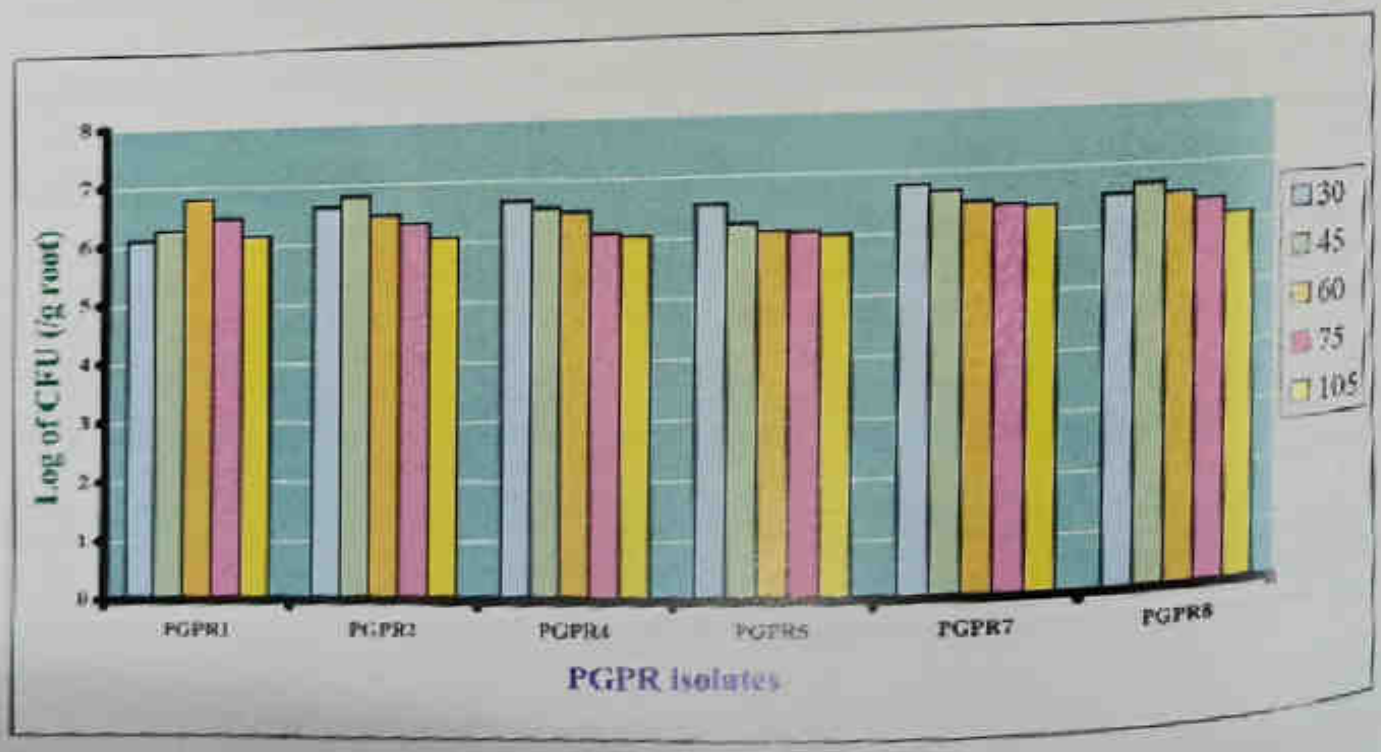


Fig 2. Population densities of different plant growth promoting rhizobacteria in the rhizoplane of groundnut, cultivar GG2, in pots, summer 2001

Sub-Project 2: Mineral nutrient requirement and their disorders in groundnut

1. Nutrient requirement of large seeded groundnut

To study the nutrient requirements of large seeded groundnut require specific studies. Work was initiated in this direction, by taking sand culture pot experiment under various levels of Ca (50, 200 and 400 ppm) and K (50 and 100 ppm) to find out their role in groundnuts with special reference to kernel filling. Two large seeded cultivars (BAU 13 and JSP 19) and a small seeded (NRCG 6919) were taken in this study.

At lower doses of K and Ca, the seeds of bold seeded groundnut genotypes were deficient in Ca resulting in lower pod filling. Increasing the level of Ca or K alone was not beneficial because Ca and K have mutually antagonistic affects. The best dose for achieving highest yield were 100 ppm K and 200 ppm Ca for large seeded genotypes and 100 ppm K and 50 ppm Ca for ordinary genotypes. At a balanced dose of 100 ppm K and 200 ppm Ca the large seed contained sufficient concentrations of these elements.

2. Screening for P-efficient groundnut genotypes

Pot (soil culture) and field experiments were conducted to identify P-efficient groundnut genotypes for calcareous soil. Seventy genotypes were grown in field and 18 in pots under two levels of P (0 and 50 kg P/ha) and based on the relative performance of growth, dry matter accumulation and yields, the P-efficient and inefficient groundnut genotypes were identified (Table 1).

Plant samples of these experiments, conducted during last year, were analyzed and the average and range of P concentration in the kernel was 0.43% and 0.21-0.565%, respectively in control (without P) and 0.486% and 0.26-0.62% in the plant treated with 50 kg/ha P. The P-efficient genotypes showed high P content and low Ca content in leaves at early growth stages and high P content of kernel and P uptake by plant at harvest.

3. Screening for Calcium-efficient groundnut genotypes

Soil culture pot and field experiment were conducted to identify Ca-efficient groundnut genotypes. Twenty eight groundnut genotypes were grown in field and eighteen in pots under two levels of Ca (0, and 100 kg Ca/ha) and based on the relative performance of dry matter accumulation and pod yield, the Ca-efficient and inefficient genotypes were identified (Table 1). The plant samples of these experiments were analyzed and kernel of Ca-efficient genotypes showed higher Ca than others.

Table 1. Phosphorus and Calcium efficient and inefficient genotypes (Three years study)

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

PROJECT 05 : STUDIES ON GROUNDNUT BASED CROPPING SYSTEMS FOR RAIN DEPENDENT AREAS

(DEVI DAYAL, Y. V. SINGH, P. C. NAUTIYAL, K. K. PAL)

1 Cropping systems

1.1 Effect of groundnut genotypes in intercropping systems:

Performance of 31 groundnut genotypes (11 Virginia and 20 Spanish) was evaluated during the kharif season of 2001 in three intercropping systems viz. groundnut-pearl millet, groundnut-pigeon pea and groundnut-castor. Sole crop of each genotype was also maintained as a control. In general, yield reduction of groundnut was more with pigeon pea/castor (43-53%) than with pearl millet (32%). There were large genotypic differences for reduction in pod yield due to intercropping systems. Virginia cultivars showed less reduction in pod yield compared with Spanish cultivars in association with pearl millet. However, much difference in yield reduction between Virginia and Spanish cultivars was observed in association with pigeonpea and castor. Genotypes, GG20, B95 and M 335, among Virginia and J11, VRI 3 and ICGS 44 among Spanish types showed less reduction in pod yield due to intercropping system.

Observations on soil pH of rhizosphere (0-15 cm) in groundnut cultivars indicated that rhizosphere pH slightly increased when groundnut was grown as an intercrop as compared to sole crop. Intercropping of groundnut with pigeon pea had higher values of soil pH than with castor and pearl millet intercropping.

Four groundnut cultivars, namely M13, J11, DRG 17 and SG 84 were intercropped with pigeon pea (cv. BDN2) and pearl millet (cv. MH 169). Groundnut faced more competition from pearlmillet (LER0.87) than pigeonpea (LER 0.92) during early crop growth stage (30 days). However, at 60 days, competition was almost similar (LER 0.89-0.90) with these two intercrops. Among the genotypes, cvM 13 recorded highest pod yield (1500 kg/ha) followed by DRG 17 (1023 kg/ha). Spanish cultivars recorded less pod yield compared with Virginia cultivars.

1.2 Response to nutrients in the intercropping systems

Very little information is available on nutrient dynamics and requirement of cropping system as compared to individual components of respective systems. In groundnut+pearl millet intercropping, nitrogen was applied in different splits (1 to 5) either in the soil or as foliar spray in the form of 2% urea solution. Observations on soil NO_3 nitrogen accumulation in 0-15 cm soil depth was recorded at 30 days interval. The NO_3 content at 30 DAS was less in 2 and 3 splits (13.125-13.428 ppm) than in one splits (17.792 ppm). Almost similar trend in NO_3 nitrogen in the soil was observed at 60 and 90DAS. Growth observations recorded at 30, 60 and 90 DAS indicated that pearl millet was a dominant component of the system and suppressed the growth of groundnut since early growth. However, this competition was more severe when nitrogen was applied as one and two splits compared with 3 or 4 splits. The maximum yield of the system was recorded when 1/4 of recommended dose of nitrogen of pearl millet as basal application and remaining amount of N in four equal splits either as soil or foliar application was applied (Fig 1).

4. Experimentations on groundnut grown with no synthetic inputs

The FYM, slurry of cow/domestic animals, briquette from groundnut-cotton waste, oilseeds cakes, mulching with local plant/weed material and bio-fertilizers (PSM + *Bradyrhizobium*) and green manuring with mungbean were evaluated. No systemic pesticides were used. Three seasons of experimentation revealed that, though the responses of FYM and cakes were higher than others, all the sources of organic matter were useful in groundnut cultivation and increased yield and soil fertility (Table 2). There was slow effect of these organics and during first season only FYM, cakes and bio-fertilizers (PSM + *Bradyrhizobium*) could produce significantly higher pod and haulm yields over control and at par with that of chemical (NPK) fertilizer. However, during next season, biogas slurry and mulching could also produce significantly higher pod yield than control.

Micronutrient availabilities of the soil after harvest of crop increased due to manuring with various organic matters. Addition of organic matter increased the organic content and changed the soil physical conditions for crop. Interestingly the soil where chemical fertilizer was applied showed lesser micronutrient availabilities after harvest of crop than organic treatments. Due to lesser organic matter and microbial activity in this treatment there was probably lesser replenishment of nutrient from the soil-labile pool than the organic fertilizer treatment, however due to high yield the crop in this treatment harvested high amount of nutrient from the soil and hence there was probably a negative balance.

Thus it is concluded that some of the organic sources of nutrients like FYM, caster/neem cakes, together with biofertilizers can perform as well as only the inorganic fertilizers. Moreover, very clearly soil health definitely improved with these organic materials. More long-term experiments will be required for confirmatory results.

Table 2. Effect of various organic farming approaches on the groundnut yields, weed biomass and availabilities of soil micronutrient

Treatments	Weed biomass	Pod Yield (kg/ha)		Haulm Yield (kg/ha)		Micronutrient content (ppm) of soil after harvest of Kharif,1998 crop				
	(Kg/ha dry wt)	Kharif, 1998	R-S 1999	Kharif, 1999	Kharif, 1998	R-S 1999	Fe	Mn	Zn	Cu	Mo
Control	317	830	868	710	3189	3310	6.01	6.5	0.60	0.93	0.42
NPK 40:40:40	256	975	1162	1021	3950	4353	5.92	6.92	0.60	0.92	0.40
FYM	469	1002	1300	1196	4325	4117	8.22	8.24	1.02	1.19	0.70
Cakes	486	927	1367	1070	3987	4061	8.53	9.15	0.68	1.10	0.70
Bio-gas Slurry	390	907	1232	1044	3466	3760	8.71	8.86	0.81	1.20	0.64
Briquet from waste of groundnut/cotton	395	872	1039	875	3261	4048	7.63	8.49	0.75	1.12	0.65
Biofertilizers	388	954	1071	872	3510	3682	7.86	7.71	0.76	0.95	0.56
Mulching	377	890	1168	845	3463	3485	8.41	9.8	0.78	1.01	0.67
Green manuring	-	-	1091	840	-	3641	-	-	-	-	-
LSD (0.05)	70	82	168	-	378	585	1.38	1.58	0.11	0.16	0.12

1.3 Long term experiment on Nutrient dynamics

Meager information is available on cumulative as well as residual fertility build up in the long run for whole cropping systems. A long term experiment with five popular groundnut based cropping systems viz. monocropping of groundnut, two intercropping systems (with pearl millet and pigeon pea) and two sequential cropping systems (groundnut-wheat and groundnut-wheat-green gram) was initiated during kharif 1998 under different combinations of organic and inorganic fertilizer regimes to study the nutrient dynamics and crop sustainability. After 4 years of cropping, the following changes in yield of groundnut and soil properties were observed.

- Among the cropping systems pod yield of kharif groundnut was the maximum (1573/ha) in groundnut - wheat-greengram cropping system.
- Irrespective of the cropping systems, pod yield was higher by 11.7% in the treatment receiving FYM @5t/ha than the treatment with RDF.
- Groundnut+pigeonpea intercropping system and groundnut-wheat-green gram sequential cropping system maintained higher available nitrogen in the soil (60.03-60.39ppm) as compared to sole groundnut (56.03ppm)
- The activities of free nitrogen fixing microbes (Fig 2) were the maximum ($50.2X10^4$ colony forming unit/g of soil) in groundnut+pigeonpea intercropping followed by groundnut-wheat-green gram ($25.66X10^4$ colony forming unit/g of soil). The least were in sole groundnut ($3.10X10^4$ colony forming unit/g of soil)
- There was a definite change in soil rhizosphere pH. Slightly higher pH (7.96-7.98) in groundnut+pearl millet and groundnut-wheat systems than that in sole groundnut (7.87) was observed. Application of FYM consistently decreased soil pH irrespective of the cropping system.
- Incidence of stem rot recorded at 45 DAS was slightly more in groundnut+pigeonpea (9.31%) and groundnut-wheat-greengram as compared to sole groundnut (7.76%).

1.4 Studies on different components of organic farming on yield and quality of groundnut

Three major components namely, organic fertilizer, bio-fertilizer and bio pesticides along with recommended dose of fertilizers (RDF) and no fertilizers (control) were evaluated for their contribution in yield (cv GG20) and soil health. The newly developed plot in which previously no fertilizers were applied was selected for the study. Growth observations recorded at 45 days after sowing indicated that plants receiving bio-fertilizers and bio pesticides along with organic fertilizer were taller with more root length compared with only organic fertilizer, RDF and the control. The activities of Fluorescent Pseudomonads, PSB and free living N fixer were considerably higher in bio fertilizer and biopesticide treatments as compared to Organic fertilizers and RDF (Table 1). The incidence of collar rot/stem rot recorded at 25 DAS (Fig 3) was also significantly less (10.25-10.75/1000 pl) compared with organic fertilizer (25.1) and RDF (38.29). The control treatment recorded the maximum incidence (80.88). RDF recoded the maximum pod yield (1606 kg/ha) followed by organic fertilizer+biofertilizers. The oil content did not vary significantly due to various treatments.

1.5 *In-situ* moisture conservation techniques for rain fed groundnut

Effect of four *in-situ* moisture conservation techniques namely, flat bed (FB), flat bed sub-soiling (FBSS), inter row water harvesting (IRWH) and broad bed furrow system (BBF) were studied on three cultivars of groundnut viz. GG2, GG20 and GG13. Crop was sown with the onset of monsoon on June 23, 2001. Plant density with respect to recommendation for each cultivar was kept optimal in all the soil moisture techniques.

1.6 Growing season rain fall

In kharif 2001, 224.5 mm in June, 230.9 mm in July, 200.5 mm in August, 117 mm in September and 25 mm in October rain fall were well distributed, and uniform and the crop did not experience any moisture stress. Sunshine hours were low during July and August (2.3 and 2.88 hrs respectively), hence, vegetative growth was more.

1.7 Water use

Water used ranged from 297.1 to 306 mm for GG2, 350 to 363 mm for GG20 and 368 to 374 mm for GG13 in FB to IRWH. Study revealed that FBSS, IRWH and BBF conserved water and resulted in higher water use than FB during cropping season. Water use with GG2 and GG13 was more as those were long duration cultivars.

1.8 Yield and yield attributes

Numbers of pods/plant, 100 pod weight and haulm yield were higher with moisture conservation technique than that of flat bed system. The pod yield of flat bed system was significantly lower than all other three moisture conservation techniques. Highest pod yield (1797 kg/ha) was recorded with IRWH followed by FBSS (1785 kg/ha). However, GG2, GG20 and GG13 recorded highest water use efficiency (WUE) with IRWH (5.65), BBF (5.13) and FBSS (4.85) kg/ha/mm), respectively. *In-situ* moisture conservation techniques have shown promises in increasing pod yield and WUE. However, IRWH was more effective as it increased the yield of GG2, GG20 and GG13 by 5,4 and 5.8% over conventional flat bed system., respectively. In respect of cultivars, 100 pod weight, 100 kernel weight, haulm and pod yields with GG20 and GG13 were significantly higher than GG2. The cultivar, GG20 produced highest yield of pods (1829 kg/ha).

2 Water budget and energy balance in groundnut based cropping systems

The study was initiated with the objective to determine the water requirement of crops and intercropping system competing at farm under rain and limited irrigation, so as to select most efficient crop and intercropping for sustainable production, efficient use of rain in conjunction with limited irrigation. The study was conducted under simulated condition using sprinkler line source design for imposing variant water deficits. Crops were sown with 2nd spell of monsoon shower on July 3, 2001. Groundnut, pearl millet, sesame, pigeon pea and castor were sole crops and groundnut with pearl millet & sesame in 1:1 and with pigeon pea and castor in 3:1 row ratio were under study. As there were good rains from July to September, line source sprinkler was not used. This system operated in pigeon pea and castor only after the harvest of groundnut, pearl millet and sesame crops. Irrigation was applied at 50% depletion of available soil moisture from the soil profile in water level 1, about 1.5 m apart across the sprinkler system. Other four treatments were spaced 2m interval from each other beginning from treatment

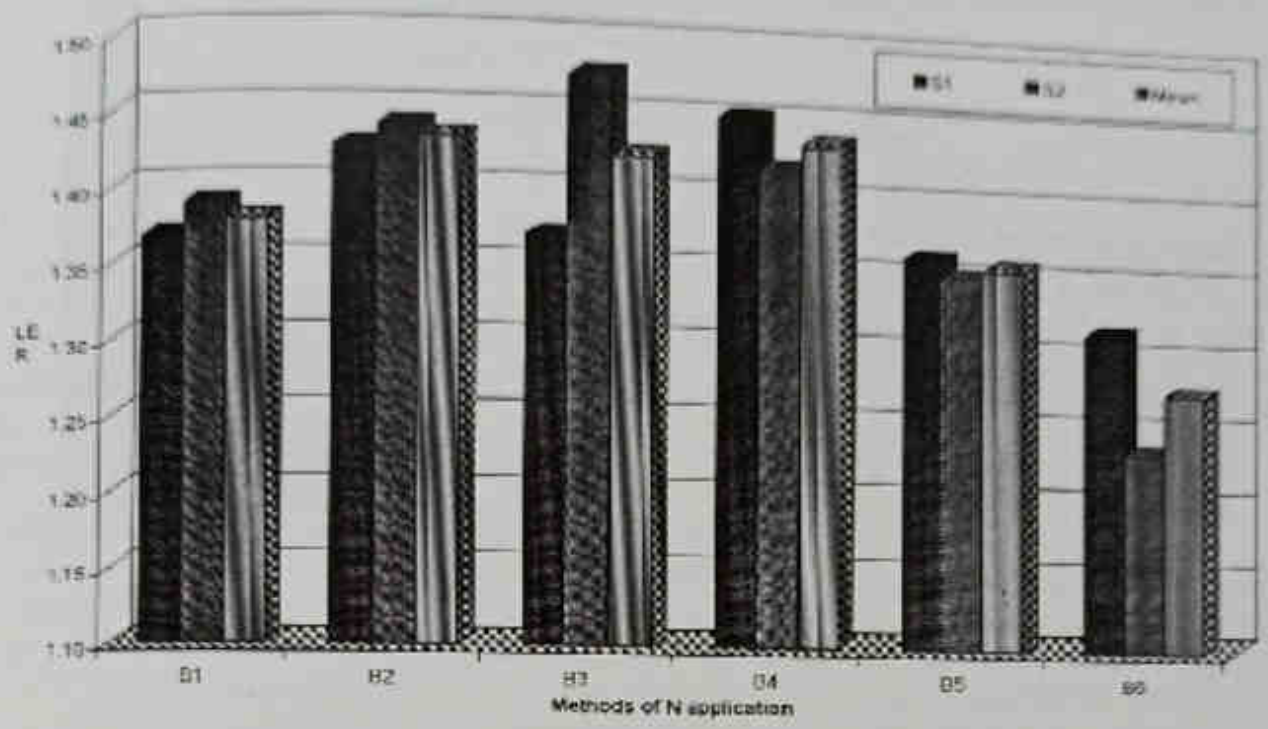


Fig 1 LER of groundnut+pearl millet intercropping

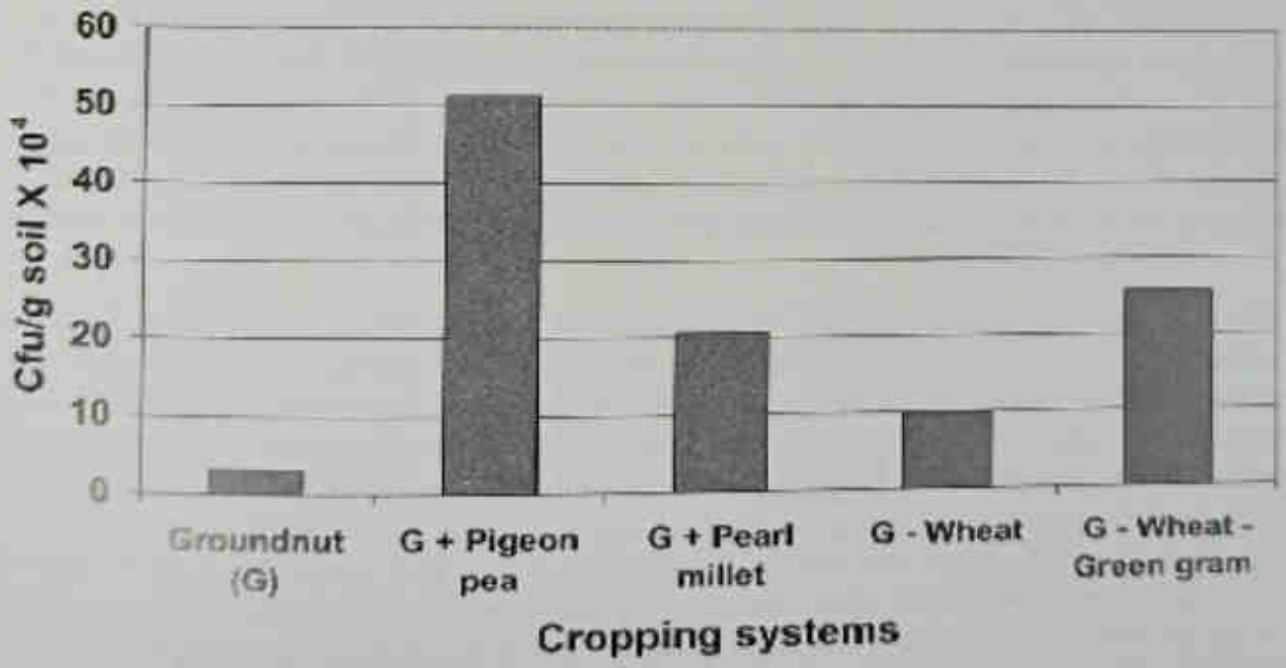


Fig 2 Effect of cropping system on free living nitrogen fixing microbes

1. Eight sprinklers spaced 6.1 m apart on single sprinkler line kept in the center of the plot achieved overlapped irrigation pattern along the line and variable water levels across the sprinkler line. There were 5 water levels within 12 m sprinkler reach and one being out was treated as rain fed. All management practices like spacing, population and fertility were kept optimum.

2.1 Comparative performance of crops and intercropping systems

Among five crops (rain fed), pearl millet recorded the highest grain yield (2198 kg/ha) with 9.92 kg/ha/mm of WUE followed by groundnut (2082 kg/ha pod and 8.08 kg/ha / mm). The yield of groundnut intercropped with pearl millet, sesame, pigeon pea and castor declined owing to reduction in pods/plant, pod weight /plant and biomass yield. Water use ranged from 221.4 mm with pearl millet to 353. mm with castor under rain fed condition. WUE was maximum (5.17 kg/ha/mm) with sesame followed by groundnut + pigeon pea (4.37 kg/ha/mm). The yield and water use of groundnut with pigeon pea was higher than castor owing to better light interception in groundnut + pigeon pea intercropping system. Since, pigeon pea and castor being long duration crops cannot rely purely on rainfall, farmers having irrigation facility provide irrigation to achieve potential yield. Yield-water relationship was established to identify the most practical deficit irrigation level for maximizing production per unit of water. This relationship revealed that the yield of pigeon pea and castor as sole and intercrop declined with increasing deficits. Though irrigation at potential ET recorded the highest yield per unit of land, WUE declined both in sole as well in intercrop of pigeon pea and castor. Maximum WUE with added ET were 5.45 and 3.33 kg/ha/mm in pigeon pea and groundnut + pigeon pea intercrop respectively, at 70% replenishment of water deficit of field capacity. In case of castor irrigation at 85% replenishment of water deficit of field capacity, maximum WUE of sole castor (4.74 kg/ha/mm) and castor + groundnut (3.12 kg/ha/mm) were realized. But irrigation at 70% replenishment of water deficit of field capacity resulted equally high WUE, 4.71 kg/ha/mm for sole castor and 3.11 kg/ha/mm for castor + G'nut. Irrigation at potential ET may increase the productivity per unit of land. On the other hand, irrigation at 70% replenishment of water deficit of field capacity may bring 0-40 ha additional land under irrigation with same amount of water available for irrigation. Though production unit of land will decline but per unit of water will increase by bringing larger area under irrigation for given water supply. Thus deficit irrigation is an effective proposition to increase the yield per unit of water.

3 Evaluation of a new herbicide 'Napropamide' in groundnut based cropping system

A new pre-emergence herbicide, Napropamide (amide group) was evaluated in groundnut based cropping system during kharif 2000. Two rabi crops namely, wheat and gram and two summer crops (pearl millet and green gram) were grown to assess the residual effect of the herbicides. Four doses of Napropamide (1,2,3 and 4 kg ai/ha) were evaluated along with recommended herbicide (Pendimethalin, 1.5 kg ai/ha). Effect of Napropamide in controlling weeds (monocots/dicots) was similar to Pendimethalin. However, there was considerable residual effect on succeeding wheat crop and germination, growth and yield of wheat were drastically reduced under Napropamide treatment. No residual effect on gram was, however, observed. In summer crops also, no significant reduction in dry matter of green gram and pearl millet was observed due to residual effect of Napropamide. Thus any new herbicide must be tested in a cropping system mode rather than in sole crop.

PROJECT 06 : STUDIES FOR TRADITIONAL RABI-SUMMER AND SPRING IRRIGATED SITUATION

(Y. C. JOSHI, P. C. NAUTIYAL)

Sub-Project : Physiological studies on abiotic stresses

1 Root studies

Concrete blocks (Nos. 15) were constructed to study vertical and horizontal growth of root under normal and water-deficit situations at different growth stages of plant. Root growth of five cultivars (Girnar 1, TAG 24, JL 24, GG 2 and ICGS 44) studied under well watered and water-deficit situations in pot culture experiment showed higher length, and root: shoot ratio; and lower volume, in plants experienced water-deficit as compared to the controlled, at 55 days after sowing. Cultivar GG 2 showed higher root length and biomass than JL 24, under drought like situations (Fig 1)

2 Leaf water relations and thermostability

A laboratory method for the measurement of high temperature tolerance in terms of leaf membrane thermostability was standardized. At 54°C, for 1-hour heat treatment, about 50% injury was recorded. Genotypic difference for high temperature tolerance was wide (45-74%) at 54°C, and narrowed down (70-80%) at temperatures between 56 and 60°C. Thus 54°C seems to be the lethal temperature for groundnut, however to trap the genetic potential for high temperature tolerance time for the exposure of leaf to high temperature (54°C) needs standardization. Cultivar ICGS 76 was found to be tolerant to high temperature stress based on studies conducted on leaf membrane thermostability. Further, these remits indicated that there is a need to study the relationship between specific leaf area (SLA) and high temperature tolerance, and genotypic variations may also be exploited to enhance genetic resources for high temperature tolerance. Six genotypes with a range of SLA (144 to 214 $cm^2 g^{-1}$) studied for water relations and leaf membrane thermostability in two different seasons. In *kharif* at pod developmental stage, low SLA lines maintained higher leaf relative water content (RWC) than the high SLA lines. However; unlike summer season in *kharif* no clear-cut picture emerged regarding the relationship between leaf membrane thermostability and SLA. The ranking of genotypes with respect to SLA remained generally unchanged, irrespective of the growth stages and seasons.

Groundnut cultivars studied for various aspects such as photosynthesis, growth and productivity under irrigated (summer-groundnut), rain-dependent (kharif-groundnut), and simulated drought conditions both in summer and kharif seasons. Further, experiments were initiated to understand crop canopy architecture and productivity. Two hundred germplasm accessions were screened for canopy architecture, temperature, and pod yield. Significant difference in canopy temperature due to variation in the canopy architect was noticed. Virginia and Spanish cultivars differed with respect to the growth, and PN, productivity, and harvest index (HI). Virginia cultivars showed higher productivity both in terms of yield and total biomass than the Spanish type; however the crop duration is more in the Virginia type. Further, Virginia cultivars were more tolerant to drought than the Spanish. Therefore, it is suggested that the Virginia, and Spanish cultivars with high HI and WUE (based on SLA), required to be developed for both irrigated and rain-dependent agriculture systems in India.

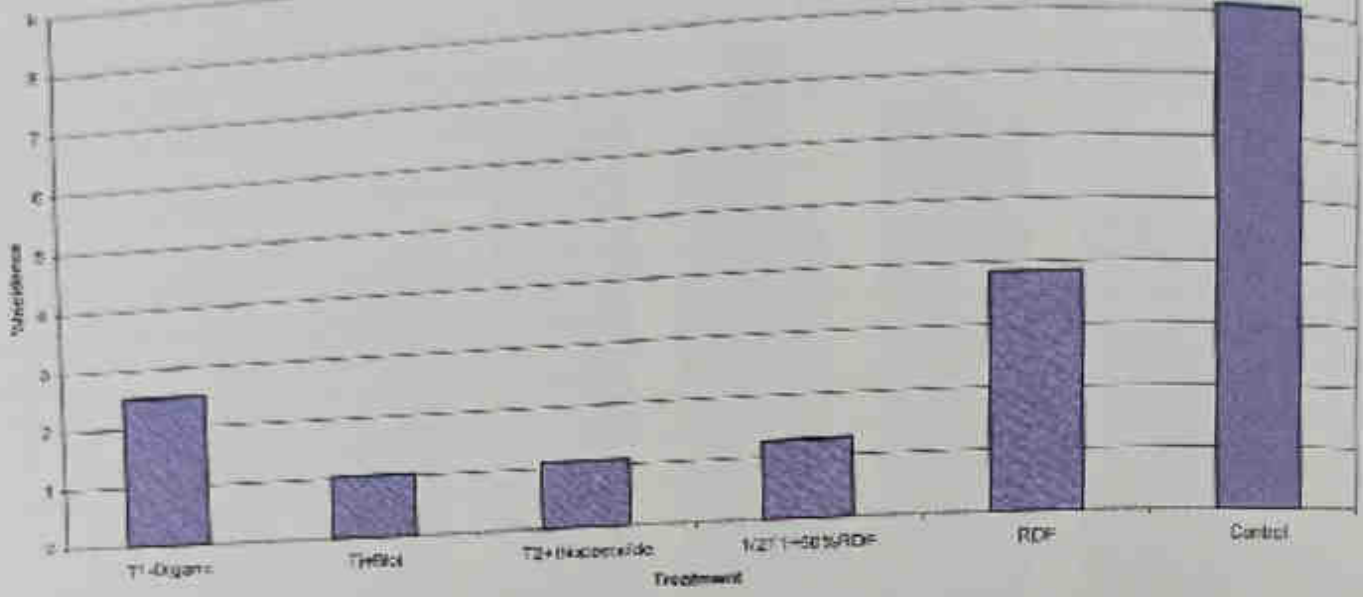


Fig 3 Incidence of Collar/stem rot(%) in groundnut at 30 DAS

3 Screening for salinity tolerance

Eighty cultivars and 40 germplasm accessions were screened in trays for the tolerance to salinity. After sowing saline water irrigation (4 Ece) was given, in addition to this cultivars were also irrigated with normal water regularly. Seedling emergence was recorded and final mortality was calculated 45 d after sowing. Mortality ranged between 40% (in GG 20) and 100% in (MH2, ICGS 37, Spanish imp. TG 3, and ALR 1). Forty germplasm accessions screened in the saline soil also showed genotypic variation in mortality rate.

Fig 1. Root growth in the root study blocks

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

A. L. SINGH M.Y. SAMDUR AND K.K.PAL (NRCG) AND K.P. SINGH, MOUSUMI RAYCHOUDHURY, N.P. SINGH, D.P. PATEL, G.C. MUNDA, GITANJALI SAHA, M. DATTA, S. MITRA, (ICAR RES. COMPLEX FOR NEH REGION))

1 Experimentations in North-East Hill regions

To provide suitable cultivation technology and to popularise groundnut cultivation in North-East Hills, three collaborative experiments were conducted at various ICAR Research complex at Barapani (Meghalaya), Lembucherra (Tripura), Imphal (Manipur) and Tura (Meghalaya).

1.1 Evaluation of recently released varieties for their introduction in NEH region

Ten recently released groundnut varieties were evaluated for their pod yield, tolerance of Al- and Fe-toxicities and Ca- and P- deficiencies in acid soils and resistance for early and late leaf spot diseases and insects pests at Barapani (Meghalaya), Lembucherra (Tripura), Imphal (Manipur) and Tura (Meghalaya). Pod yields of the cultivars ranged from 938-1838 kg/ha against 938kg/ha of the check (JL 24) at Barapani in Meghalaya and 522-2087 kg/ha against 671 kg/ha of the check (JL 24) at Lembucherra in Tripura. The average pod yields were 1225 and 1250 kg/ha in Meghalaya and Tripura, respectively. The cultivars K 134 (1838 kg) R 9251 (1630 kg/ha) and TKG 19A (1375 kg/ha) were high yielder in Meghalaya. However, ICGS 76, and ICGV 86590 and DRG12, were the high yielders in Tripura during Kharif 2000. The high yielding groundnut genotypes were also tolerant of Al-toxicity, resistant to ELS, LLS and rust diseases and hence can be grown in NEH region.

The field experiments conducted for four consecutive years under rainfed condition have shown that the average pod yield of recently released groundnut cultivarts, in NEH region, was more than 1000 kg/ha (more than the national average). The cultivars ICG 76, and ICGV 86590 and TKG 19A were found to be highest yields and suitable for the NEH Region.

1.2 Screening and evaluation of germplasm lines

The foot hill upland of ICAR Res. Complex, Imphal, (Manipur) and Barapani and 'Tilla' lands at Lembucherra (Tripura), respectively, were identified as hot spot for screening for soil acidity and Al-toxicity.

One hundred germplasm lines of groundnut were grown in acid soils having pH nearly 5.0, under fertilized (50 kg/ha P + 2500 kg/ha lime) and unfertilized (control) conditions and the performance of these genotypes were assessed for pod yield and their tolerance of Al and Fe toxicities, Ca and P deficiencies. Based on the root and shoot growth, and pod yield, the Al-toxicity and acid soils tolerant and sensitive genotypes were categorized and based on the three years of data these were as follows:

Tolerant : ICG 813, 1001, 1021, 1048, 1056, 1064, 1355, 3606, 10964,11183.

Sensitive: ICG 2120, 4407, 6727, 6855, 7288, 7600, 7787, 7821, 10580, 11748.

yield over control, but when it was combined with *Bradyrrhizobium* it could increase 102 % pod yield over control. However, application of NPK (30:50:40 kg/ha) fertilizers showed 46 % increase in pod yield over control.

1.5 Amelioration of Al-toxicity

The ameliorative role of lime and FYM was noticed in experiments conducted at Barapani to overcome the Al-toxicity through soil amelioration (Table 5). The data of three years revealed that addition of 10t/ha FYM alone increased pod yield varying from 28-100%. Addition of 2.0 t/ha of lime, on the other hand, increased 31-46%, and NPK (20:60:40 kg/ha) increased 30-97% pod yield over control. The combined application of these amelioratives though increased pod yield, over their application, but were not always beneficial. Application of lime and FYM increased the nutrient contents particularly of Ca and P in the plant facing Al-toxicity and increased growth and yield. Thus application of lime and FYM ameliorate the Al-toxicity and any one of these could be used.

2 Basic studies on Al-toxicity at NRCG

2.1 Standardization of Al-doses and screening groundnut genotypes

The various Al doses when tested in sand culture experiments showed that in general 200 µM Al, as $AlCl_3$, was beneficial to groundnut, but the doses above 40 µM Al were toxic and caused reduction in growth and yield. However, the effects of Al-toxicity varied with groundnut genotypes.

Thirty-one groundnut genotypes were screened for their tolerance of Al-toxicity. Most of the groundnut genotypes tolerated 500 µM of Al (as $AlCl_3$) till 50-60 days after sowing (DAS), but later on Al-toxicity symptoms on roots and subsequently on plant growth were noticed causing reduction in growth and yields. Based on these parameters and relative performance of the genotypes under normal and Al-stress conditions, the genotypes having tolerance and susceptibility of Al-toxicity were classified.

Based on the data on two consecutive year's study, it was concluded that the genotypes NRCG 7599 and 1038, 3498 and, 6919 showed comparatively more tolerance than others. However, the genotypes GG 4 and GG 5 and GG 20 were most sensitive.

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

Bradyrhizobium and PSM cultures were isolated from the acidic soils collected from Tura, Manipur and Barapani. From these the various isolates of PSM and *Bradyrhizobium* are being purified and tested for their further inoculation and release.

The plant samlpes from the earlier experiments were analysed for Al, P, Ca and Fe contents. The groundnut plant grown in acid soils contained extremely high Al-concentration (1000-2700 ppm) and high Fe and Mn content and low Ca and P content in their tissues. Presence of Ni (from 2-24 ppm) and trace of Co was also reported in groundnut kernel from these region. However, presence of Cd, could not be detected through AAS in any of the samples.

The groundnut seed, collected from these experiments, at these regions showed low Ca content sometimes below 300 ppm causing low shelling and viability. However, the minimum Ca content in seed, for good germinability and vigour, is reported to be above 400 ppm. Application of lime (2t/ha) increased Ca and P content of plant and seed and brought down Al, Fe and Mn contents.

1.3 Integrated nutrient management in groundnut

The experiments on integrated nutrient management were conducted at Imphal, (Manipur), Tripura and Barapani to compare the effects of inorganic nutrients (P, K, Ca) and biofertilizers (*Bradyrhizobium* and PSM) and their interactions in acid soils.

In general very good response of *Bradyrhizobium* and PSM was noted with phosphatic fertilizer and lime at all the three locations in NEH Region. However, their effect was only marginal without P and Ca. The soil amelioration with lime and P increased the productivity of groundnut. The groundnut crop inoculated with PSM and *Bradyrhizobium* showed green canopy but the crop without *Bradyrhizobium* and PSM showed shunted growth with chlorotic leaves, poor nodulation and N and P deficiency symptoms. At Tripura, lime+P+ *Bradyrhizobium*, and lime+P+PSM increased 45 and 31% more nodulation, respectively and 50 and 50% more nodule mass, respectively over control at 30 days after emergence (DAE). However, these increases were 18, 22 % and 67%, respectively at 60 DAE. Application of lime + P + PSM produced 1580 kg/ha pod yield as 1050 kg/ha against control whereas, Lime + PSM only produced 1280 kg pod/ha. Combined application of lime+P+ *Bradyrhizobium* and lime+P+PSM could increase 40 and 50 % pod yield and 11 and 20 % haulm yield, respectively. At Barapani, maximum pod yield (2700 kg/ha) was obtained by inoculation of NC 92 + NPK (20:60:40) against 1500 kg/ha of the control and 2310 kg/ha with NPK.

At Manipur application of lime @ 2t/ha alone increased the pod yield by 25% over no lime and further application of P and biofertilizers additionally increased the yield. The combined application of P (50 kg/ha)+*Bradyrhizobium* +PSM showed maximum pod yield (67% more over control) followed by P (50 kg/ha)+*Bradyrhizobium* (51%) and (50 kg/ha)+PSM (49%). Interestingly the *Bradyrhizobium* +PSM also increased 42% pod yield over control indicating the potentials of these biofertilizers.

Thus, Ca and P are the key nutrients for growing groundnut in acid soils of NEH region and biofertilizers must be applied.

1.4 Experiment on organic farming

The various organic farming approaches were tested in Manipur taking the cultivar, TG 22. Organic fertilizers showed its superiority over inorganic one and FYM (at 10 t/ha) alone could double the productivity (Table 4). Application of mustard cake (at 1 t/ha) increased 51 % pod

Table 3. Influences of various INM practices on groundnut variety JL 24 at Manipur during 2000.

S.N.	Treatment	Pod yield (kg/ha)			
		Lo	L2	Mean	% increase over control
1.	Control (without P, K and biofertilizers)	840	1130	990	
2.	*Bradyrrhizobium*	960	1230	1090	10.1
3.	PSM (*B. polymyxa*)	850	1320	1150	16.1
4.	*Bradyrrhizobium* + PSM	1170	1650	1410	42.4
5.	P50	1110	1430	1270	28.3
6.	P50+ *Bradyrrhizobium*	1460	1520	1490	50.5
7.	P50+ PSM	1380	1560	1470	48.5
8.	P50 + *Bradyrrhizobium* + PSM	1470	1850	1650	66.6
	Mean	1160	1450		
	LSD (0.05)				
	Lime		214		
	Fertilizer		440		
	Interactions (LxF)		NS		

Where L0 and L2 are control and 2 t/ha lime

Table 4. Experiments on organic farming at Manipur during 2000 variety TG 22

S.N.	Treatment	Pod yield (kg/ha)	% increase over control
1.	Control	950	46.3
2.	$N_{30}P_{50}K_{40}$	1390	44.2
3.	T2 + lime (2 t/ha)	1370	100
4.	FYM (10 t/ha)	1900	50.5
5.	Mustard cake (1 t/ha)	1430	71.6
6.	FYM + *Bradyrrhizobium*	1630	102.0
7.	Mustard cake + *Bradyrrhizobium*	1920	
	LSD (0.05)	355	

Table 1: Perfomance of groundnut varieties in acid soils of NEH region during Kharif 2000

S.N.	Varieties	Pod yield (kg/ha)	
		Barapani	Tripura
1.	Girnar 1	1000	-
2.	ICGS 11	1125	-
3.	K 134	1838	882
4.	DRG 12	1058	1804
5.	VRI 2	1121	-
6.	OG-52-1	1219	-
7.	R-9251	1630	920
8.	TG 26	1153	1642
9.	VRI 4	1078	
10.	JL 24	938	671
11.	ICGS 44	1163	-
12.	TKG 19 A	1375	-
13.	ICGS 76	-	2087
14.	ICGV 86590	-	1471
15.	BAU 13	-	522
	Mean	**1225**	**1250**
	LSD 0.05	**250**	**371**

Table 2. Influences of various INM practices on groundnut variety ICGS 76 at Tripura during 2000.

Symbol	Treatment details	Wt. g/Plant		Yield (kg/ha)		% increa seover control	100 Pods wt. (g)	100 Seed wt.(g)
		Pod	Seed	Pod	Haulm			
T1	Control (without P, K and biofertilizers)	10.6	7.6	1050	4085	-	131	100
T2	*Bradyrrhizobium*	11.6	8.6	1275	5039	21.4	126	93
T3	PSM	10.1	8.1	1300	4551	23.8	136	101
T4	Lime (2.5t/ha)	12.6	9.3	1427	4884	35.9	151	111
T5	T4+ T2	9.1	7.1	1199	4828	14.19	135	103
T6	T4 + T3	9.3	14.6	1275	5217	21.4	133	101
T7	P50	9.8	7.0	1404	3441	33.7	142	105
T8	T7+T2	11.9	8.9	1618	4218	54.1	132	102
T9	T7+T3	13.5	9.8	1130	3186	7.6	140	106
T10	T4+T7	7.5	5.5	1528	4328	45.5	134	101
T11	T4+T7+T2	15.5	12.1	1468	4635	39.8	132	98
T12	T4+T7+T3	14.3	12.4	1578	4551	50.3	136	101
	Mean			**1354**	**4410**	**29.0**	**135**	**102**
	LSD 0.05	**ns**	**ns**	**340**	**490**			

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

(K. RAJGOPAL, K. CHANDRAN, S.K. BERA, V. NANDAGOPAL, S. DESAI)

1 Acquisition of germplasm

Three hundred and sixty seven accessions of cultivated groundnut and 34 accessions of wild Arachis species were procured from ICRISAT. Fourteen accessions collected through exploration in the country were received from NBPGR regional stations and 17 released cultivars obtained from different agricultural Universities. Five advanced breeding lines developed by Plant breeding section of NRCG and 14 inter-specific derivatives developed by Cytogenetics section were supplemented to the germplasm collection. Three accessions of wild *Arachis* species were also assembled from USDA through NBPGR.

2 Supply of germplasm

Three thousand five hundred and ninety one accessions including wild species, promising accessions and released cultivars were supplied to 35 indenters within the country. This includes nine hundred accessions to various AICRP (G) centers for screening against foliar diseases and characterization at multi locations, and to other agricultural and traditional Universities.

3 Characterization of cultivated groundnut germplasm

The accessions acquired and accessions available in the working collection were subjected to detailed characterization during kharif 2001. A total of 1467 accessions comprising, Virginia bunch (IIYB): 284, Virginia runner (IIYR): 216, Spanish (VUL) : 602 and Valencia (FST) : 365 were grown during kharif season in an augmented block design with respective checks at a spacing of 75 cm between rows and 10 cm between plants. The crop was sown in the second fortnight of June and harvested in September-October. The collection was scored for 19 qualitative and 25 quantitative traits at various crop stages. A brief evaluation report is as under.

3.1 Qualitative traits

The collection harbored wide variability for both qualitative and quantitative traits. Extreme range of characters was observed for many of the qualitative traits like colour of standard petal, pod morphologies, testa colour. The branching pattern also showed considerable variation, alternate (250 acc.), sequential (759 acc), irregular with flower on main stem (207acc) and irregular without follower on main stem (251acc). The distribution of accessions for different qualitative traits has been given in table 1.

Table 5. Amelioration of Al-toxicity in groundnut variety ICGS 76, at Barapani during kharif season

Symbol	Treatment	Pod Yield (kg/ha) During the various years		
		1998	1999	2000
T1	Control (no fertilizer)	1550	1625	1080
T2	FYM (10 t/ha)	1983	2125	2163
T3	NPK (20:60:40 kg/ha)	2022	2150	2123
T4	Lime (2 t/ha)	2261	2271	1420
T5	T2 + T4 (10 t/ha FYM + 2 t/ha Lime)	2100	2500	1747
T6	T3 + T4	2344	2950	1663
T7	T2 + T3 + T4	2021	3250	2290
	LSD (0.05)	238	225	350

4 Maintenance and multiplication of iron-efficient and inefficient lines

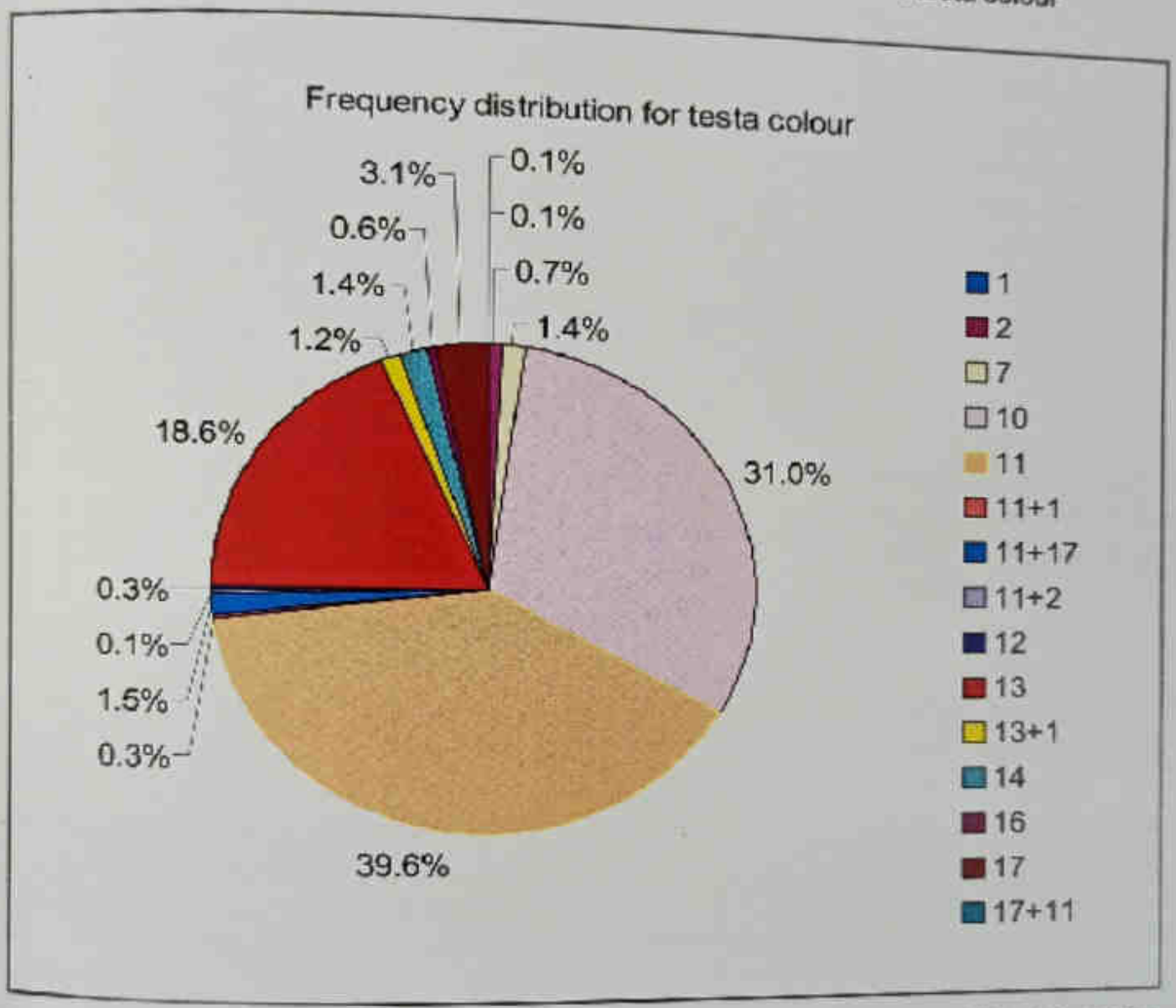
The nutrient-efficient groundnut genotypes were grown for maintaining the seed stocks of these genotypes. Two of the Fe-efficient groundnut genotypes namely FeESG-8 and FeESG-10-1 were multiplied at Bhubaneswar and ICRISAT for acquiring sufficient seed for testing them in AICRP(G) system. These two genotypes entered into the AICRP(G) system out-yielded the checks during two consecutive seasons and hence were promoted for AVT testing in zone II.

Table 1. Frequency distribution of different qualitative traits

Sl no.	Descriptor	Descriptor states				
1	Growth habit	Decumbent 1 (83)	Decumbent 2 (149)	Decumbent 3 (1068)	Erect (167)	-
2	Stem pigmentation	Absent (881)	present (586)	-	-	-
3	Peg pigmentation	Absent (233)	Present (1234)	-	-	-
4	Flower colour	Orange (1426)	Dark orange (25)	Garnet (15)	Yellow (1)	-
5	Leaf colour	Yellowish green (1)	light green (646)	Green (776)	Dark green (44)	-
6	No. of pegs/node	Single (601)	Multiple (840)	Elongated (26)	-	-
7	Stem hairiness	Glabrous (50)	Slight (432)	Moderate (806)	Profuse (178)	Woolly (1)
8	Leaflet hairiness	Almost glabrous (310)	Slight (957)	Moderate (200)	-	-
9	Leaflet shape	Lanceolate (1193)	Oblong (274)	-	-	-
10	Leaflet tip	Acute (1193)	Obtuse (274)	-	-	-
11	Pod beak	none (129)	Slight (1010)	Moderate (293)	Prominent (32)	Very prominent (3)
12	Pod constriction	Absent (16)	Slight (613)	Moderate (780)	Prominent (53)	Very prominent (5)
13	Pod reticulation	Absent (10)	Slight (1097)	Moderate (260)	Prominent (52)	Very prominent (48)
14	Seed shape	Round (259)	Fusiform (1178)	Elongated (30)	-	-
15	Seed size	Small (67)	Medium (1329)	Large (71)	-	-
16	Shell thickness	Thin (407)	Moderate (845)	Thick (215)	-	-
17	Pod size	Small (70)	Medium (1319)	Large (78)	-	-

The colour of testa ranged from white to purple in monochrome category whereas five different combinations of variegation were observed for variegated category as depicted in Fig 1. Rose, salmon and red testa was common accounting more than 88% of the collection.

Fig 1 : Percentage of accessions in total collection for various testa colour



1= White, 2= Off-white, 7= Tan, 10= Rose, 11= Salmon, 11+1= Salmon with white flecks, 11+17= Salmon with purple flecks, 11+2= Salmon with off-white flecks, 12= Light red, 13= Red, 13+1 Red with white flecks, 14= Dark red, 16= Light purple, 17= Purple, 17+11= Purple with salmon flecks

3.2 Quantitative traits

Considerable variation was observed for various morphological traits viz., plant height, length of lateral branches, leaflet size and number of secondary branches in addition to yield-related traits. The range and average values for 25 quantitative traits are given in table 2

Table 2. Range of variation for quantitative traits

No.	Traits	Min	Max	Average	sd
1	Days to germination	6.0	9.0	8.0	0.0
2	Days to initial flowering	14.0	25.0	17.0	2.0
3	Days to 50% flowering	15.0	28.0	20.0	2.0
4	Leaflet length (cm)	42.0	93.0	66.0	8.3
5	Leaflet length/width (cm)	19.0	41.0	29.4	3.4
6	Leaflet length/width (cm)	1.6	2.9	2.3	0.2
7	Height of main axis (cm)	23.0	137.0	70.2	16.1
8	Length of primary branches (cm)	26.8	131	83.4	14.3
9	Number of primary branches	2.3	6.0	4.2	0.4
10	Number of secondary branches	0.0	18.0	3.7	4.0
11	Days to maturity	83.0	126.0	102.0	13.0
12	One-seeded pods (%)	0.0	50.0	5.0	5.9
13	Two-seeded pods (%)	0.0	100.0	75.5	30.1
14	Three-seeded pods (%)	0.0	96.0	16.6	26.2
15	Four-seeded pods (%)	0.0	94.0	2.9	9.7
16	Pod length (mm)	15.2	47.2	26.8	4.9
17	Pod width (mm)	7.1	16.0	11.7	1.1
18	Seed length (mm)	7.4	19.2	11.9	1.6
19	Seed width (mm)	4.5	10.4	7.8	0.7
20	100 pod mass (g)	26.0	218.0	117.0	30.7
21	Shelling outturn (%)	31.8	88.6	72.1	6.1
22	Sound mature kernel (%)	50.0	99.8	91.0	8.0
23	100 seed mass (g)	21.0	94.0	42.5	9.9
24	Pod yield (g)/plant	3.1	41.2	17.0	8.4
25	Pod yield (g)/m²	40.3	326.7	138.7	41.3

Owing to favorable weather conditions and well-distributed rainfall, the shelling outturn was high for most of the accession with an average of 72%, so as the percentage of sound mature seeds (91%). The promising accessions identified for higher yield and related traits are listed in table 3

Table 3. Promising NRCG accessions for yield related traits.

Traits	Accessions
Pod yield(>250g/m-2)	1886,10249, 10588, 10900, 10912, 10975, 10976, 11693,12316
Percent of sound mature seed (>99)	12564, 12565, 12819, 12327, 12551, 12648
High shelling out-turn (>85%)	6993, 12866, 12278, 12280, 12068, 12616, 12790
Bold seeded Virginia types: (100 seed mass >75g)	NRCGs 699, 1898, 5427, 8968, 8972, 9074, 12211, 11661, 12312, 12481, 12576, 12951, 12760, 12882, 12883, 12948
Bold seeded Spanish and Valencia types (100 seed mass>55g)	11651, 10561, 10648, 11723, 11503, 12482 (Spanish); 10824, 10976, 10978, 10982, 12980, 12898 (Valencia)
Early maturing Spanish (83 days)	9801
Early maturing Virginia bunch: (<105 days of maturity)	10249,11725, 11710, 11767, 12659, 12709,12717, 12321

4 Developing a core collection from working collection

Two-thousand nine hundred and forty three germplasm accession of cultivated groundnut representing four habit types viz., HYB: 464, HYR: 348, VUL:1530 and FST: 601 have been characterized for 17 qualitative traits and 21 quantitative traits in three kharif seasons of 1998, 1999 and 2000 are subjected to analysis to develop a core collection. The core set was selected on the basis of cluster analysis and grouping on qualitative traits and quantitative traits and based on logical selection to represent geographical area, special attributes and reaction to pests and diseases.

Five sets of accessions were drawn as indicated below:

4.1 Set I

The entire collection was grouped in to two parts; one consists of ssp. *hypogea* (HYB and HYR types) and other ssp. *fastigiata* (VUL and FST type). Twenty-five arbitrary clusters for ssp. *hypogaea* and 50 clusters for ssp. *fatigiata* were made based on qualitative characters in accordance with their total representation in the working collection, and one accession per each cluster was drawn. Thus 75 accessions were drawn in this group.

4.2 Set II

A second set of accessions was drawn from the groups on the basis of quantitative traits as mentioned in the previous step. The representatives were taken from each cluster. If the cluster is already represented by a sample in the previous step, such cluster has been omitted. In this way 26 accessions from ssp. *fastigaiata* and 13 accessions from ssp.*hypogaea* were selected.

Table 5. Minimum, maximum, average and standard deviation (SD) values for 21 quantitative traits for total and core collection

No.	Quantitative traits	Total collection				Core collection			
		Max	Min	Average	SD	Max	Min	Average	SD
1	Days to germination	5.0	9.0	7.0	0.9	5.0	8.0	7.1	0.7
2	Days to initial flowering	12.0	27.0	18.6	2.7	14.0	26.0	18.3	2.5
3	Days to 50% flowering	14.0	30.0	21.1	3.3	15.0	28.0	20.7	3.0
4	Days to maturity	92.0	130.0	106.3	8.8	94.0	130.0	108.1	9.1
5	Leaflet length (cm)	3.6	8.7	6.0	0.8	4.0	8.7	6.1	0.9
6	Leaflet width (cm)	1.6	4.5	2.6	0.4	1.8	4.5	2.6	0.4
7	Leaflet length/width	1.4	3.2	2.3	0.2	1.4	3.1	2.4	0.3
8	Pod yield (g)/ plant	1.2	44.6	11.5	5.2	1.3	44.2	11.6	6.6
9	Pod yield (g)/M^2	10.0	282.0	108.0	45.7	26.1	268.0	100.7	46.0
10	Hundred pod mass (g)	38.0	274.1	93.6	29.4	44.7	274.1	104.4	35.9
11	% of one-seeded pods	0.0	98.0	16.9	11.7	0.0	91.7	37.2	15.0
12	% of two-seeded pods	0.0	100.0	71.6	22.4	0	100.0	60.8	28.8
13	% of three-seeded pods	0.0	100.0	11.0	21.9	0.0	100.0	19.2	29.6
14	% of four-seeded pods	0.0	63.8	0.6	3.6	0.0	63.8	2.5	8.7
15	Pod length (mm)	13.9	83.5	26.3	5.1	13.9	83.5	28.8	7.5
16	Pod width (mm)	8.8	19.0	11.6	1.2	9.0	19.0	12.1	1.5
17	Seed length (mm)	8.5	21.0	12.4	1.9	9.0	20.0	13.0	2.2
18	Seed width (mm)	5.0	9.9	7.7	0.6	6.0	9.3	7.8	0.6
19	Shelling outturn (%)	37.1	91.6	66.4	8.0	40.0	80.5	63.6	8.7
20	Sound mature seed (%)	50.0	100.0	87.3	7.9	50.0	97.8	86.8	8.4
21	Hundred seed mass (g)	18.0	88.0	37.5	9.1	20.0	68.0	37.2	10.0

5 Evaluation of large seeded accessions

Fifty-four large seeded accessions identified in the preliminary evaluation trial were further tested in replicated trial along with M 13, BAU 13 and TKG 19-A as checks. The accessions showed significant differences for the yield and yield related traits (table 6). Among Virginia bunch accessions NRCGs 11946, 11949,12074,2063 showed significantly higher shelling percent than check cv., GG 20 and in Virginia runner type NRCG 12121 showed higher shelling. NRCG 584 showed significantly higher hundred seed mass than check M 13. The Valencia accessions NRCG 5001 and 11860 were also promising for higher hundred seed weight among Valencia types. None of the accessions showed significantly higher yield than the respective checks.

4.3 Set III

The samples selected in previous two steps covered representation from 47 countries out of 77 present in total collection. One representative sample were drawn from rest of the countries which are not represented in the previous steps thus a total of 30 accessions have been added into this group.

4.4 Set IV

In our earlier evaluation programme carried out, a few accessions have been identified with desirable agro-economic traits. Preference has been given to cover these accessions in the previous steps. However, 27 such accessions which have were omitted in the previous steps is also included.

4.5 Set V

This set covered 25 accessions to represent resistant/tolerant lines to various biotic and abiotic stress factors. As in above set, these accessions were identified by screening by multi-disciplinary research programme at the Centre.

The core group of 41 Virginia bunch, 18 Virginia runner, 85 Spanish and 69 Valencia habit types thus selected showed entire spectrum of variability for both qualitative and quantitative traits (table 4) and had representation of all countries. The mean values of various quantitative traits of total population and the core collection were subjected to paired "t" test showed no significant differences indicating the true representation in the core group.

Table 4. The minimum, maximum values for qualitative traits and percentage availability in core collection

No.	Qualitative traits	Total		Core	
		Max	Min	max	% availbility
1	Growth habit	4	1	4	100%
2	Branching pattern	4	1	4	100%
3	Stem pigmentation	1	0	1	100%
4	Stem hairiness	9	0	9	100%
5	Type of inflorescence	2	1	2	100%
6	Flower colour	3	0	3	100%
7	Peg pigmentation	1	0	1	100%
8	Leaflet colour	4	1	4	100%
9	Leaflet shape	2	1	2	100%
10	Leaflet hairiness	7	0	7	100%
11	Leaflet tip	2	1	2	100%
12	Pod beak	9	0	9	100%
13	Pod constriction	9	0	9	100%
14	Pod reticulation	9	0	9	100%
15	Testa colour	17+11	1	17+11	100%
16	Seed shape	3	1	3	100%
17	Shell thickness	3	1	3	100%

Table 6. ANOVA for Yield related traits among large seeded accessions

Traits	Minimum	Maximum	Average	MSS
Pod yield/plant (g)	8.2	20.5	13.9	24.0**
Pod yield/m² (g)	77.6	209.9	139.9	2831.8**
Hundred pod weight (g)	125.3	240.7	169.5	1530.6**
Hundred seed weight (g)	44.0	80.7	62.0	193.5**
Shelling outturn (%)	65.3	81.0	72.0	33.7**
Sound mature seed %	84.1	96.5	90.7	18.7
Pod length (mm)	24.6	44.5	31.3	50.7**
Pod width (mm)	12.4	17.1	14.4	3.2**
Seed length (mm)	12.7	18.1	16.0	5.6**
Seed width (mm)	8.1	9.9	9.2	0.5**

** Significant at 5% level

6 Preliminary screening against foliar diseases

Three hundred and sixty seven accessions of cultivated groundnut assembled from ICRISAT were scored for rust under epiphytotic conditions. The disease intensity ranged from 2 to 7 in the collection. Twenty-four accessions have been identified as promising showing low infection rate of less than 3.1.

One thousand four hundred accessions scored for Late Leaf Spot under epiphytotic conditions. The disease intensity ranged between 1.2 to 7.6 in 1-9 scale. Eleven accessions NRCG's 12819, 12311, 12312, 12319, 12354, 12399, 12413, 12421, 12492, 12504 and 12569 have been identified as resistant.

7 Multilocation evaluation of groundnut germplasm

Nine hundred groundnut germplasm accessions were supplied to nine AICRP Centres for morphological characterization in 5 lead Centres and for screening against major pests and diseases in four other Centres. The collection was scored for ELS, LLS, Rust, PBND, PSND, Limb rot, *S.litura*, and *Heliothes*. Promising accessions for foliar diseases have been identified, but none found resistant/tolerant to pests

The pods of 75 groundnut germplasm accessions were screened in collaboration with GAU, Anand for occurrence of root-knot nematodes (*A.armigera*) but none of the accessions found tolerant to nematodes.

8 Characterization of released cultivars

Eleven released cultivars were characterized for 19 qualitative and 25 quantitative traits. Two cultivars, AK 159 and GG 7 had dark orange flowers. The testa colour of BAU 19 was red which was distinct from other cultivars. The cv's GG 5 and GG 6 had high shelling percentage of 82.0% and 81.4% respectively. Only JL 220 had three seeded pods. Some of the qualitative and quantitative traits are listed in table 3 & 4.

Table 3 Qualitative traits

Cultivars	FLC	STP	LFC	PEC	INF	STH	PDB	PDC	PDR	SDC
Virginia bunch										
BAU19	Orange	Absent	Green	Present	Multiple	moderate	Slight	Slight	Slight	Red
BG 1	Orange	Absent	Green	Present	Multiple	Hairy	moderate	Moderate	Prominent	Salmon
BG 3	Orange	Absent	Green	Present	Single	moderate	Slight	Moderate	moderate	Rose
HNG 10	Orange	Absent	Green	Present	Single	moderate	Slight	Moderate	Slight	Rose
Spanish										
AK 159	Dark Orange	Absent	Green	Absent	Multiple	moderate	Slight	Slight	Slight	Salmon
Co 2	Orange	Present	L. green	Present	Single	Hairy	Slight	Moderate	Slight	Rose
GG 5	Orange	Absent	Green	Absent	Single	Hairy	Slight	Slight	moderate	Salmon
GG 6	Orange	Absent	L. green	Present	Single	Hairy	Slight	Slight	Slight	Salmon
GG 7	Dark orange	Absent	Green	Present	Single	Hairy	Slight	Slight	moderate	Salmon
JL 220	Orange	Present	Green	Present	Single	Hairy	Slight	Deep	Prominent	Salmon
VG 9521	Orange	Present	Green	Present	Multiple	Hairy	Moderate	Slight	moderate	Rose

FLC=Flower colour; STP=Stem pigmentation; LFC=Leaflet colour; PEC=Peg colour; INF=Inflorescence; STH=Stem hairiness; PDB=Pod beak; PDC=Pod constriction; PDR= Pod reticulation; SDC= Seed colour

Table 4 Quantitative traits

Cultivars	DTM	PYP	SHP	SMK	HSM	HPM	OSP	TSP	THP
Virginia bunch									
BAU19	98	135.0	77.2	88.0	38.8	92.8	2	98	0
BG 1	108	252.9	70.4	82.9	60.0	161.0	4	96	0
BG 3	108	227.8	70.8	88.8	48.0	108.2	0	100	0
HNG 10	105	249.9	69.9	91.9	38.0	81.0	4	96	0
Spanish									
AK 159	98	176.7	71.3	91.0	42.8	94.0	2	98	0
Co 2	96	108.3	71.6	88.1	28.0	82.4	6	94	0
GG 5	97	201.1	82.0	93.9	47.0	100.0	4	96	0
GG 6	95	121.5	81.4	94.2	35.0	105.6	4	96	0
GG 7	97	201.7	78.3	90.9	51.0	112.4	10	90	0
JL 220	96	179.9	74.3	90.3	59.4	164.0	0	94	6
VG 9521	98	91.5	74.0	82.0	28.4	67.6	4	96	0

DTM=Days to maturity; PYP=Pod yield/m2 (g); SHE=Shelling outturn (%); SMK=Sound mature seed (%); HSM=Hundred seed mass(g); HPM=Hundred pod mass(g); OSP=1-seeded pods (%); TSP=2-seeded pods (%); HP=3-seeded pods (%)

9 Multiplication of germplasm

Two hundred germplasm accessions were multiplied to enhance the seed quantity for depositing in base collection

10 Conservation of germplasm

A field gene bank for wild species of Arachis has been maintained. 80 accessions of 26 species belongs to 5 section (*Arachis, Procumbentes, Erectoides, Heteranthae and Rhizomatozae*) are being maintained. Seeds/pods of 3892 woirking collection have been conserved in medium term storage at the Centre (Table 5).

About 700g seeds of 725 accessions of cultivated groundnut were sent for conservation in base collect at NBPGR, New Delhi.

Table 5 Status of Germplasm holding as on March 2002

Place of storage	status	No. of accession
NRCG, Junagadh	Working collection	3892
-do-	Field gene bank fo wild Arachis species	80
NBPGR, New Delhi	Base collection	5458

11 *In vitro* conservation of wild *Arachis* species

Multiple shoots of two wild species, *A. duranensis* and *A. kretschneri* were induced from de-embryonated cotyledons and the *in vitro* grown cultures were sent to NBPGR New Delhi to standardize protocols for cryo- preservation.

12 Enhancing the recombination frequency in groundnut

12.1 Studies on chemically induced functional male sterility:

To induce functional male sterility, five different concentrations (25, 50,100, 200, and 400 ppm) of 2,3,5- Triiodo-benzoic acid (TIBA) was sprayed on four cultivars viz., MH 2, GG 2, GG 20, and M 13 from 35 days after sowing to 50 days. The range of pollen sterility observed was from 5 to 95%. Considerable pollen sterility was observed in low concentrations (25 and 50 ppm) than higher concentrations and control.

13 Documentation

All the characterization data were electronically documented and a catalogue of 596 accessions is under publication

segregation of chromosomes in this particular cross-indicated the probable involvement of inversion heterozygosity in the hybrid by showing the presence of bridges.

4 Intra varietal crosses

The F2 progenies of five different crosses were raised separately and characterized for their morphological characters in F1's. The seeds were harvested crosswise and stored. The details of the crosses are as follows:

Puckered leaf X black seed coat

Puckered leaf X corduroy leaf

Golden yellow leaf X black seed coat

TMV NLM X black seed coat

Puckered leaf X Jamun seed coat

The number of plants obtained in each cross was below 50.

5 DNA fingerprinting of the released varieties and enhanced germplasm of groundnut

In order to identify suitable primer combinations which can detect the polymorphism, three cultivars each belonging to the four habit groups were selected and tested for the polymorphism using the 64 primer combinations given earlier. The cultivars used are listed in Table 1. The cultivars Chandra, RS1, TMV7, UF70-103 were again used for confirmation of the results. Four cultivars viz. ICGS1, ICGS11, ICGS 44 and Kadiri 3 (all selections from Robut 33-1) were used to validate the primers for their capability to assess the polymorphism in the related cultivars.

Table 1 List of cultivars used for screening primers for DNA polymorphism.

Cultivar	Habit type	Pedigree
MH 2	Valencia	Selection from Gujarat dwarf mutant
M H 4	Valencia	Not known
Gangapuri	Valencia	Not known
TMV 10	Virginia bunch	Natural mutant from Argentina
Kadiri 3	Virginia bunch	Selection from Robut 33-1
Kadiri 2	Virginia bunch	Nigerian culture MK 374
Chandra	Virginia runner	Selection from Ah 114
UF 70-103	Virginia runner	Introduction from USA
RS 1	Virginia runner	Selection from local collection
Spanish Improved	Spanish	Selection from Spanish groundnut
TMV 7	Spanish	Selection from Tenesse white
JL 24	Spanish	Selection from EC 94943

All the samples were restricted, preamplified and then selective amplified by PCR for primer. The samples were separated on the PAGE and silver stained to detect polymorphism and select suitable primers. The best 5 primers were tested with Kadiri 3, ICGS1, ICGS 44 and ICGS 11 all derived from Robut 33-1.

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

(RADHAKRISHNAN T, P. PARIA, NANDAGOPAL, S. DESAI, K. CHANDRAN, CHUNILAL, LUKE RATHNAKUMAR)

1 Morphological characterization of Wild *Arachis* species

Fifty three accessions of wild *Arachis* species were characterized for floral morphology and 29 accessions for pod traits. *A. glabrata* showed largest flowers with longer hypanthium (8.5 cm) and larger standard petal (length 2.8 cm and width 2.6cm). *A. duranensis* showed smallest standard petal with 0.6cm length and 0.9cm width.

Of the 29 accessions the hundred seed weight ranged from 4.9 gm (*A. pusilla*) to 21.9 gm (*A. batizogaea*). Shelling percentage had a range from 53 (*A. apressipila*) to 86% (*A. duranensis*) and sound mature kernel from 62 (*A. apressipila*) to 99.8% (*A. duranensis*)

Twenty-eight accessions of 13 pod bearing willd *Arachis* species were characterized for pod traits viz., pod beak, pod reticulation pod length, pod width, seed length and seed width. The pod beak on apical segment ranged from slight o prominent and pod reticulation form smooth (*A.pusilla*) to prominent (*A.villosa*). The pod length varied from 8.7mm (*A.cardenasii*) to 14.8mm (*A.paraguariensis*). Pod width had range from 4.6 (*A.cardenasii*) to 8.1mm (*A.monticola*). Seed length and seed width was also lowest in *A.cardenasi*. *A. stenophylla* had the longest seed (11.8 mm) among the wild species studied.

2 Interspecific hybridizations

Two interspecific hybrids, namely J 11 X *Arachis cardenasii* (12046 pollinations) and *Arachis duranensis* (11802 pollinations) and two intra sectional hybrids namely J 11 X *Arachis kretschmeri* (12029 pollinations) of the section *Procumbens* and J 11 X *Arachis oteroi* (11796 pollinations) of the section *Erectoids* were attempted.

Altogether 61 hybrid plants in all the three crosses were identified morphologically and isolated for further characterization and chromosomal analysis. The selfed seeds were collected from five plants of the cross J 11 X *Arachis kretschmeri* and two plants from J 11 X *Arachis duranensis* and three plants from J 11 X *Arachis cardenasii*. The number of seeds in these crosses varied from 2 to 15.

3 Cytological characterization

Most of the plants in the above three interspecific crosses were sterile. The pollen stainability (aceto carmine) of the three interspecific hybrids was analysed. The stainability ranged from 0 to 1.3 % in the cross, J 11 X *A. duranensis* and 0 to 21.3% in the cross J 11 X *A. cardenasii*. The pollen stainability in the cross J 11 X A. *kretshmeri* was from 0 to 9.3%.

The chromosomal analysis of the three inter specific hybrids were carried out individually. The number of chromosomes in the hybrids were found to be 2 n = 30 in plants studied excepting for one plant of the cross J 11 X *A. kretshmeri*. Although, the plant morphologically resembles the wild diploid parent further studies are required to confirm its identity. The anaphase

The sixty-four primer pairs tested showed different banding patterns which ranged from no bands to 76 scorable bands. The primer pairs showing more than 10% of polymorphism, ranked in the decreasing order and the five primer pairs from the top were *Eco* RI-AAC+*Mse* I-CAG (P3), *Eco* RI-ACG+*Mse* I-CAC (P50), *Eco* RI-AGC+*Mse* I-CAG (P51), *Eco* RI-AGC+*Mse* I-CAT (P52), and *Eco* RI-AGG+*Mse* I-CTG (P63).

Of the five primers tested on the cultivars TMV 7, Chandra, RS 1 and UF 70-103, P3 showed maximum similarity (62.6%) between TMV 7 and UF 70-103 (Fig 1). The minimum similarity was observed between TMV 7 and Chandra (30.02) with P50. The overall polymorphism observed was between 12.3 and 15.4%. The primer-wise polymorphism estimated ranged from 12.1 to 77.3% (Table 2).

Table 2. AFLP polymorphism in the four groundnut cultivars

Variety	Primer-wise polymorphism (%)				
	P3	P50	P51	P52	P63
Chandra	61.5	77.3	30.0	67.7	30.4
RS1	48.1	23.3	33.3	21.2	42.9
TMV 7	12.1	36.4	32.0	72.0	50.0
UF 70-103	34.8	50.0	40.0	46.4	--
Mean	39.1	46.7	33.8	51.8	41.1

Primer pair P52 showed maximum mean polymorphism across the four cultivars. However, the differences between primer pairs in polymorphism was not significant (P=0.386). The same primer pairs could detect an overall polymorphism of 10.5 to 14% in the cultivars, ICGS1, ICGS11, ICGS 44 and Kadiri 3 (all selections from Robut 33-1).. The primer-wise polymorphism had a range from 24.5 to 65.5%. The difference in polymorphism between primers were significant (P=0.005). The maximum number of bands was resolved between 329 and 61 bp (Fig 2). For primer pairs, in the decreasing order of polymorphism was P65>P3>P52>P50>P51 (Table 3).The similarity between the cultivars was 45.8 to 74.5% and was higher than that was observed in the previous set of cultivars but for the primer pair P3. The higher similarity and lower level of polymorphism between the cultivars indicates the near relatedness of the cultivars being selections from a common parent.

Table 3. AFLP polymorphism in the four selections from Robut 33-1

Variety	Primer-wise polymorphism (%)				
	P3	P50	P51	P52	P63
ICGS 1	42.1	37.2	36.4	42.9	51.3
ICGS 11	52.2	32.5	35.4	36.8	46.3
ICGS 44	35.3	44.9	33.3	38.5	46.7
Kadiri 3	38.9	34.1	24.5	41.5	62.5
Mean	42.1	37.2	32.4	39.9	51.7

5.1 Standardization of a sampling method for DNA finger printing

Individual and bulked samples (2, 5 and 10 plants) of the cultivar Kadiri 3 was tested with AFLP using the already identified 5 primers viz. Eco RI-AAC+*Mse* I-CAG (P3), *Eco* RI-ACG+*Mse* I-CAC (P50), *Eco* RI-AGC+*Mse* I-CAG (P51), *Eco* RI-AGC+*Mse* I-CAT (P52), and *Eco* RI-AGG+*Mse* I-CTG (P63). Analysis of the AFLP patterns revealed very minor differences in samples from single plants, and bulked sample from 10 plants did not show any difference. It was concluded that a minimum of 10 plants may have to be bulked for making fingerprints in groundnut.

5.2 RAPD of Girnar 1 Mutants

Genomic DNA from the 20 mutants of the cultivar Girnar 1 was extracted, purified and estimated. RAPD of the DNA was done with sixty random primers (decamers obtained for OPERON). Initially the standard PCR conditions were followed and no amplifications were observed. Considering the various aspects like primer annealing temperature etc. different PCR cycles were done and it was confirmed that the PCR technique is not capable of detecting the polymorphism in the mutants.

Since the mutants could not be characterised using RAPD, the AFLP analysis was done using the 5 primers identified by us earlier for fingerprinting purpose (The experiment was done once and has to be repeated for confirmation). The analysis of the AFLP gels using the software GelComparII was done to workout the similarities between the genotypes. The similarity matrices of the genotypes are shown in Figs 3, 4, 5 and 6.

In the comparison P51 showed least similarity between the mutants studied (11.1 - 43.1) and the remaining primer pairs showed similarities ranging from 22 to 70% (P50 had 27.9-70.4 and P3 22.52 - 67.8 and P52 28.8-67.9). M7 and M 13 showed close similarity across the primers pairs.

5.3 DNA typing of the interspecific hybrids and their parents by AFLP

The Genomic DNA from the following interspecific hybrids and their parents were isolated, purified and estimated for quality and quantity by the spectrophotometric technique.

J11 X *A. kretschmeri*, 5 plants

J11 X *A. cardenasii* 29 plants

J11 X *A. duranensis* 43 plants

Parents: J11, *A. kretschmeri A. cardenasii* and *A. duranensis*

5.4 Study of DNA polymorphism in accessions of A. glabrata and A. duranensis

The Gnomic DNA from the 23 accessions of *A. glabrata* and 8 accessions of *A. duranensis* were isolated, purified and estimated for quality and quantity by the spectrophotometric technique.

6 Standardization of transformation protocols

Several co-cultures each with 50 explants were taken up with embryonal axes, deembryonated cotyledons and immature leaves as explants. Of these, about 1000 shoots are now growing in cultures.

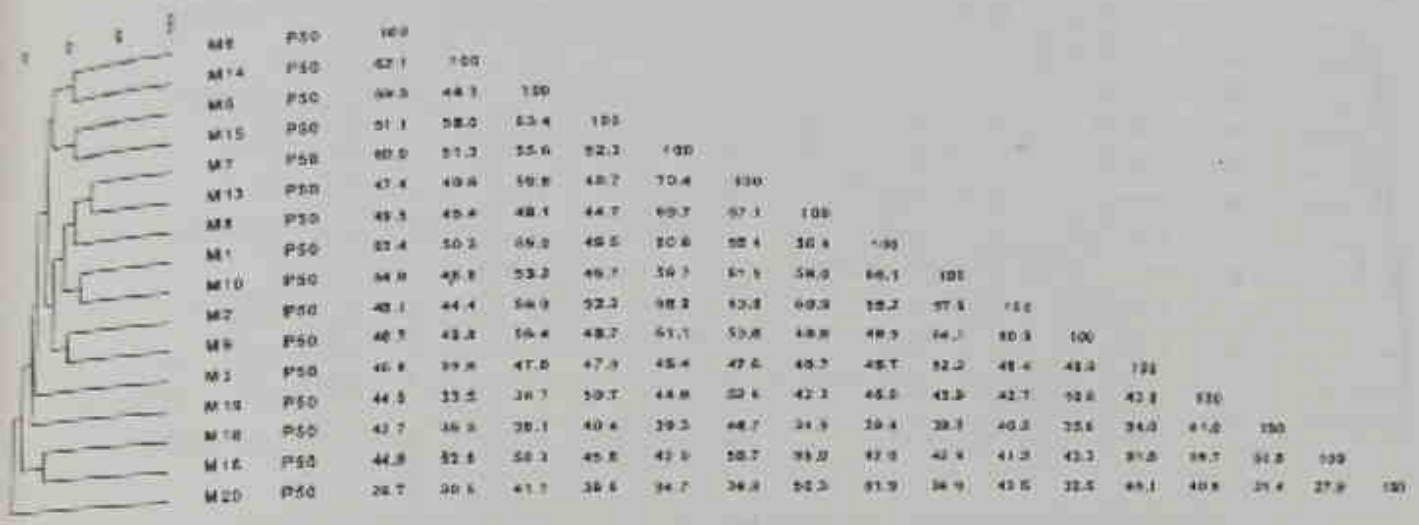


Fig 3. Similarity matrix for Girnar 1 mutants amplified using P50

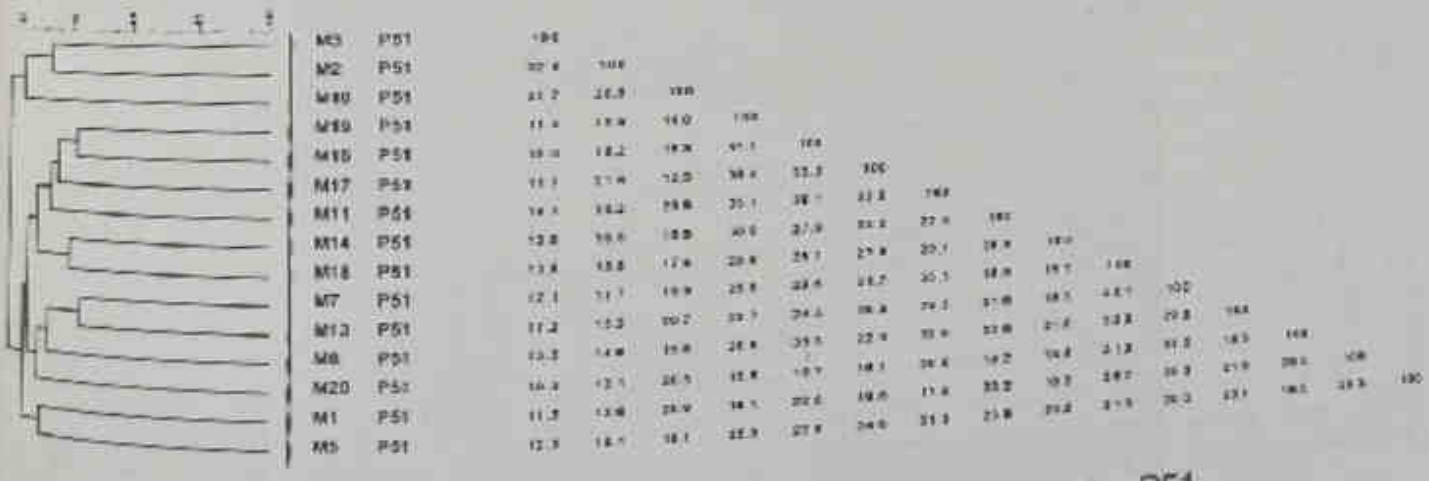


Fig 4. Similarity matrix for Girnar 1 mutants amplified using P51

Two hundred shoots from earlier co cultures have survived the selection with hygromycin and are now being rooted. Rooting was induced in 165 shoots and then hardened. The total survival was 90% after hardening (before field planting). The leaf disks from the hardened plants were collected and assayed for the expression of GUS (Fig 7). Sixty two percent of the plants tested positive in the tests repeated at least thrice.

6.1 Iso enzyme analysis in the germplasm materials

The iso enzymes of PPO, Estesrase and Peroxidase were studied in the wild *Arachis* species namely *Arachis duranensis, A. caradenasii, A. kretschmeri* (all resistant to Rust and LLS and J 11 (susceptible to Rust and LLS) and their F1s. No variations in isoenzyme pattern are discernible.

7 Experiment on Isolation Distance:

To determine isolation distance for seed production programmes in groundnut, an experiment was conducted with two varieties namely, HNG 10 (Virginia bunch) and Gangapuri (Valencia) belonging to the two sub-species using a dominant marker, crinkle leaf. The dominant marker was raised in the centre in 1 m^2 area for both HNG 10 and Gangapuri. The seeds were sown in concentric squares at equi-distance of 45 cm the case of HNG 10, and 30 cm in case of Gangapuri. The plant-to-plant spacing was maintained at 10 cm uniformly in both the cases.

The plants were harvested and bulked from the 8 directions each distances from the dominant pollen source separately. Presence of hybrids in these bulk samples will be determined.

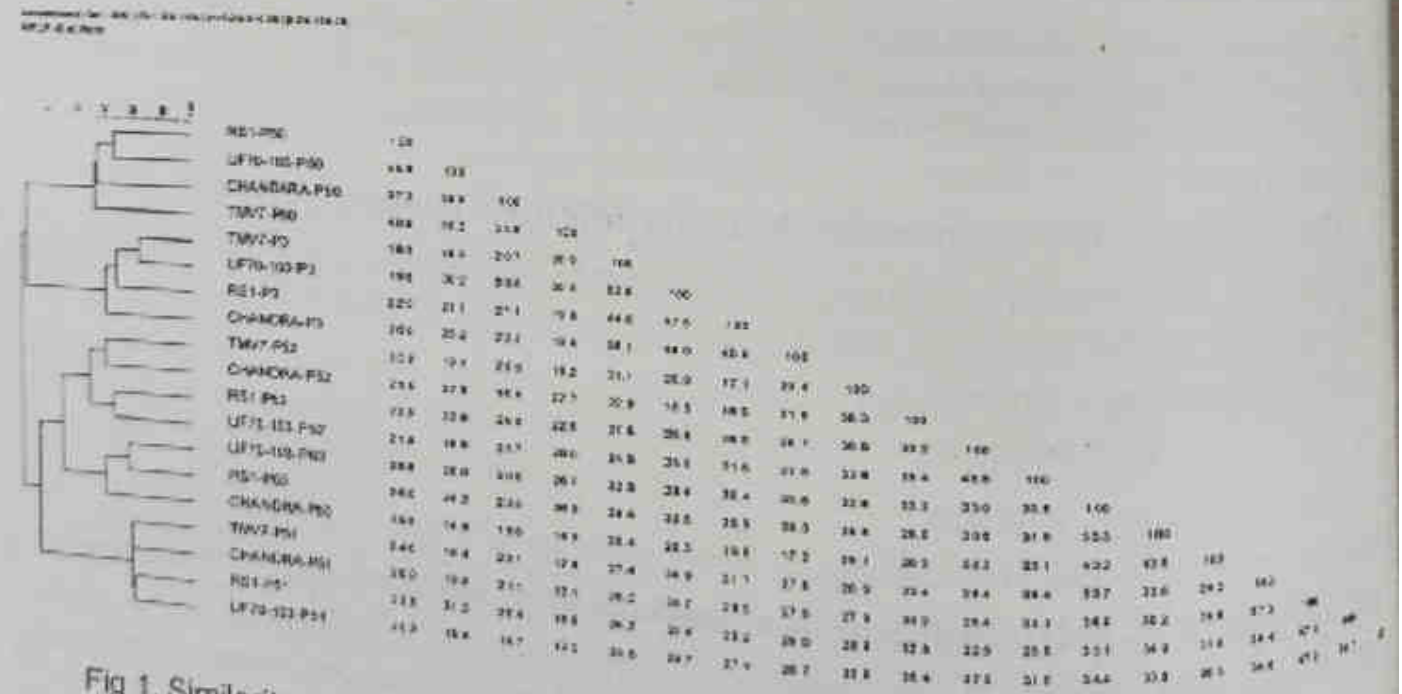


Fig 1. Similarity matrix for four different groundnut cultivars with five selected primers

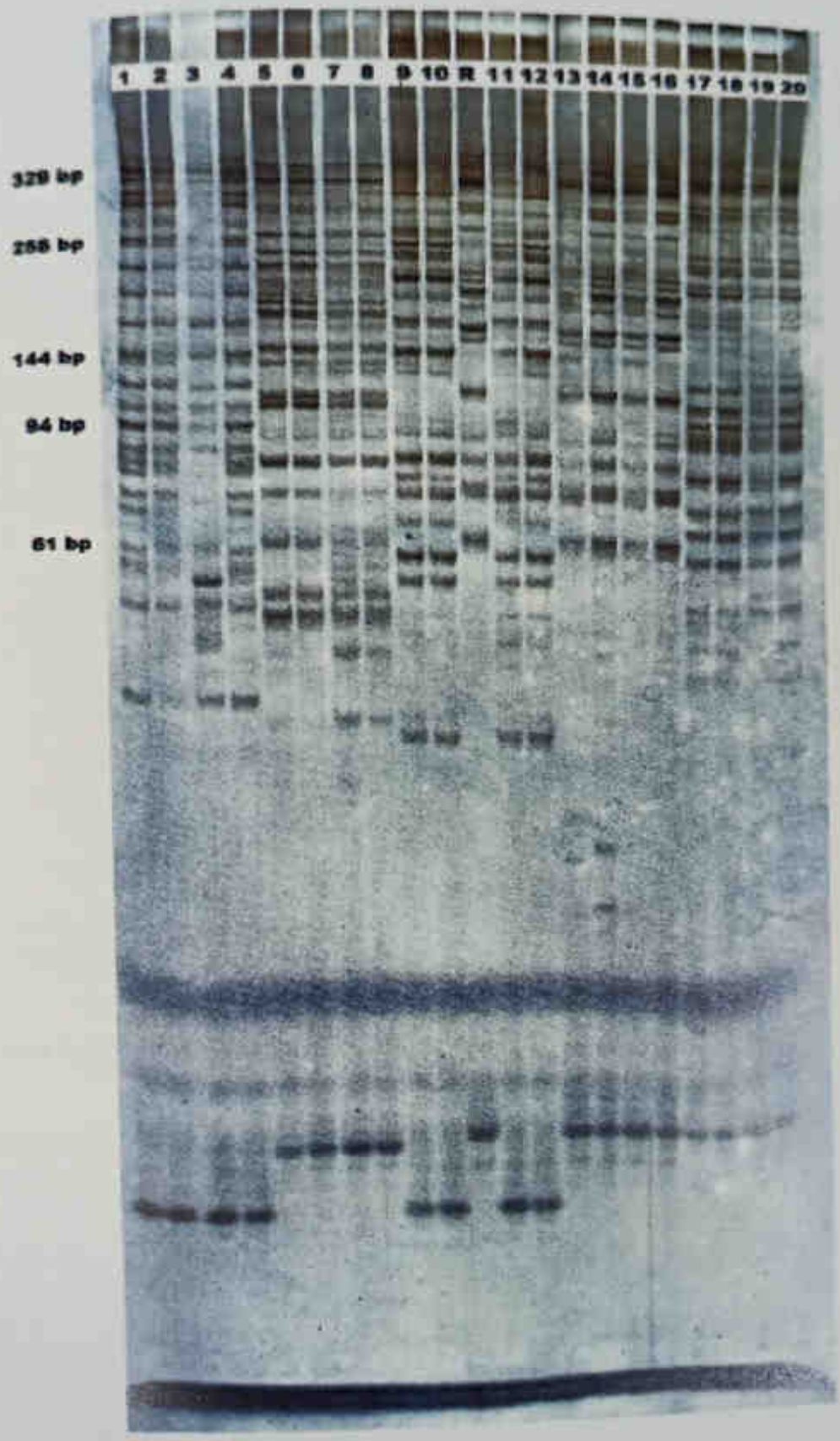


Fig 7. An AFLP Gel showing polymorphism

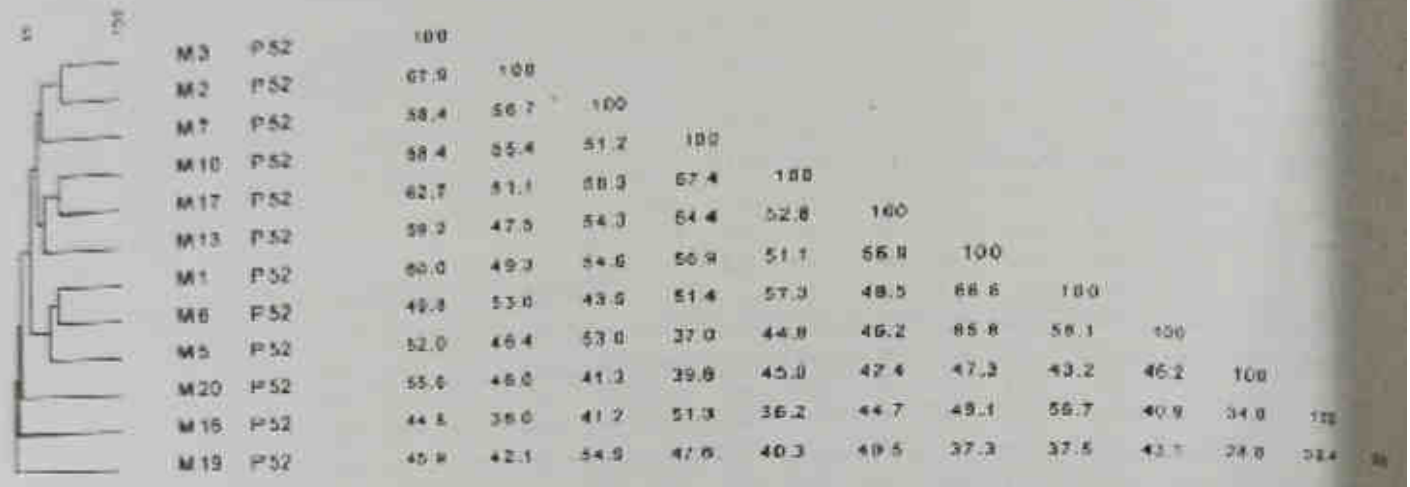


Fig 5. Similarity matrix for Girnar 1 mutants amplified using P52

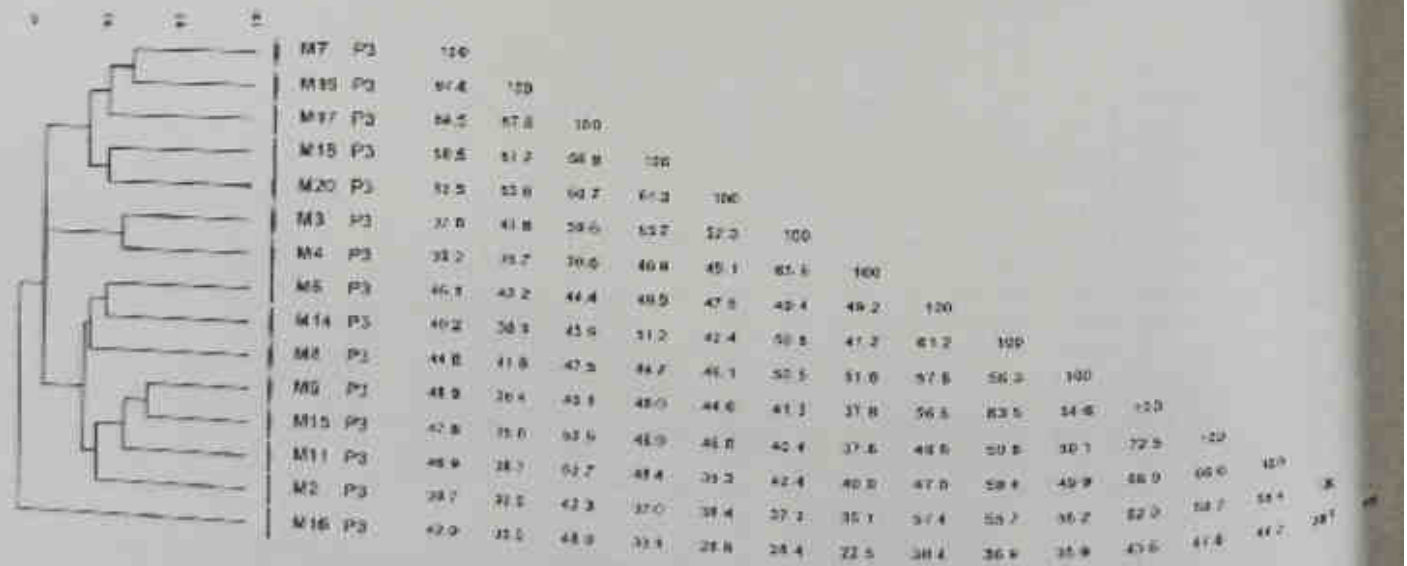


Fig 6. Similarity matrix for Girnar 1 mutants amplified using P3

1.1 Multiplication, Generation advancement and selection in segregating generations

Fifty-two advanced breeding lines were multiplied in *kharif* 2001. Of these, 38 lines were analyzed for quality attributes (Table 4). Another 12 cultures received from BARC were also multiplied.

Out of 26 crosses attempted for seed size, 16 were advanced from F2 generation to F3 generation. All the 15 crosses attempted for bold seed type were advanced to F3 generation. One cross for bold seed was advanced from F3 to F4 generation.

Out of 41 selections made for bold seed trait, 10 crosses and 27 selections were advanced to F6 generation.

Ten bold-seeded lines were evaluated in 5 row plots of 5 m length in RBD with three replications during *kharif* 2001 along with four checks BAU 13, GG 20, Somnath and B 95. PBS 29025, 24005, 24041, and 28014 were found to be the promising ones. Some attributes of these lines are given in table 5.

Sub-project 3: Genetic engineering for enhancement of quality

For attempting male gametophyte mediated transformation of groundnut, preliminary experiments were conducted to develop protocols for transformation of groundnut pollen grains. About 30% transformation of pollen grains could be achieved in the preliminary experiments. Anthers were removed from the flowers plucked early in the morning and forced to burst open and spread pollen grains on a petri dish precoated with agar medium and overlaid with a filter paper. Macrocarriers coated with gus gene were bombarded on the pollen grains through a 1100 psi rupture disc with the help of gene gun. Histochemical test of pollen grains confirmed expression of gus gene in about 30% pollen grains (fig 1).

Sub-project 4: Biotransformation of groundnut shell into useful products

1 Analysis of proximate composition of groundnut shell

The shell samples of the cultivars ALR 1 and B 95 (VB), GAUG 10 and GAUG 13 (VR), GG 2 and JL 24 (Spanish), Gangapuri and MH 2 (Valencia) representing four habit groups of groundnut were analyzed for their proximate composition. On an average basis, the groundnut shell contained 0.004% ether extract, 7.0% moisture, 2.52% total and 0.958 % reducing sugars, 6.18% crude protein and 4.8% ash (Table 6). The ether extract ranged from 0.001 to 0.012% and was highest in Virginia runner varieties while the Spanish varieties had the highest moisture content. The variety B 95, a Virginia bunch type, had the highest total sugar content (4.270%) while the Spanish varieties showed the highest reducing sugars. The highest crude protein content was found in the Virginia runner varieties. The maximum ash content was found in the Virginia bunch varieties.

2 Utilization of shell for soil amendment in groundnut crop

A field trial was conducted with cultivar GG 2 in *kharif*-01 to evaluate the potential of groundnut shell as organic amendment of soil in groundnut crop. The experiment was conducted in split split plot design with two main treatments for the time of application (30 days in advance of sowing and at the time of sowing), there were four sub-treatments for dose of application

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

J.B. MISRA, P. MANIVEL (UPTO 15-03-2002, AND CHUNI LAL; W.E.F.16-03-2002), K.K. PAL, R. DEY

Sub-project 1: Assessment of quality in germplasm collection, breeding material and produce of other experiments

1 Relationship between oil and protein contents of groundnut genotypes:

From the produce of *kharif*-2000, kernel samples of 84 genotypes (3 replications) were analyzed for protein content by Kjeldahl method. The protein content was in the range of 17.1 and 30.6% (Table 1). The oil content of these samples was in the range of 41.6 and 53.4%. A highly significant inverse relationship ($r = -0.37^{**}$) was observed between oil and protein contents of genotypes.

2 Further testing of performance of improved model of arachilipometer:

The performance of the improved model of arachilipometer was tested on the seed samples of 84 genotypes. The oil content of these samples (as determined by the conventional Soxhlet method) was in the range of 41.6-53.4% with a value of 47.5% for mean. When the oil content of these samples was determined by arachilipometer, the corresponding values of were 40.8-52.3% and 46.6%, respectively. The samples showing the minimum oil contents were identical for both the methods. The value of coefficient of correlation was quite high (0.92; significant at 1% level). It was thus demonstrated that for groundnut seeds, the improved model of arachilipometer has all the potential of providing a simple, economical and rapid alternative for Soxhlet method.

3 Service to other sections

A total of 1010 samples emanating from various field trials conducted at NRCG and elsewhere were analyzed for their oil content and 84 samples for their stability index (O/L ratio). The ranges of values obtained are shown in tables 2 and 3, respectively.

Sub-project 2: Genetics and breeding for confectionery and HPS groundnut

1 Hybridization programme

Using high oil genotypes, HNG(HPS)2 and Kadiri 3, as high-oil parents, and TMV2 and TGK 19A as the low-oil parent, fresh crosses in six cross combinations were attempted during *Kharif* 2001 to study the genetics of oil content (4 crosses- HNG(HPS)2 x TMV 2, TMV2 x HNG(HPS)2; Kadiri 3 x TKG 19A, TKG 19A x Kadiri 3). Another 2 crosses were made for studying inheritance of bold-seeded trait. PBS 11039 was used as bold-seeded parent while *A. monticola* was used as small seeded parent. The crosses were PBS 11039 x *A. monticola*, and *A. monticola* x PBS 11039). A total of 252 probable hybrid pods were harvested.

Table : 1 Protein content of kernels of groundnut genotypes.

	Genotype	Protein
Spanish bunch		
1	ICGS 1	17.1
2	ICGS 21	18.1
3	ICGS 11	19.5
4	TKG 19-A	20.5
5	ICGS 44	20.7
6	VRI 2	22.2
7	K 134	22.4
8	TG 26	22.4
9	TPT 2	23.2
10	JYOTI	23.3
11	TAG 24	24.0
12	ALR 2	25.2
13	Tirupati 4	25.2
14	KRG 1	25.4
15	VRI 3	25.7
16	Girnar 1	25.9
17	RG 141	25.8
18	TMV 7	25.9
19	VG 9521	26.1
20	J 11	26.3
21	Jawan	26.4
22	ICGS 76	26.6
23	TPT 1	27.2
24	ICGV 86590	27.3
25	JL 24	27.4
26	TG 17	27.4
27	AK 12-24	27.6
28	TG 3	27.7
29	TMV-12	28.2
30	ICG(FDRS)4	28.3
31	MH 1	28.4
32	Sp.improved	27.03
33	SB XI	28.04
34	TMV 2	28.1
35	SG 84	28.3
36	DH 8	28.5
37	TG 87	28.7
38	DH 3-30	29.1
39	S 206	29.8
40	GG 3	30.6
	Min	**17.1**
	Max	**30.6**
	Mean	**25.6**
Virginia bunch		
41	TG 64	18.5
42	HNG(HPS)2	20.6
43	ICGV 86325	20.8
44	Kadiri 3	21.1
45	R 9251	21.4
46	TMV 10	24.2
47	BG 2	24.3
48	ICGS 5	24.3
49	R 8808	24.6
50	BAU 13	26.4
51	RSB 87	26.7
52	B 95	26.8
53	ALR 3	27.3
54	M 145	27.7
55	T 28	26.7
56	Somnath	27.7
57	ALR 1	27.9
58	LGN 2	28.4
59	M 522	28.8
	Min	**18.5**
	Max	**28.8**
	Mean	**25.0**
Valencia		
60	Gangapuri	28.3
Virginia runner		
61	Chandra	17.5
62	GG 13	19.1
63	Punjab 1	21.4
64	Chitra	21.6
65	UF 70-103	21.7
66	Kaushal	22.1
67	M 335	22.9
68	GG 11	23.2
69	DRG 12	23.7
70	NRCG 750	23.7
71	GG 20	23.9
72	CSMG 884	28.5
73	GG 2	24.7
74	M 13	25.6
75	RS 1	25.6
76	GG 4	25.8
77	M 197	25.9
78	M 37	26.3
79	DRG 17	27.1
80	GG 12	27.8
81	KARAD 4-1	27.9
82	S 230	28.3
83	CSMG 84-1	28.5
84	GAUG 10	29.4
	Min	**17.5**
	Max	**29.4**
	Mean	**24.7**

applied (0, 5, 10 and 15 t/ha) and two sub-sub treatments for level of inoculation (uninoculated and inoculated with *Bacillus*- a shell decomposing organism). The results are presented in tables 7, 8 and 9.

2.1 Effect of time of application

The plant biomass (45 days after sowing), pod and haulm yields, HKM and shelling outturn were significantly higher in the plots where the shell was applied at the time of sowing than where the shell was applied 30 days in advance of sowing. In addition, there was also an improvement in nodule number, nodule dry mass and nitrogen content of kernel and phosphorus content of kernel and soil. The differences, however, were marginal. There was no significant difference in the two treatments on the phosphorus content of plant but there was a significant lowering in plant nitrogen content.

2.2 Effect of dose of shell

The highest pod yield (1576 kg/ha) was obtained with the dose of 10 t/ha, which was accompanied by the highest haulm yield, plant biomass, nodule number and dry weight, and plant phosphorus content. The next highest pod yield (1545 kg/ha) was obtained with the dose of 5 t/ha, which was accompanied by the next lowest haulm yield. In the control plots without the application of shells, the pod (1365 kg/ha) and haulm yields, plant biomass, HKM, shelling out turn, nodule number and dry weight were the lowest.

2.3 Effect of inoculation

The effect of inoculation of shell with *Bacillus* sp. was not significant on most parameters studied. There was, however, a significant improvement in haulm yield, nodule dry weight and plant nitrogen content.

Thus application of groundnut shell brought about significant improvement in both growth and yield attributes of groundnut crop when applied at the rate of 5 to 10 t/ha.

3 Utilisation of shell as a substrate for production of industrially useful organic acids and enzymes:

Work was initiated at laboratory scale in a 10L fermenter for converting shell carbohydrates into alcohols and organic acids. Preliminary experiments were successful in obtaining alcohol by employing *Saccharomyces cerevisiae* while citric acid could be produced by employing *Aspergillus niger*. Isolation of the fermentation products from the broth is in progress.

Attempts were also made to produce cellulase using groundnut shell as substrate for *Phanerochaete chrysosporium*- a cellulase producing fungus. The cellulase so produced has been isolated. Studies are also underway to optimize the production.

Table 5. Some attributes of advanced bold-seeded breeding lines

Breeding line	Pod yield (kg/ha)	Increase over checks(%)				Shelling out turn(%)	100-seed mass (g)
		B 95	GG 20	Somnath	BAU 13		
PBS 29025	4321	20	15	50	30	73	71
PBS 24005	4068	13	8	41	23	72	54
PBS 24041	4061	12	8	40	23	72	65
PBS 28014	3947	10	6	36	20	74	63

Table 6. Proximate composition of groundnut shell

Habit group and cultivar	Ethere xtract(%)	Moisture (%)	Total sugars (%)	Reducing sugars (%)	Crude protein (%)	Ash (%)
Virginia bunch						
ALR 1	0.006	6.3	0.575	0.479	4.13	6.04
B 95	0.003	6.8	4.270	0.901	6.88	6.18
Virginia runner						
GAUG 10	0.012	7.5	2.085	0.735	8.19	3.98
GAUG 13	0.003	7.5	2.205	0.732	7.56	3.10
Spanish						
GG 2	0.005	8.0	2.882	1.212	5.13	7.54
JL 24	0.003	7.2	2.869	1.295	7.38	3.90
Valencia						
Gangapuri	0.001	6.6	3.052	1.185	5.63	2.20
MH 2	0.001	6.3	2.224	1.124	4.50	5.46
Mean	0.004	7.0	2.520	0.958	6.18	4.80

Table 7. Effect of soil amendment with groundnut shell on the growth and yield of groundnut cv. GG 2 (*Kharif* 2001)

Time of application, dose and inoculation status	Yield		Plant biomass (45 days after sowing)	HKM	Shellingout turn
	Pod	Haulm			
	Kg/ha	Kg/ha	(g/p)	(g)	(%)
A. Time of application					
30 Day before sowing	1356	2705	12.02	35.89	69.92
At the time of sowing	1542	2904	13.60	37.98	71.12
LSD (0.05)	55	118	0.25	1.16	0.949
B. Dose (shell t/ha)					
0	1305	2582	12.06	35.63	69.33
5	1545	2799	12.92	36.64	70.17
10	1576	2916	13.41	37.36	71.50
15	1371	2921	12.85	38.10	71.08
LSD (0.05)	48	67	0.49	0.37	0.877
C. Inoculation status					
Without inoculation	1453	2749	12.74	36.91	70.50
With inoculation	1446	2860	12.88	36.96	70.54
LSD (0.05)	NS	50	NS	NS	NS

Table 2: Oil content and range of values for the samples received from various trials

Section	Soxhlet method			Arachilipometer		
	Number	Range(%)	Mean(%)	Number	Range(%)	Mean(%)
Genetic resources	27 (ws)	41.2-52.0	47.8	653	41.3-54.8	47.8
	8 (rv)	45.4-53.6	48.9	114	45.3-52.5	48.9
Plant breeding Row trial				54	44.3-53.3	
Spanish trialVirginia trial				48	46.3-51.8	
Physiology				53	42.8-50.5	
GAU				33	42.5-49.5	

ws = wild species; rv = released variety

Table 3: Stability Index of groundnut kernel samples received from various trials:

Section	No.	Range
Agronomy (organic farming)	24	3.5 - 6.7
GRS (released varieties)	8	1.22 - 4.63
GRS (wild spp.)	27	0.81 - 2.33
Physiology (seed colour)	25	1.1 - 4.9

Table 4: Oil content of some advance bold seeded breeding lines:

SN.	Identity name	Oil %	SN.	Identity name	Oil %
1	PBS 11037	51.7	22	PBS 30084	50.2
2	PBS 12160	48.0	23	PBS 30104	50.7
3	PBS 14013	48.5	24	PBS 30110	47.8
4	PBS 14026	48.8	25	PBS 30132	47.5
5	PBS 18003	48.5	26	PBS 30135	48.3
6	PBS 18019	48.7	27	PBS 30147	50.7
7	PBS 18035	47.8	28	PBS 30156	52.3
8	PBS 18046	48. 7	29	PBS 30158	52.5
9	PBS 18063	48. 7	30	PBS 30159	50.2
10	PBS 18064	49. 7	31	GG 2* NRCG 2746A	49.0
11	PBS 21046	52.2	32	GIRNAR	49.7
12	PBS 22039	49. 7	33	GG 2	45.3
13	PBS 30016	49.8	34	JL 24	46.8
14	PBS 30031	51.0	35	KADIRI 3	45.7
15	PBS 30036	48. 7	36	ICGS 44	48.7
16	PBS 30037	48. 7	37	PBS 29058	51.2
17	PBS 30041	51.1	38	PBS 29060	50.0
18	PBS 30044	49.5			
19	PBS 30052	48.8		Minimum	45.33
20	PBS 30071	49.0		Maximum	52.50
21	PBS 30073	49.8		Mean	49.31

PROJECT 11. PREVENTION AND MANAGEMENT OF AFLATOXINS IN GROUNDNUT

(S. DESAI, M.P. GHEWANDE)

Aflatoxins are carcinogenic mycotoxins produced by species *Aspergillus* especially *A. flavus* and *A. parasiticus*. The fungus can contaminate the crop in the field, in the storage, during processing and transshipment. During 2001-2002, the objectives set were survey for the incidence of the problem in different agro-ecological conditions and then develop integrated management package for on-farm evaluation. This major work was done under the externally funded project namely Aflatoxin contamination in groundnut: Mapping and management in Gujarat, Andhra Pradesh and adjoining areas where the results are presented.

Table 8. Effect of soil amendment with groundnut shell on nodulation characteristics and plant nitrogen content of cv. GG2 (*Kharif*, 2001)

Time of application, dose and inoculation status	Nodulation		Nitrogen	
	(no/plant)	Dry weight (mg/plant)	Haulm (%)	Kernel (%)
A. Time of application				
30 Day before sowing	56	74.98	1.75	4.75
At the time of sowing	72	93.29	1.61	4.85
LSD (0.05)	6	4.51	0.05	0.021
B. Dose (shell t/ha)				
0	53	69.87	1.69	4.76
5	61	86.48	1.72	4.84
10	70	91.14	1.65	4.82
15	74	89.05	1.68	4.78
LSD (0.05)	3	4.93	NS	0.048
C. Inoculation status				
Without inoculation	61	80.17	1.66	4.78
With inoculation	68	88.10	1.71	4.82
LSD (0.05)	3	4.01	0.02	0.025

Table 9. Effect of soil amendment with groundnut shell on plant and soil phosphorus contents of groundnut cv. GG2 (*Kharif*, 2001)

Time of application, dose and inoculation status	Phosphorus		
	Plant (%)	Kernel (%)	Soil (ppm)
A. Time of application			
30 Day before sowing	0.139	0.439	2.33
At the time of sowing	0.139	0.452	2.46
LSD (0.05)	NS	0.011	0.042
B. Dose (shell t/ha)			
0	0.133	0.442	2.06
5	0.138	0.441	2.48
10	0.144	0.442	2.47
15	0.140	0.458	2.57
LSD (0.05)	0.0033	0.010	0.058
C. Inoculation status			
Without inoculation	0.139	0.445	2.36
With inoculation	0.139	0.446	2.43
LSD (0.05)	NS	NS	0.039

EXTERNALLY FUNDED PROJECTS

SYNTHESIS OF GLM PHEROMONE LURES

(DR. V. NANDAGOPAL)

SOURCE OF FUNDING : AP CESS FUND

1 Synthesis and studies on GLM pheromone lures

1.1 Behavioral studies

With individual pheromone components, blend and lures were used to confirm species specificity using Electroantennograph (EAG) & Wind tunnel equipment. To understand the behavioral aspect of the GLM against the pheromone components, the antennae (Fig-2).

1.1.1 Using Electro Antenna Gram (EAG)

The antenna of the one day old males maintained in the laboratory was cut using a micro-scissor and fitted into the holder of the EAG with the help of a special gel which has been connected to the EAG main equipment. The different components of the sex pheromone were smeared in a concentration of 1 µ g/1 µ l on a filter paper, and inserted in to EAG end. On activation of the EAG, sterile airflows carrying the sex pheromone compound, which in turn carries the pheromone on to the antenna. On the receipt of the pheromone the antenna responded in terms of µ volt (Table 1).

Table 1. The EAG response of male antennae to the component of pheromone

S. No.	Compound	EAG in mV
1.	Synthetic lure	1.934
2.	Z. isomer (Z7-decenyl acetate)	2.478
3.	E. isomer (E7-decenyl acetate)	0.884
4.	Hexane	0.387

GLM males showed good EAG response to sex pheromone lure as well as to the individual components. Since the response to Z-isomer was the highest in the experiments significant behavioral activity could be expected in the wind tunnel bioassay also.

Dose response activity: EAG responses of GLM males against different concentrations of synthetic lures (NRI sample) and the individual components synthesized at IICT were recorded in order to establish the suitable doses for monitoring GLM in the wind tunnel and in the field trials. The different doses were always obtained from 1% solutions prepared in N- hexane.

1.1.2 Wind tunnel bioassay

It is a large structure having a transparent PVC cylinder, one side fitted with a filter and another side with a suction motor having a switch which can be adjusted to any wind speed with which it sucks the air. In side the transparent PVC cylinder two holders of an height of about 20 cm where the pheromone source is held. In the other holder, the freshly emerged virgin females in a small box are held. The lid of the plastic box was removed allowing the males to respond to the pheromone comes from the sources kept in the holder. Each time about 5 to 8 males were

used and the number males moved towards the source of the pheromone and the distance moved in terms of % distance were noted.

Behavioral bioassay experiments were conducted against GLM males using the synthetic lures in vials and with the individual pheromone components (Z-7, E-7 Decenyl acetates). The individual components were impregnated in rubber septa and plastic vials. Experimental procedures, scoring system and the wind tunnel used for the experiments were described earlier. The results of the experiment is summarized in the Table 2.

Table 2. Response of male to pheromone in the wind tunnel

Compound	Septa	No. of insects released	Distance traveled in the tunnel		
			(100%)	(50%)	NO ACTIVITY
Z-7	Rubber septa	7	2(full of activity)	2	3
	Plastic vial	5	1	3	2
E-7	Rubber septa	7	-	-	-
	Plastic vial	9	4	1	4
Blend	Plastic vial	5	2	1	2

50%= SCORE 2; 100%= SCORE 3 & 4; Insects exhibiting score 2, 3 & 4 behaviour always showed score 1 behaviour i.e., taking flight upwind.

1.2 GLM activity studies

In addition to the behavioral bioassays activity patterns of GLM were also recorded with the help of Microwave Radar Actometer. The activity pattern of insects provide information about the most activity periods such as calling and mating, which would be subsequently used for the proper pheromone extraction and utilization. The activity charts for the male GLM was recorded by monitoring insects for 24 hrs in the actometers I & II under 12:12 day: night conditions. The results indicated that the male GLM showed activity mostly during the nighttime. The actual activity started after 2 hrs of the onset of the scotophase. However, the continued activity was recorded only from the midnight i.e., from 2400 to 0330 hrs. This activity in the male GLM would represent the period of most receptivity.

1.3 Field trial using pheromone

Pheromone components synthesized by IICT and blends were taken for field efficacy studies. The result indicate that one pheromone component (Z) 7- Decenylacetate III (3mg\vial) trapped 10.8 moths\day\trap, the highest among all component though the initial infestation by GLM larvae was below 2%. Even the precursor 7-Decenyl-9-ene-acetate (3mg/ vials) attracted 2.6 males/day/trap (Table 3).

Table 3. The sex pheromone precursor tried in the field

S. No.	Compound	Treatment	Loading	Males Trapped day/trap
01	7-Decyn-9-ene-acetate	Pheromone precursor	3 mg	2.6
02	(Z)7-Decenyl acetate (III)	Pheromone component	3 mg	10.8
03	(E)7-Decenyl acetate (II)	Pheromone component	3 mg	1.2
04	(E)7-Decenyl acetate (II) + (Z)7-Decenyl acetate (III)	Pheromone Blend of II & III in 2:1.4 ratio	3 mg	1.4
05	7-Decen-9-ene acetate, E7-Decenyl acetate (II) & Z7-Decenyl acetate (III)	Pheromone Blend in 10:2:1.4 ratio	3 mg	3.4

1.4 Evaluation of the traps

Traps were fabricated using polyvinyl sheet and the commercially available sticka trap from Pest Control India. These were evaluated by modifying the size of the entry holes. Among them a market available sticky trap (4IID) - 24 cm length X 10 cm width (triangle) with square mobility hole of 12 cm length X 10 cm width on both the side taken bottom, altogether four holes could trap the maximum number of males (25.6/trap/day).

TECHONOLOGY ASSESSMENT AND REFINEMENT-INSTITUTE VILLAGE LINKAGE PROGRAMME (TAR-IVLP)

(M.P. GHEWANDE, V.NANDGOPAL, DEVIDYAL, SAMDUR, SATISHKUMAR, K.S.MURTHY)

SOURCE OF FUNDING : NATP

Eight interventions were evaluated in four targeted villages namely, Vadhavi, Umatwada, Nandarkhi and Zanjarda of Junagadh district (Gujarat) during the year 2001-2002. Integrated Nutrient Management (INM) in groundnut + Pigeonpea intercropping with application N, P and K through ammonium sulphate, SSP and MOP along with PSM increased pod yield of groundnut by 55% and grain yield of pigeon pea by 44 % over the farmers' practice of nutrient management (application of DAP only). The recommended NPK treatment recorded higher gross monetary returns of Rs. 65617/ha with CBR of 1:4.18 in case of groundnut + pigeon pea as against Rs. 45502.84/ha under farmers' practice(CBR 1: 3.13). Superiority of INM in groundnut + castor intercropping was also demonstrated. Intercropping of Groundnut + castor with recommended NPK increased pod yield of groundnut by 17 % over the farmers' practice. Groundnut + castor intercroping with recommended NPK and gypsum + PSM gave maximum monetary return of Rs. 60387.45/ha. However, CBR was slightly higher (1:3.90) in recommended NPK alone. The IPM technology was tested against the farmers' practice of the pest control (disease and insect pests) in rain fed groundnut.

This technology included seed treatment with carbendazim @ 2g/kg seed, soil application of castor cake @ 500 kg/ha, foliar spray of neem oil 2%, pheromone trap @ 8/ha and castor as a trap crop. The IPM technology improved plant stand by 6 % and significantly reduced defoliators, sucking pests and diseases (leaf spots, stem and collar rots), and thereby increased pod yield of groundnut by 15.19 % and gross monetary return by 15.72% with ICBR of 4.06 over the farmers' practice. Integrated disease management of collar and stem rots of groundnut through the application of castor cake @ 500 kg/ha + *Trichoderma viride* @ 62.5 kg/ha resulted in reduction of incidence of collar rot by 83% and stem rot by 66%, thus, increased pod yield by 47.44% over the farmers' practice. Soil application of castor cake recorded higher gross monetary return of Rs. 47976/ha as against Rs. 33173/ha under farmers' practice. But ICBR of 24.79 was higher in soil application of *T. viride*. Basal application of sulphur @ 20 kg/ha reduced yellowing in groundnut considerably by 50% and increased pod and haulm yields by 20.63% and 27.07% respectively, and gross monetary return by 20 % over the farmers' practice. The practice of Deep tillage in rain fed groundnut increased pod and haulm yields by 24.65% and 19.71% respectively over the shallow tillage as practiced by the farmers. Deep tillage also reduced incidence of collar and stem rots by 78% and 51% respectively and increased gross monetary return by 24% over the farmers' practice of shallow tillage. Cotton + groundnut intercropping gave higher monetary return of Rs. 66148/ha with CBR of 1:2.49 as against farmers' practice(Rs. 19320/ha, CBR- 1: 1.61). Feeding of Silage of fodder Sorghum increased milk yield by 15.27% with higher monetary return of Rs. 91 per day per animal as against farmers' practice (Rs. 79 per day per animal).

IDENTIFICATION OF EFFICIENTLY NODULATING AND NITROGEN FIXING STRAINS OF BRADYRHIZOBIUM IN GUJARAT AND THEIR APPLICATION

(K. K. PAL, RINKU DEY)

SOURCE OF FUNDING: DBT

Artificial inoculation quite often fails especially in groundnut because of competition from native rhizobia and the fact that groundnut can be nodulated by a whole plethora of rhizobial strains. Therefore, the project aims at identifying efficient strains of groundnut rhizobia from the native soil which will be able to out compete the inefficient strains.

1 Nodule occupancy in field

In order to study the nodule occupancy under field conditions spontaneous rifampicin resistant mutants of the competitive strains were developed. The nodule occupancy of all the inoculants strains was determined both in pots and in field during rabi-summer and kharif seasons of 2001.

2 Pot trials during rabi-summer and kharif seasons of 2001

During the rabi-summer season, a total of fourteen isolates were tested in pots. In general, the inoculated treatments resulted in greater pod yield compared to that of control. Significantly higher pod yield was recorded in treatments inoculated with TAL1000 and NRCG 9 cultures.

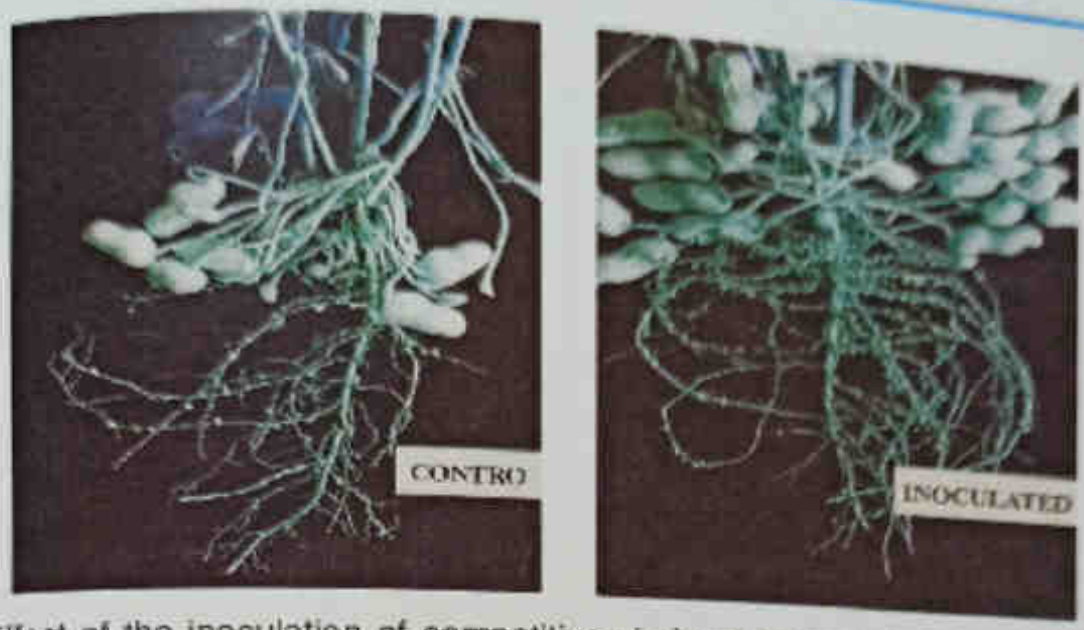


Plate 1. Effect of the inoculation of competitive strain of groundnut *Rhizobium*; left: control; right:inoculated

There was considerable seasonal variation in the biological nitrogen fixation parameters and the crop growth and yield parameters. Therefore, examining all the BNF parameters and yield attributes, best consistency was found in case of two cultures viz., NRCG4 and NRCG9 inoculation of which enhanced nodule number, nodule dry weight, nodule occupancy, plant biomass, ARA and pod yield in majority of the cases. Both the cultures (NRCG4 and NRCG9) were $Aba^{+}Sid^{+}$.

3.3 Nodule occupancy of the inoculants using Tn5::*lacZ* molecular marker:

Tn5::*lacZ* molecular marker was used for studying the nodule occupancy of an inoculant strain, NRCG12, in pots. One hundred sixty one putative mutants were obtained. The nodule occupancy was studied in pots under un-sterile conditions. In some of the mutants, nodule occupancy was enhanced, while majority of the mutants exhibited nodule occupancy like that of the wild type (Table 4).

a b

Plate 2. (a) Variation in nodule size of groundnut formed by different competitive strain of groundnut rhizobia; (b) evaluation of nodule occupancy of groundnut rhizobia using Tn5::*lacZ* molecular marker

The other inoculated treatments resulted in pod yield at par with control (Table 1). There was a significant increase in nodule dry weight in treatments inoculated with TAL1000, NRCG4, NRCG5, NRCG6, NRCG7, NRCG8, NRCG9 and NRCG22 isolates. All other inoculated treatments resulted in increase in nodule dry weight at par with control. However, significantly higher ARA values were recorded with treatments inoculated with NRCG2, NRCG4, NRCG5, NRCG8, NRCG9 and NRCG22 isolates (Table 1). The maximum ARA value was obtained in case of isolate NRCG9. When nodule occupancy was determined on the basis of spontaneous rifampicin resistance it was evident that most of the newly isolated rhizobial cultures exhibited better nodule occupancy than NC92 and TAL1000 cultures. Isolates NRCG9, NRCG4 and NRCG3 showed very high nodule occupancy and the maximum nodule occupancy was recorded with NRCG 9 (74%).

A total of twelve isolates were tested during the kharif season of 2001. Results indicated that inoculation of groundnut rhizobia isolates NRCG 3, NRCG4 and NRCG9 significantly enhanced pod yield, nodule dry weight and ARA activity (Table 1) as compared to control. Nodule occupancy of the inoculants strains, as evaluated on the basis of spontaneous Rifampicin resistance, indicated that there was considerable variation among the inoculants strains in occupying the nodules (Table 1). Maximum nodule occupancy was obtained with NRCG9 (75%).

3 Field trials

3.1 Rabi-summer

In a field trial during summer 2001, treatments inoculated with groundnut rhizobia enhanced the pod yield, haulm yield, nodule dry weight, and ARA in general. However, significantly higher pod yield, haulm yield, nodule dry weight and ARA activity were recorded with the inoculation of rhizobial NRCG4 and NRCG9 (Table 2) as compared to control. There was also an enhancement in the N content in shoot and kernel (Table 2). In field, nodule occupancy of the inoculated treatments was recorded on the basis of spontaneous rifampicin resistance. At 45 DAS, the NRCG isolates exhibited nodule occupancy of 25% (NRCG 22) to 77%(NRCG 4), with NRCG 6 and NRCG 8 isolates showing 66% and 65% nodule occupancy respectively, while NC92 exhibited 59% nodule occupancy. At 75 DAS, the nodule occupancy ranged from 21% (NRCG1, NRCG22) to 68%(NRCG5), with 63% nodule occupancy in case of NRCG6 and NRCG8, while NC92 showed 31% nodule occupancy (Table 2).

3.2 Kharif season:

During the kharif season, significantly higher pod yield, haulm yield, nodule dry weight, ARA activity, and nitrogen contents in shoot and kernel was recorded with the inoculation of rhizobial isolates NRCG9 (Table 3). However, groundnut rhizobial isolates NRCG3, NRCG5, NRCG6 and NRCG12 enhanced haulm yield. Isolates TAL1000, NRCG4, NRCG6, NRCG8, NRCG11 and NRCG12 enhanced pod yield. Isolates NRCG4 enhanced nodule dry weight and ARA, significantly as compared to control. Nodule occupancy, under field conditions, as evaluated on the basis of spontaneous rifampicin resistance varied considerably from 31-71%.

Table 3. Evaluation of efficient and competitive strains of peanut rhizobia in field (cultivar GG2, kharif, 2001)*

Isolates	Pod yield (Kg/ha)	Haulm yield (Kg/ha)	NDW (mg/p)	ARA (µmole C2H4/p/hr)	N in shoot (%)	N in kernel (%)	Nodule occupancy (%)
Control	1208	2845	86.37	53	1.345	4.226	-
NC 92	1237	2847	83.90	58	1.622	4.161	43
TAL 1000	1477	2722	94.93	64	1.479	5.003	38
NRCG 1	1286	2849	93.25	47	1.608	4.867	56
NRCG 2	1237	3030	77.55	39	1.597	5.059	44
NRCG 3	1267	3211	84.90	44	1.860	5.031	56
NRCG 4	1383	2787	103.30	69	1.772	5.039	59
NRCG 5	1239	3142	82.30	61	1.440	5.031	37
NRCG 6	1487	3195	73.65	49	1.562	5.384	22
NRCG 8	1387	2967	82.40	61	1.770	4.791	31
NRCG 9	1434	3230	105.45	73	2.105	5.070	71
NRCG 11	1365	3127	65.75	49	1.712	4.912	60
NRCG 12	1339	3217	90.40	55	1.385	4.376	58
CD (0.05)	**105**	**286**	**14.01**	**12.92**	**0.521**	**0.761**	-

*Data represents mean of four replications

Table 4. Nodule occupancy of NRCG 12 using Tn5::lacZ marker during kharif season of 2001 in pots, cultivar GG2 (Summary)

Wild type/mutants	Nodule occupancy	Wild type/mutants	Nodule occupancy
Wild type	52	M 57	60
M 13	61	M 62	46
M15	50	M 65	54
M16	45	M 70	41
M22	58	M73	44
M23	49	M 78	39
M35	50	M 105	61
M39	58	M 108	62
M44	51	M 109	52
M48	44	M 112	53
M51	54	M 154	48
M55	56		

Table 1. Evaluation of efficient and competitive strains of peanut rhizobia in pots (rabi-summer and kharif, 2001)

	Pod yield (g/p)		Nodule dry weight (mg/p)		Nodule occupancy (%)		ARA (µmole C_2H_4/plant/hr)	
	Rabi	Kharif	Rabi	Kharif	Rabi	Kharif	Rabi	Kharif
Control	5.11	3.14	76.33	44.37	-	-	27	41
TAL 1000	6.37	3.41	95.67	39.31	48	27.5	39	47
NC 92	5.95	3.53	88.33	77.91	44	38.3	41	61
NRCG 1	5.24	3.43	73.00	67.23	57	30.0	32	39
NRCG 2	5.58	3.68	78.33	55.64	63	57.5	47	54
NRCG 3	4.75	3.94	72.67	77.82	71	40.0	36	63
NRCG 4	5.20	5.99	103.67	113.23	73	60.0	67	59
NRCG 5	5.65	5.73	97.67	54.31	54	67.0	53	38
NRCG 6	6.07	3.67	105.67	46.21	54	60.0	31	41
NRCG 7	4.61	-	110.33	-	35	-	25	-
NRCG 8	5.84	3.50	115.33	63.67	65	25.0	53	68
NRCG 9	6.40	5.32	118.00	93.28	74	75.0	72	39
NRCG 11	5.88	5.12	89.00	66.34	54	37.5	29	33
NRCG 12	5.39	3.37	70.00	51.25	70	58.3	51	42
NRCG 22	5.67	-	117.67	-	61	-	44	-
CD (0.05)	**1.00**	**0.64**	**16.10**	**18.79**	-	-	**17.8**	**13.2**

Table 2. Evaluation of efficient and competitive strains of peanut rhizobia in field (cultivar GG2, rabi-summer, 2001)*

Isolates	Pod yield (Kg/ha)	Haulm yield (Kg/ha)	Nodule dry wt. (mg/ 5 plant)	ARA (µmole C2H4/p/hr)	N content (%)		Nodule occupancy (%)	
					Shoot	Kernel	45 DAS	75 DAS
Control	2417	4163	321	39	1.421	4.312	-	-
TAL 1000	2607	4246	188	51	1.652	4.453	39	41
NC 92	2487	3960	211	48	1.509	5.112	59	31
NRCG 1	2541	4346	213	53	1.712	4.939	58	21
NRCG 2	2103	4330	386	56	1.608	4.841	54	30
NRCG 3	2552	4276	240	31	1.895	5.210	54	48
NRCG 4	2611	4580	411	87	1.919	5.119	77	53
NRCG 5	2391	4183	411	69	1.670	4.876	47	68
NRCG 6	2282	4240	346	61	1.623	5.267	66	63
NRCG 7	2551	4133	241	43	1.781	4.389	33	37
NRCG 8	2306	4430	372	58	1.801	4.779	65	63
NRCG 9	2758	4616	451	73	2.117	5.201	36	42
NRCG 11	2250	3800	197	59	1.813	4.879	56	49
NRCG 12	2134	3926	236	38	1.725	4.568	44	48
NRCG 22	2393	3810	343	47	1.654	4.546	25	21
CD (0.05)	162	275	78.3	19.32	0.427	0.691	-	-

* Data represent mean of three replications

1.1.4 Nutrient uptake

Nitrogen and phosphorus uptake by Spanish cultivars did not differ significantly due to various treatments. However, interaction of depth of soil and method of moisture conservation & fertilizer application was found to be significant for nitrogen uptake. The recommended method of moisture conservation & fertilizer application increased nitrogen uptake by 22.8 % over the farmers practice in medium depth of soil

In Virginia cultivars, variety GG 20 had significantly higher nitrogen and phosphorus uptake than the remaining varieties. The recommended method of moisture conservation & fertilizer application increase nitrogen uptake by 10.2 % over the farmers practice. However, P uptake was not affected significantly. The interaction of depth of soil and method of moisture conservation & fertilizer application was found to be significant. The recommended dose of fertilizer application increased N & P uptake 17 &7.4 %, respectively over the farmers practice in medium depth of soil. However, no effect was observed in shallow soil .

1.1.5 Economics:

Gross returns, net returns and cost benefit ratio did not vary significantly due to various treatments in Spanish groundnut. However, the values of these parameters under medium depth of soil were considerably greater than those recorded under shallow soil.

Economic parameters were significantly influenced by various treatments in Virginia groundnut. Cultivar GG 20 gave significantly higher gross return (25.2%) and net returns (3.78%) with a greater BCR of 3.76 than the local cultivar (GAUG-10). Interaction of depth of soil and method of moisture conservation & fertilizer application were found to be significant and recommended dose of fertilizer in medium depth of soil recorded the highest values of net returns (Rs. 25540/-) and BCR (3.44).

2 At Kadiri

2.1 Soil moisture content

Soil moisture was recorded at four stages of crop growth namely at 45, 65, 85 days after sowing (DAS) and at the maturity. The recommended method of moisture conservation & fertilizer application conserved significantly higher soil moisture recorded at 65 & 85 DAS as compared to the control. No difference in soil moisture content was recorded at 45 DAS and at maturity.

2.2 Growth and yield parameters

The recommended method of moisture conservation & fertilizer application improved growth and yield parameters compared with the farmers practice. The recommended method of moisture conservation & fertilizer application significantly increased number of pods/plant by 16 % and gave higher pod yield (973 kg/ha) and haulm yield (1479 kg/ha) than the control Cultivar K-134 was superior to cv JL-24, and recorded significantly higher pod yield (970 kg/ha) than cv JL-24 (919 kg/ha).

2.3 Quality parameters

The quality parameters namely, 100 seed weight, shelling and sound mature kernel (SMK) were significantly influenced by method of moisture conservation & fertilizer application and

EVALUATION OF CULTIVARS OF MAJOR OILSEED CROPS OF THE PRODUCTION SYSTEM FOR MOISTURE AND NUTRIENT CONSTRAINTS IN DIFFERENT SOIL TYPES

(DEVI DAYAL, M.Y. SAMDUR, SATISH KUMAR)

SOURCE OF FUNDING : NATP ROPS-12

The project aims at evaluating groundnut cultivars under moisture and nutrients constraints in the farmer's fields. Twenty farmers in two villages of Junagadh district and 10 farmers in two villages of Ananthapur district (ARS, Kadiri, AP) were selected based on soil depth and available phosphorus content. Two habit groups of groundnut cultivars namely; Virginia cv GG20, GG13, GAUG10 (local) and Spanish cv, GG5, GG2 and J11 (local) were evaluated at Junagadh while cv. K134 and JL24 (spanish0 were evaluated at Kadiri.

1 At Junagadh

1.1 Effect of treatment

1.1.1 Moisture content

Due to uniform distribution of rainfall during the crop period (826.9 mm in 49 rainy days), no significant difference in moisture content at 0-15 and 15-30 cm depth of soil was recorded under different treatments. However, recommended methods of moisture conservation tended to conserve slightly higher moisture at 15-30 cm depth of soil than the control (farmers method).

1.1.2 Growth and yield parameters

No significant difference on growth and yield parameters of groundnut due to moisture conservation treatment was observed. In case of Spanish cultivar. However, cultivar differed significantly and variety GG 20 recorded more no. of pods, higher pod weight and higher pod yield than those recorded in cultivar GAUG 10 (control variety). Interaction of depth of soil and method of moisture conservation & fertilizer application were found to be significant. Under shallow soil method of moisture conservation & fertilizer application did not affect yield & yield attributing characters of Virginia groundnut. However under medium depth of soil, recommended method of moisture conservation & fertilizer application significantly increase pod no. (17 %), pod weight (24 %), pod yield (11.5 %) and haulm yield (14.5 %) over the farmers method of moisture conservation & fertilizer application (table 6).

1.1.3 Quality parameters

In Spanish cultivars, different treatments did not influence quality parameters except shelling where cultivar GG 2 recorded significantly higher shelling (68.74 %) than the local variety (67.15 %).

In Virginia cultivars, the quality parameters differed significantly due to various treatments. Cultivar GG 20 recorded significantly higher 100-pod weight and 100 seed weight than cultivar GG 13 and GAUG 10. Among the method of moisture conservation & fertilizer application, recommended dose of fertilizer recorded significantly higher 100 seed weight than that in farmer's method. Shelling was not influenced by various treatments .

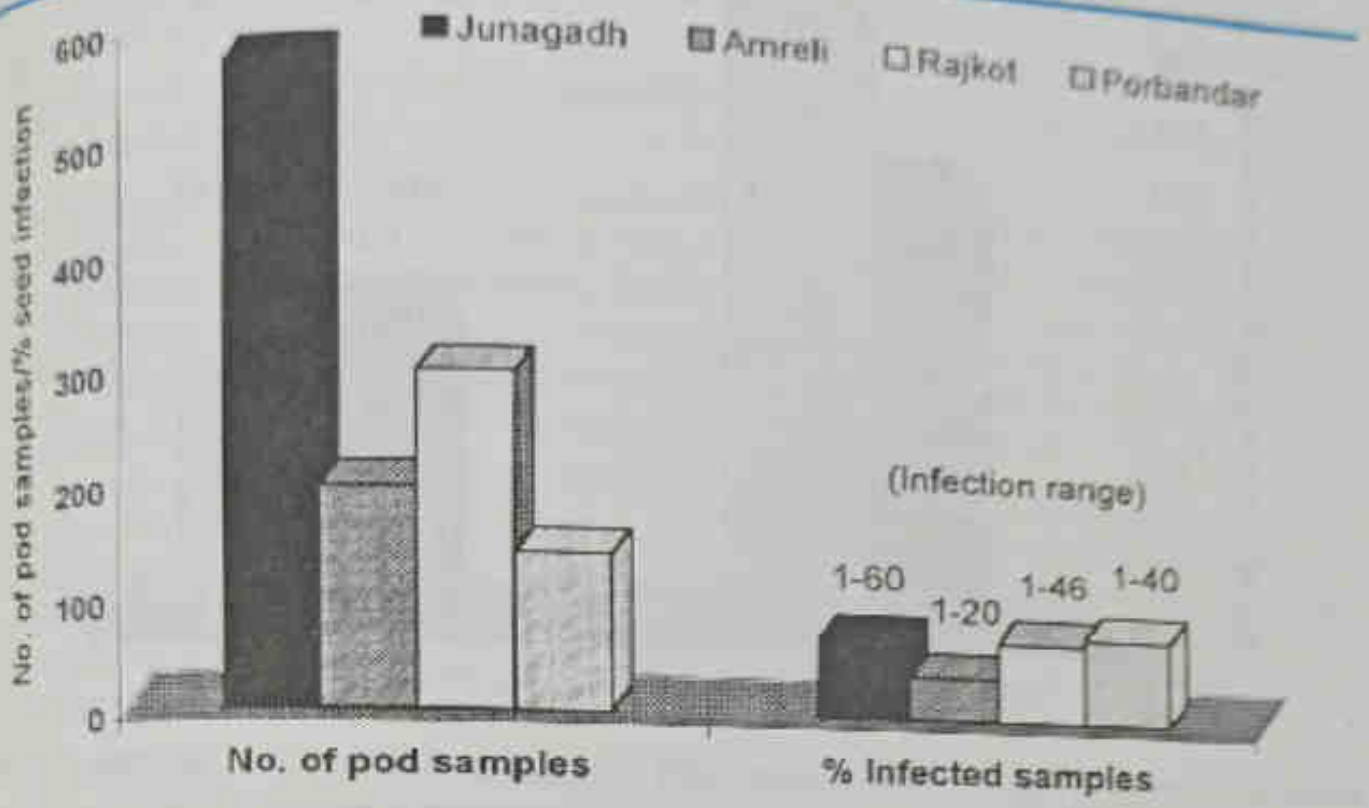


Figure 1. Number of pod samples and percent infection by Aspergillus in samples collected from Gujarat

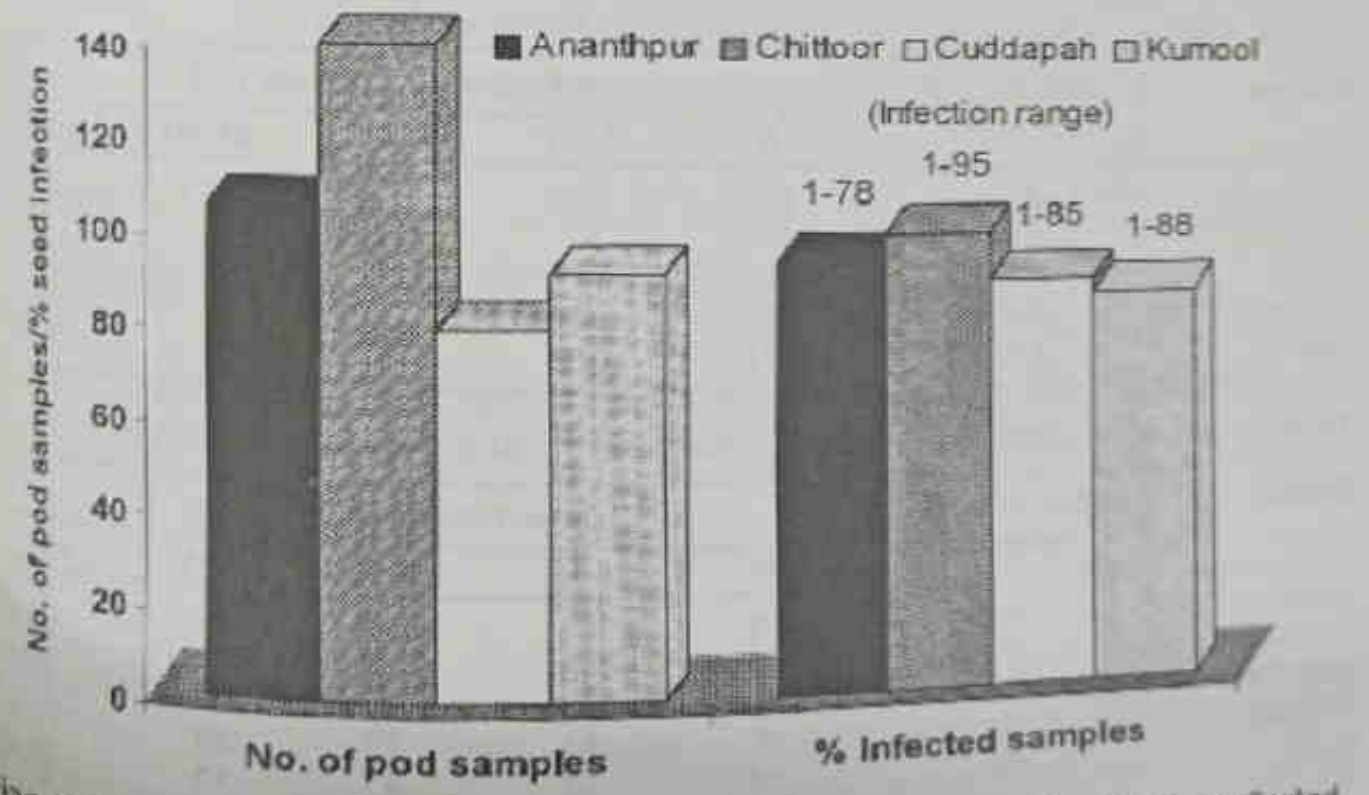


Figure 2. Number of pod samples and per cent infection by Aspergillus in samples collected from Andhra Pradesh

variety. Cultivar K-134 recorded significantly higher 100 seed weight and shelling than cv JL-24. However, SMK was higher in cv JL-24 (83.8 %) than in K-134 (79.6 %). The recommended method of moisture conservation & fertilizer application significantly improved 100 seed weight by 9%, shelling by 3.7 % and SMK by 3.8% over the farmers practice.

2.4 Nutrient uptake

Cultivar K-134 recorded significantly higher P uptake (5.81 kg/ha) than cv JL-24 (5.49 kg/ha). The recommended method of moisture conservation & fertilizer application increased P uptake by groundnut (5.97 kg/ha) significantly as compared to P uptake (5.38 kg/ha) under farmers practice.

Table1: Effect of different treatments on microbial activities in the soil

Treatment	Fluorscent Pseudomonads (x 10^4)	Pseudomonads (x 10^6)	PSB (x 10^5)	Free living N fixer(x 10^5)
T1	1.55	2.90	0.80	0.80
T2-T1+Biol.	2.93	6.00	1.80	1.07
T3-T2+Biopesticide	2.26	9.60	1.60	0.95
T4-50%RDF+1/2 T1	2.91	8.50	1.09	1.08
T5-RDF	0.49	0.50	0.50	0.53
T6-conrol	0.38	0.51	0.45	0.78

AFLATOXIN CONTAMINATION IN GROUNDNUT: MAPPING AND MANAGEMENT IN GUJARAT, ANDHRA PRADESH AND ADJOINING AREAS

(S. DESAI)

SOURCE OF FUNDING : NATP, AED, Rainfed Farming, CRIDA, Hyderabad)

Participating centers:

NRCG; ICRISAT Patancheru; Main Oilseeds Research Station, Gujarat Agricultural University, Junagadh.

1 Survey for aflatoxins in groundnut seeds

For the period ending March 2002, 3234 pod- and 2786 soil-samples have been collected from the farmers' fields from the target districts (table 1). It is seen that in Gujarat, the sampling was done in 327 villages across 55 taluks. Similarly, in Andhra Pradesh, 1128 villages of 123 mandals and in Karnataka, 164 villages of 10 taluks were covered. The frequency of seed infection across samples was worked out and presented in figure 1, 2, and 3 for Gujarat, A.P. and Karnataka, respectively.

From the data compiled for the pod samples processed so far (tables 2a and 2b) the following inferences could be drawn.

a. The infection levels were considerably high in Andhra Pradesh and Karnataka as compared to Gujarat.

b. The degree of infection was considerably low in Gujarat. For instance, 35 per cent samples showed zero infection in Gujarat as against only 19% samples in A.P. and Karnataka. In A.P. and Karnataka, 54, 15, 12 and 5% of the samples showed 1-10, 10-20, 21-50 and >50% infection frequency, respectively. On the contrary in Gujarat, relatively less number of samples were infected (49, 13, 2, and 0.3% of samples showing 1-10, 10-20, 21-50 and >50% infection frequency, respectively).

Out of the six districts in A.P. and Karnataka, in Tumkur maximum samples were free from infection. Similarly, in Gujarat, in Amreli district maximum samples were free from infection. All the soil samples collected from Gujarat have been analyzed. The population of Aspergillus varied across the districts. The preliminary results suggest that there could be a possibility to get some plots free from Aspergillus which was one of the main objectives of the project. The details are presented in table 4 and 5.

Table 4. Analysis of soil samples for Aspergillus population in Gujarat

District	No. of soil samples analyzed	% samples contaminated	Population range of Aspergillus (x 103/g of soil)
Junagadh	428	70	1-386
Amreli	192	70	1-216
Rajkot	239	58	1-220
Porbandar	133	81	1-160
Total	**942**		**1-386**

Table 5. Analysis of soil samples for Aspergillus population in A.P. and Karnataka

District	No. of soil samples analyzed	% samples contaminated	Population range of Aspergillus (x 103/g of soil)
Kurnool	26	100	1-740
Ananthpur	73	100	1-144
Chittoor	93	68	1-480
Cuddapah	23	100	3-92
Total	**215**		**1-740**
Kolar	121	67	1-69
Tumkur	171	78	1-420
Total	**292**		**1-420**
Grand Total	**507**		**1-740**

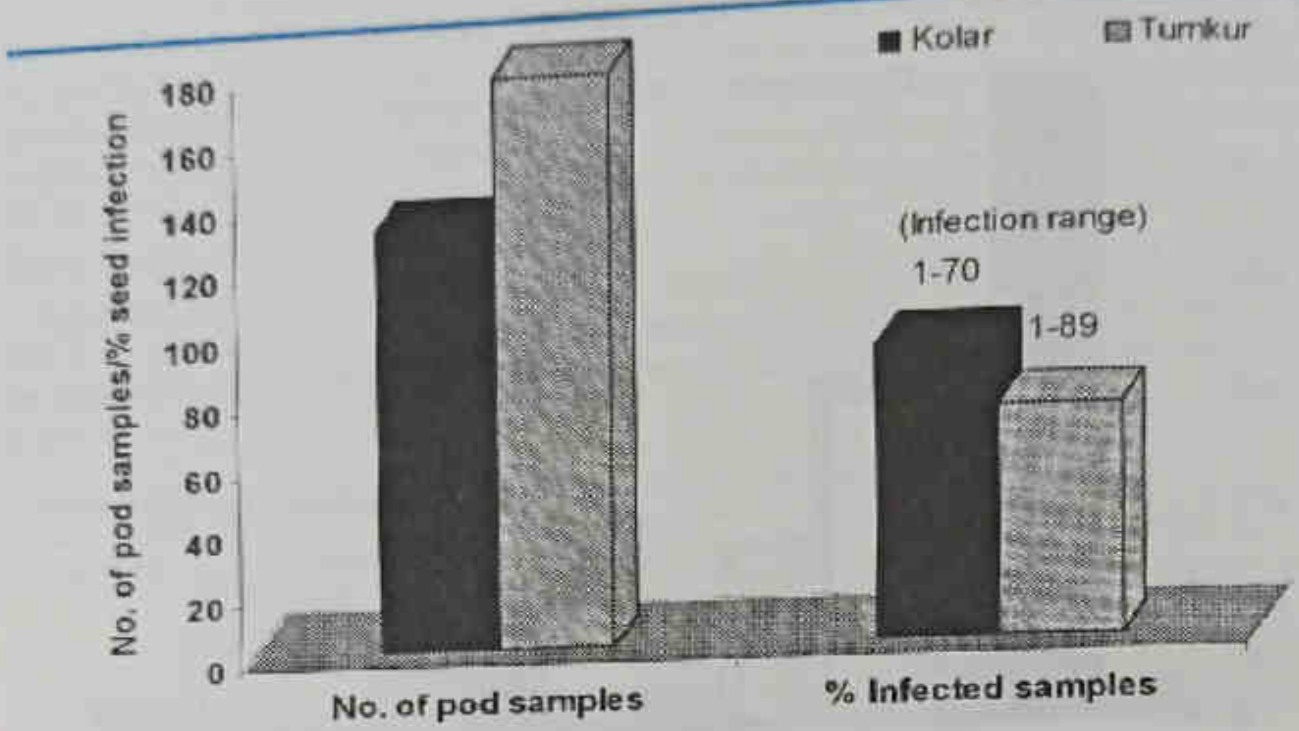


Figure 3. Number of pod samples and per cent infection by Aspergillus in samples collected from Karnataka

The frequency distribution of kernel infection for Gujarat, A.P. and Karnataka are shown in Table 2 and 3.

Table 2. Analysis of kernel infection by Aspergillus flavus in Gujarat

District	No. of pod samples	Infection frequency (%)				
		0	1-10	11-20	21-50	>50
Junagadh	559	175	271	73	9	4
Amreli	192	120	52	20	0	0
Rajkot	290	87	147	44	9	0
Porbandar	135	32	108	20	5	0
Total	**1176**	**414**	**578**	**157**	**23**	**4**

Table 3. Analysis of kernel infection by Aspergillus flavus in A.P. and Karnataka

District	No. of pod samples	Infection frequency (%)				
		0	1-10	11-20	21-50	>50
Kurnool	90	13	44	16	12	5
Cuddapah	78	9	43	12	10	4
Ananthpur	104	8	61	19	14	2
Chittoor	138	2	61	27	30	18
Kolar	130	14	81	20	10	5
Tumkur	175	53	96	15	8	3
Total	**715**	**99**	**386**	**109**	**84**	**37**

critical inputs were provided to the farmers which included carbendazim for seed dressing; castor cake @ 500 kg per ha; Trichoderma formulation for soil application along with castor cake; neem seed for spray against insect-pests and diseases, and a mixture of cabendazim and mancozeb for management of foliar diseases. The results of the on-farm trials are given in table 5. Some interesting observations are given below.

1 Out of 36 trials, seed infection was low in 20 trials where the integrated package was followed as against farmers' practice. Whereas in four trials, the infection was same in both the treatments, in 12 plots it was higher in treated plots as compared farmers' practice.

2 Seed colonization was low in 15 out 36 trials where integrated package was adopted where as in 12 trials the colonization remained equal in both the treatments and only 9 plots the colonization was higher in treated plots.

3 The soil population of Aspergillus was monitored at the beginning of the trial and at the harvest. It was observed that in 24 out of 32 treated plots, there was a reduction in the population levels out of which in seven plots the population was reduced to zero level. Only in two trials an increase in the population was observed while in six trials the population remained static. Some interesting observations were made as regards to the control plots also where similar variations were noticed in the soil population of the fungus, which needs a thorough investigation.

4 Aflaroot infection was decreased in 78% of the trials where the improved package was adopted, in 10% of the plots there was an increase in treated plots and in 13% of the plots there was no difference between improved package and control.

In as many as 74% of the plots reduction in stem rot was observed which was a spin-off of the treatment, probably due to the effectiveness of the combination of castor cake coupled with Trichoderma. In 23% of the plots there was no change and in 5% of the treated plots there was a slight increase in the disease.

MASS MULTIPLICATION AND DELIVERY OF BIOCONTROL SYSTEMS FOR MANAGEMENT OF LATE LEAF SPOT OF GROUNDNUT IN MAHBOOBNAGAR AND NALGONDA DISTRICTS OF ANDHRA PRADESH

(S. DESAI)

SOURCE OF FUNDING: Biotechnology unit of AP-NL Programme, Institute of Public Enterprise, Hyderabad.

Participating centers: NRCG; Regional Agricultural Research Station, Palem, Acharya NG Ranga Agricultural university, Hyderabad.

Late leafspot of groundnut is a major foliar disease occurring through out the country. To protect the crop of farmers of Mahboobnagar and Nalgonda districts, a project to mass-multiply the fungal biocontrol agents that have been identified by this centre and test them under field conditions was awarded. The significant achievements of the project for the year 2001-02 are presented here.

2 Host plant resistance

One hundred genotypes were obtained from ICRISAT for screening under artificially inoculated conditions to identify resistant lines for use as a component in the integrated management of aflatoxin contamination. Out of 100 genotypes 80 genotypes were screened in the concrete blocks inoculated with most toxigenic strain (Af 11-4) of Aspergillus flavus. The blocks were heavily infected with the fungus. Among them, 19 genotypes were free from infection (Table 6).

Table 6. Screening of promising groundnut genotypes for resistance against aflatoxin contamination

Genotype	Inf%	Col%	Pod mass/ plant (g)	Fodder mass/ Plant (g)	100pod mass (g)	HSM (g)	Shp%
2	0	0	10	14.7	77.0	36.0	72
3	0	0	8	14.2	74.0	27.0	50
6	0	0	6	12.0	46.0	30.5	73
7	0	0	10	17.3	76.0	55.0	65
9	0	0	13	14.0	75.0	32.5	71
15	0	0	13	24.6	83.0	29.5	64
25	0	0	11	14.4	93.0	38.0	67
29	0	0	8	15.0	66.5	46.0	60
30	0	0	8	15.9	66.0	33.5	69
32	0	0	13	16.9	77.5	32.5	70
36	0	0	9	17.1	60.0	26.0	73.5
39	0	0	8	15.6	65.0	25.0	57
49	0	0	12	15.0	79.0	33.0	70
59	0	0	11	15.0	68.0	39.0	73
66	0	0	10	11.1	78.0	29.0	67
68	0	0	11	12.9	75.0	40.0	62
71	0	0	17	30.0	75.0	36.0	66
72	0	0	5	16.7	49.0	30.5	55
73	0	0	14	18.3	74.5	33.0	77

As seen from the above table, out of 80 genotypes 19 did not show any infection and colonization. When up to 2% infection was considered, 30 genotypes were found to be promising. Further screening is in progress to confirm these results and screen more genotypes to identify promising ones for use in integrated management of aflatoxin contamination.

3 Integrated Aflatoxin Contamination Management

All the 40 trials were sown between 10th and 25th of June 2001. The farmers were spread over the target districts. However, final observations could be obtained form only 36 farmers. The

1 Mass multiplication of Biocontrol Agents

Five broth media such as potato-dextrose broth (PDB), glucose-nitrate broth (GNB), maltose-peptone broth (MPB), sabouroud-dextrose broth (SDB) and molasses-yeast extract broth (MYB) were tested for mass production of these biocontrol agents in a fermentor. Each broth medium required 15 to 20 mdays. The MYB supported the maximum growth of *P. islandicum and V. lecanii*. Considering high cost of yeast extract in MYB, yeast extract was successfully replaced with cheaper nitrogen source i.e. soy-flour thus bringing down the cost by about 10 times. The optimum fermentation conditions for obtaining maximum biomass of these biocontrol agents in Molasses-soyflour broth (pH 7.0) were 72-96 h of fermentation at 28 + 1°C; 40% dissolved oxygen concentration; and a stirring rate of 200 rpm for first 48h and 350 rpm for rest of the period. Dissolved oxygen and pH decreased as the growth and sporulation of biocontrol agents increased. Dry weight of biomass of P. islandicum was maximum at 72 h while V. lecanii showed greatest mass at 96 h of fermentation. A total 2kg formulated spore mass and 70 liter culture filtrate of each biocontrol agent was produced for field trial in kharif 2002 at NRCG and collaborative centre Palem (A.P.).

2 Viability of Fermentor Biomass

The fermentor biomass was formulated as wet and dry formulations and viability was monitored for six months. The formulated product was packed in polyethylene bags by using sterile distilled water for wet form and without water as dry form. These packets were kept in BOD at 28 + 1°C for six months. Populations of these biocontrol agents were tested weekly taking 100mg of the product and diluted to 106. 100µl of the dilution were added in petridishes containing 15 ml maltose peptone agar medium and number of colonies were recorded. The results in fig1& 2 indicated that the population of the test fungi in the formulated product increased up to 180 days in wet-and 75 days in dry-formulations. There after, a reduction in cfu was recorded (Figs 1 and 2).

Fig 1. Evaluation of shelf life and multiplication of *P. islandicum*

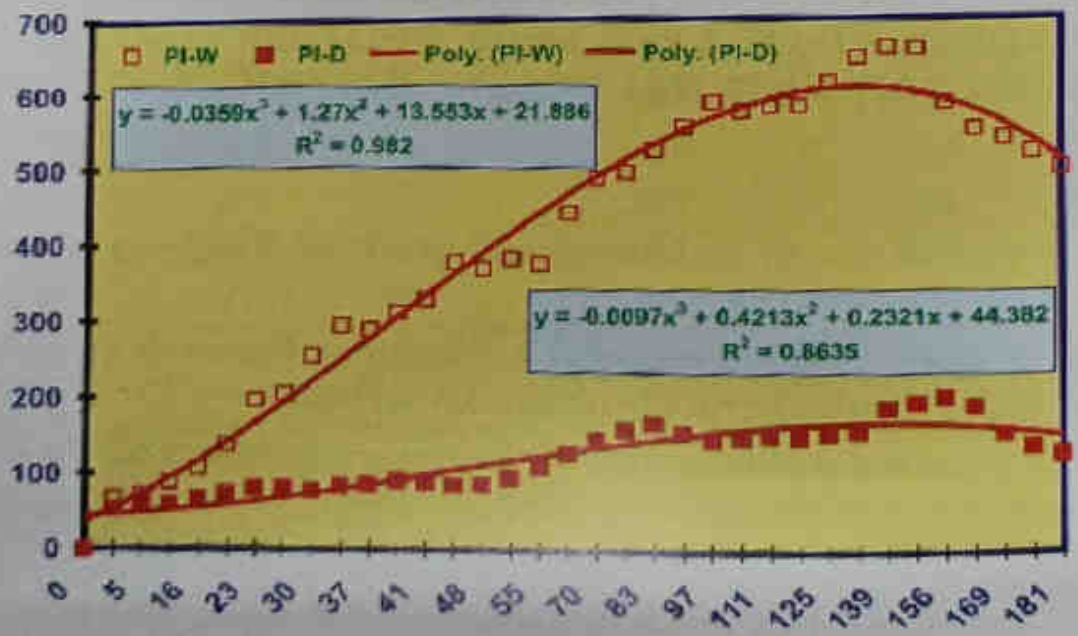
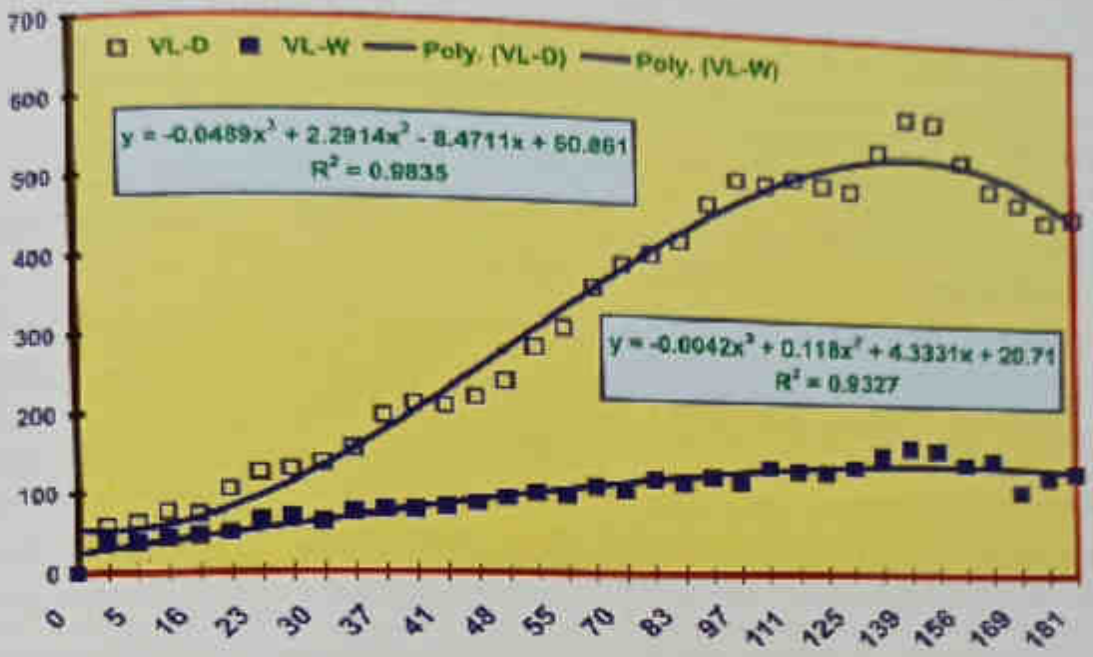


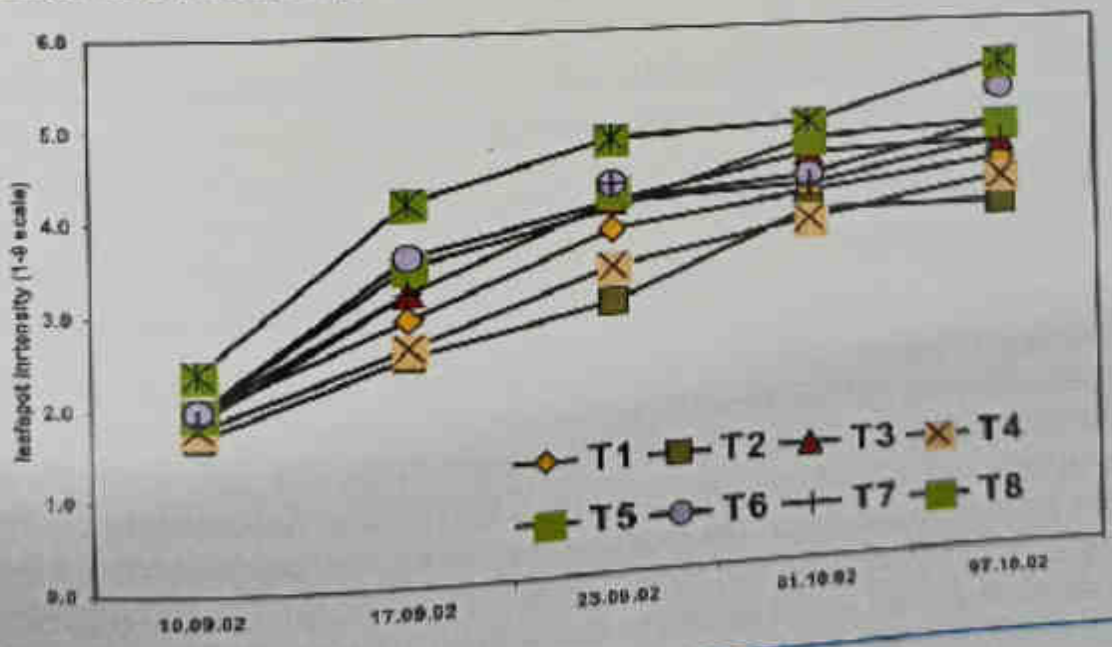
Fig 2. Evaluation of shelf life and multiplication of *V. lecanii*



Field-testing of V. leccanii, P. islandicum and Bacillus sp. against late leaf spot of groundnut:

During Kharif 2002 as per the work plan a station trial was planted for evaluating biocontrol agents Viz. *Penicillium islandicum, Verticillium lecanii* and *Bacillus* sp. Spraying of spore suspension and culture filtrate of *V.lecanii* and spore suspension of *P. islandicum* was found to be effective. The effect of these biocontrol agents against leaf spot of groundnut is shown in table 1a and 1b fig. 3.

Figure 3. Effect of biocontrol agents on leaf spots over time during kharif 2002 at NRCG



In addition to NRCG, data for the last ten years on weather and for the last five years on insect-pests has been collected from ICRISAT centre. A preliminary analysis of the data obtained from ICRISAT was done at NRCG. Efforts were also made to collect such information from AICRP centers. However, no valid data could be obtained that could be used in the project.

Historical data collected from various centers is presented in the following table.

Junagadh (90-01)	Daily weather Tmax, Tmin, Rh1, Rh2, Wd1, Wd2, Soil5, Soil10, Soil20, Ws(kmph), Bss, Evp, RF
Coimbtore (91-00)	Daily weather Tmax, Tmin, GM, Dry,Wet, Rh, Evp, Wv, RF, SR, Bss
Anantapur (91-00)	Daily Weather viz., Tmax, Tmin, Rh1, Rh2, Wv, Bss, RF, RD, Evp
Udaipur (90-00)	Weekly Weather viz., Tmax, Tmin, Rh1, Rh2, Wv, Bss, RF, Evp
Vriodachalam (90-99)	Temp (Dry, wet, dry, wet, max, min), soil5, Soil10, Soil15, Rh1, Rh2, Wv, Wd1, Wd2; Monthly data on RF, Wv, EvpThe missing data on Spodoptera (kharif 89, 93, 95; and rabi 91, 92, 94); leaf miner (kharif 91, 92, 95, 96, 99, 2000 and rabi 89, 90, 94, 95); late leaf spot (kharif 89, 90, 91, 92, 94, 95, 98; rabi 89, 91, 92, 96, 98) and rust (kharif 89, 90, 91, 92, 94, 95, 98 and rabi 89, 91, 92, 96, 98) is being collected.
Chintamani (1988-98) & 1995 missing	Tmax, Tmin, RF, Rh, Rh2, Bss
Anand (91-00)	Daily weather TMax, TMin, TMean, Rh1, Rh2, ET, Evp, Bss, RF, WD, Wv, Soil1, Soil2, Soil3, Soil4, Soil5, Soil6.

2 Literature survey

This activity was meant to collate the information on bioecology of target pests and models already developed by various workers to analyze their suitability to Indian conditions. The information so collected has been presented in the recently concluded mid-term review meeting of the project at CRIDA. Additional information is being collected through literature survey. From TNAU centre, 31 research papers on pest and diseases in groundnut (leaf spot, rust and leaf miner) in relation to weather variables were collected and submitted to main lead centre, CRIDA, Hyderabad and Junagadh. The review indicated that relative humidity and maximum temperature were correlated highly with diseases, while dry spell and maximum temperature influenced the leaf miner incidence.

3 Development of models

The data collected from all the participating centers and additional centres has to be supplied to centers like NCIPM and IISc to develop models for validation in the forthcoming season. A set of data has been provided to the main lead centre i.e. CRIDA for maintaining the database.

4 Field experiments

Experiment was conducted with four (4) treatments viz., spray of insecticides, spray of fungicide, spray of fungicide and insecticide and control with three (3) dates of sowing and the observations were taken with 0 to 9 scale

Table 1a. Pod and fodder yields as influenced by the spray of biocontrol agents and fungicides for the management of leafspots of groundnut

Treatment	Pod weight	Fodder wt.
Spore suspension of *P. islandicum*	4.1	6.5
Spore suspension of *V. leccanii*	5.1	7.3
Culture filtrate of *P. islandicum*	4.6	6.8
Culture filtrate of *V. leccanii*	5.0	7.6
Cell mass of *Bacillus* sp.	3.7	6.1
Culture filtrate of *Bacillus* sp.	3.3	6.3
Carbendazim (0.05%)+ Mancozeb (0.2%)	4.8	5.6
Water spray (control)	3.8	5.2

Table 1b. Shelling percentage and hundred kernels wet (g) as influenced by the spray of biocontrol agents and fungicides for the management of leaf spots of groundnut

Treatment	Shelling %	Hundred Kernels wet (g)
Spore suspension of *P. islandicum*	69.7	32.3
Spore suspension of *V. leccanii*	74.7	39.7
Culture filtrate of *P. islandicum*	67.7	33.0
Culture filtrate of *V. leccanii*	77.3	39.0
Cell mass of *Bacillus* sp.	63.7	31.3
Culture filtrate of *Bacillus* sp.	63.7	33.3
Carbendazim (0.05%)+ Mancozeb (0.2%)	71.3	35.3
Water spray (control)	60.7	31.7

DEVELOPMENT OF WEATHER BASED FOREWARNING MODELS FOR GROUNDNUT PESTS AND DISEASES

PI: DR. S. DESAI, CO-PI, DR. V. NANDAGOPAL

Source of funding: NATP

I Development of database

Efforts were made to collect historical data on weather, incidence/intensity of target insect-pests and diseases for the last ten years. Complete set of weather data has been collected. The weather data collected from Junagadh includes Tmax, Tmin, Rh (morning), Rh (evening), wind direction (morning), wind direction (evening), Soil temp at 5, 10, and 20 cm depth, wind speed (kmph), bright sunshine hours (h), evapotranspiration (mm), and rainfall (mm). However, data on insect-pests and diseases was not at regular intervals. All this information has been supplied to the Main PI and would be sent to IISc and NCIPM for analysis.

In 3rd date of sowing, the lowest incidence (2.7) was observed in case of insecticide sprayed plot as compared to control (3.2), which was negatively correlated with maximum temperature (32.7°c). In case of fungicide treated plot the incidence was 4.18 and was negatively correlated rainfall. The equations fitted are given below.

Treatment	Equation	R^2
Fungicide	Y = 1.4+0.36x1+0.33x2-0 .05x3 where X1=wv, X2=vapour pressure, X3=rainfall	0.22
Insecticide	Y = 1.03+0.04x1-0.04x2-0.001x3+0.001x4 where X1=Tmax, X2=Tmin, X3=wd1,X4=wd2	0.26
Insecticide+ Fungicide	Y= 0.74+0.03x1-0.008x2+0.4x3 where X1=Rh1, X2=wde, X3=ws	0.35
Control	Y= -4.3-0.17x1+0.001x2+0.002x3+0.23x4+0.03x5 where X1=Tmax, X2=Rh1, X3=Rh2, X4=ws, X5=vapour pressure	0.18

Six traps were installed for monitoring the male moths *S litura* male moth caught throughout the season and peak population was 149.2 moths/trap during 3rd week of September. During this period minimum temperature (24.36° C), soil temperature (32.2° C), wind velocity (4.25 km/h) and evaporation (5.23 mm) were negatively correlated with *S litura*.

4.2 Leafminer:

The incidence of leafminer (GLM) was negligible and a scanty incidence was noticed in September month, near maturity stage of groundnut crop.

4.3 Late leafspot:

The disease LLS was initiated at 50 DAS in D1 and it gradually increased upto the end of the crop. Maximum of 3.24 scale was noticed in control at 84 DAS. In D2 maximum disease noticed at 118 DAS with maximum temperature 35.8° C and minimum temperature 23.3° C, Rhmax 80.1 % and Rhmin 40.9 % and in case of D3 maximum disease noticed at 118 to 129 DAS with maximum temperature range form 32.9° C to 37.3° C, Minimum temperature range form 23° C to 32 ° C, Rhmax range form 53 to 80 % and Rhmin 18 to 22 %.

4.1 Spodoptera litura:

The initiation of *Spodoptera* damage was noticed at 50 DAS, and peak incidence was noticed during 88 DAS in D1 with Maximum Temperature 32.8° C, Minimum Temperature 23.4° C, Rh1(86.5 %), Rh2 (57.5%) and 88 & 94 DAS in D2 and D3 plot with Maximum Temperature range 32.8° C to 34.9° C and Rh1(86.5 %), Rh2(57.5 %) with 23.5 mm rainfall.

In first date of sowing (20.06.01), the mean incidence of *S litura* was 2.9 scale, The equations are given below.

Treatment	Equation	R^2
Fungicide	Y= - 0.524-0.12x1+0.15x2+0.035x3-0.018x4-0.001x5+0.43x6+0.009x7 where X1=Tmax, X2=Tmin, X3=RH1, X4= RH2, X5=wd1, X6= evaporation, X7=rainfall	0.32
Insecticide	Y = 8.9 + 0.083x1-0.29x2+0.09x3-0.18x4 where X1=Tmax, X2=Tmin, X3=Soil temp(5), X4= soil temp(10)	0.26
Insecticide+ Fungicide	Y=-3.12 -0.62x1-0.011x2+0.0x3+0.12x4-0.59x5+0.7x6+0.98x7-0.05x8 where X1=Tmax, X2=Rh2, X3=wd1, X4=soil temp(5), X5=soil temp(10), X6=soil temp(20), X7=bright sunshine, X8=vapour pressure	0.64
Control	Y=-35.2 +0.007x1-1.17x2-0.028x3+2.46x4+0.323x5-0.06x6 where X1=wd2, X2=soil temp(5), X3=soil temp(10), X4= soil temp(20), X5=wind speed,X6=rainfall	0.43

In 2nd date of sowing, the incidence of *S. litura* in all four treatments ranged from 2.4 to 3.6. The equations fitted are given below.

Treatment	Equation	R^2
Fungicide	Y = 16.9+0.022x1+0.046x2-0.24x3+0.22x4-0.54x5 where X1=Tmax, X2=Tmin,X3=soil temp(5), X4=soil temp(10), X5=soil temp(20)	0.27
Insecticide	Y = -4.9+0.07x1+0.19x2-0.002x3 where X1=Tmax,X2=Tmin, X3=wd2	0.39
Insecticide+ Fungicide	Y= -3.5+0.18x1+0.06x2+0.16x3+0.01x4 where X1=Tmin, X2=bss, X3=vp, X4=rainfall	0.60
Control	Y= -9.1-0.04x1+0.1x2+0.01x3-0.002x4-0.001x5-0.05x6+0.36x7 where X1=Tmax, X2=Tmin,X3=Rhmax, X4=Rhmin, X5=wde,X6=soil temp(10), X7=soil temp(20)	0.49

In 3rd date of sowing, the mean incidence of leafspot ranged from 1.4 to 1.9. The regression equations are given below.

Treatment	Equation	R^2
Fungicide	Y=-4.3+0.03X1-0.009X2-0.0003X3-0.0009X4+0.1X5-0.07X6+0.1X7+0.04X8 where x1=Tmax, x2=Rh1, x3=Rh2, x4=wd1, x5=S5, x6=S10, x7=S20, x8=Bss	0.95
Insecticide	Y=-5.3+0.07X1-0.06X2+0.01X3-0.0007X4-0.4X5+0.8X6-0.07X7-0.005X8 where x1= Tmax, x2=Rh1, x3=Rh2, x4=wd1, x5=S5, x6=S10, x7=S20, x8=Bss	0.95
Insecticide+ Fungicide	Y=0.71-0.02X1-0.08X2-0.004X3+0.3X4+0.02X5+0.04X6 where x1=Tmax, x2=Rh1,x3=Rh2, x4=S20, x5=Bss, x6=vapor pressure	0.94
Control	Y= 3.31+0.05X1-0.07X2+0.01X3+0.06X4+0.05X5-0.02X6 where x1=Tmax, x2=Rhmax,x3=Rhmin,x4=S10,x5=Bss, x6=vapor pressure	0.88

4.4 Rust:

Rust incidence was negligible and hence the disease observations were not recorded.

Yield and yield attributes as influenced by dates of sowing, pest and disease management treatments during *kharif 2001*. The data on pod and halm yield indicated that the yields were higher in the sowing taken up during (1st week of July) second days of sowing over the 1st and 3rd DOS. Among the treatments, treatment against pest-disease (T3) recorded highest pod yield (1920 kg/ha) followed by disease management (T1) (1880 kg/ha), while in control (T4) 1592 kg/ha of pod yield was recorded. Treatment against disease gave 18% yield and 20 % yield in treatment T3 (both pest & disease) gave over control plot yield.

5 Real-time survey in farmers' fields

Detailed data was collected on the incidence of GLM in the farmers' fields indicated that the incidence was very low and hence the incidence could not be recorded.

The mean incidence of *S litura* in farmer's field was (3.12) positively correlated with maximum temperature (31.6°C), soil temperature at 10 cm (30 °C) and negatively correlated with relative humidity (m) (88.8%) and relative humidity (e) (67.39%).

$$Y = 308+0.37X1-9.1X2-0.28X3+0.005X4+3.8X5-2.6X6-3.8X7+2.9X8$$

Where x1=Tmax, x2=Tmin, x3=Rhmax, x4=Rhmin, x5=soil temp(5), x6=soil temp(10), x7=soil temp(20) with an R^2 of 0.88.

The mean incidence of leafspot (2.69) in farmer's field was positively correlated with soil temperature 5 cm, 10cm and 20 cm (30.8°C, 30.7°C, 30°C) and negatively correlated with wind velocity (5.6 kmph).

In 1st date of sowing, the regression equations are given below.

Treatment	Equation	R^2
Fungicide	Y = 1.6-0.03X1-0.01X2-0.01X3+0.09X4+0.06X5-0.01X5-0.01X6 where x1=Tmax, x2=Rh1, x3=rh2, x4=soil temp(10), x5=bss, x6=vapor pressure	0.86
Insecticide	Y=-1.6-0.06X1-0.03X2-0.002X3-0.001X4-0.4X5+0.7X6+0.01X7+0.01X8-0.03X9 where x1= Tmax, x2=Rh1, x3=rh2, x4=wd1, x5=S5, x6=S10,x7=S20, x8=bss, x9=vapor pressure	0.87
Insecticide+ Fungicide	Y= 2.9-0.6X1-0.05X2-0.2X3+0.09X4-0.3X5+0.01X6-0.04X7 where x1=Tmin, x2=S5,x3=S10, x4=S20, x5=bss, x6=vapor pressure	0.81
Control	Y= -0.006+0.06X1-0.05X2+0.001X3-1.5X4-1.3X5+2.3X6-0.8X7+0.14X8-0.2X9 where x1= Tmax, x2=Rhmax,x3=Rhmin,x4=wd2, x5=S5, x6=S10, x7=S20, x8=bss, x9=vapor pressure	0.96

In 2nd date of sowing, the regression equations are given below.

Treatment	Equation	R^2
Fungicide	Y= -2.1+0.08X1-0.09X2+0.02X3-0.6X4+1.1X5-0.19X6+0.04X7-0.1X8 where x1=Tmax, x2=Rh1, x3=Rh2, x4=S5, x5=S10, x6=S20, x7=Bss, x8=vapor pressure	0.88
Insecticide	Y=7.2-0.03X1-0.1X2-0.0009X3-0.1X4+0.06X5+0.2X6+0.06X7-0.1X8 where x1=Tmax, x2=Rhmax, x3=Rhmin, x4=S5, x5=S10, x6=S20,x7=Bss,x8=vapor pressure	0.94
Insecticide+ Fungicide	Y=4.0-0.09X1-0.15X2+0.02X3-0.4X4+0.6X5+0.13X6+0.18X7-0.09X8 where x1=Tmax, x2=Rh1, x3=Rh2, x4=S5, x5=S10, x6=S20, x7=Bss, x8=vapor pressure	0.90
Control	Y= 1.3+0.03X1-0.09X2+0.01X3-0.2X4+0.3X5+0.06X6+0.1X7-0.1X8 where x1=Tmax, x2=Rh1, x3=Rh2, x4=S5, x5=S10, x6=S20, x7=Bss, x8=vapor pressure	0.85

OTHER INFORMATION

FARM

During the period under report various activities including development work attended by the farm section are described herewith

- An area about 48.0 ha in kharif 2001 and 3.5 ha in R/S 2001-2002 was covered under experiments and land utilization programme. The area under experiments breeder seed of groundnut and for general crop including agroforestry (under land utilization programme) was 15.5, 6.5 and 26 ha respectively. Four submersible pumps of 10, 15 and 20 HP capacities were installed and two pump houses got constructed. Three hundred and twenty five pipes of HDPE with 75 mm diameter and 20 feet each were procured. Five numbers of Knapsack sprayer pumps were procured for field spraying. Ninety trolleys of FYM were incorporated in the fields in addition to green manuring in 18 ha area to maintain fertility of soil. By disposing farm products, Rs. 2.45 lakh was generated.

ADMINISTRATION

Staff Strength

Total staff in NRCG, and the Number of SC,ST and OBCs employees as on 31-3-2001.

category of staff	sanctioned	filled	vacant	No of SC	No of ST
No of OBC					
Scientific	40	20	20	5	-	1
Technical	45	43	2	9	3	5
Administrative	16	15	01	3	-	-
Supporting	19	20	-	5	-	10
Total	120	98	23	22	3	16

Departmental Promotion Committees

1. The DPC/Assessment Committee Meeting were held at NRCG during the January 7 2002 for thirteen technical personal. Six of them were promoted to the next higher Grade and 7 got the benefit of advance increment.
2. Assurance Career promotion Committee (ACP) held on 11-2-2002 for considering the cases of Financial up gradation of supporting staff.
3. RAC Meeting was held on 24-25 Sept. 2001.

Transfer / Appointment

- Dr.A. Bandyopadhyay transferred as National coordinator, NATP New Delhi on 16-1-2002, after completing his term as Director.
- Dr. Manivel , Scientist, CPRI, Simla, 16-3-2002, on getting selected as Senior Scientist.

$$Y = 20+4.9X1-4.9X2-0.6X3-2.0X4$$

Where, x1=S5, x2=S10, x3=S20, x4=ws with an R^2 of 1.00.

The mean incidence of rust (2.7) in farmer field was negatively correlated with minimum temperature (24.3oC), wd(1) and wind velocity (6.5 kmph).

$$Y = 108.9-4.6X1-0.01X2+0.02X3+0.4X4$$

Where x1=Tmin, x2=wd1, x3=wd2, x4=ws with an R^2 of 0.45.

5.1 Natural enemies:

Several natural enemies were recorded on various pests during the crop period at NRCG and farmers' fields. *Apanteles* spp adults were found while taking sweepnet and observation were also recorded. Several masses of *Apanteles* pupa were also found on groundnut leaves at NRCG as well as farmer's field. Predatory fly (*Crosopalpus* spp) were also noticed during the month of September. Predators like Spiders, Chrysoperla, Coccinella spp. were observed higher in the month of September. In the month of August severe infestation of *Nomuraea rileyi* was noticed on *Helicoverpa armigera* larvae. *In vitro* studies were carried out on different larval instars of *Helicoverpa* with different conc. and *N. rileyi* causes higher mortality in younger instars (1st to 3rd) than older one. Gradually decrease the mortality per cent with increasing age. NPV and *Beauveria bassiana* were also noticed on larvae of *Helicoverpa armigera* and *Spodoptera litura*.

5.2 Other pests recorded:

The pests other than the target pests recorded during the crop period were *Helicoverpa armigera*, Castor semilooper, aphids, jassids, and thrips. Severe infestation of gray weevils was noticed at farmer's field.

Project 08 : Germplasm management of cultivated groundnut and its wild relatives

Project Leader : Dr. K. Rajgopal

Sub-Project : Collection, evaluation, documentation and distribution of cultivated groundnut and related Arachis species

Sub-Project : In vitro-and Cryo-conservation of groundnut germplasm

Sub-Project : Enhancing the recombination frequency in groundnut

Project 09 : Biotechnological approach to characterization and genetic enhancement of groundnut

Project Leader : Dr. T. Radhakrishnan

Sub-Project : Characterization, enhancement and molecular screening of Arachis gene pool

Sub-Project : Developing and utilizing transformation protocols for groundnut to produce insect and virus resistant trangenics.

Project 10 : Assessment and enhancement of quality in groundnut and its value aded products

Project Leader : Dr. J.B. Misra

Sub-Project : Assessment of quality in germplasm collection, breeding material and produce of other experiments.

Sub-Project : Breeding for HPS and confectionary cultuvars

Sub-Project : Genetic engineering for enhancement of quality

Sub-Project : Microbial recycling of groundnut shell into useful products

Project 11 : Prevention and management of aflatoxins and other mycotoxins in groundnut

Project Leader : Dr. S. Desai

TECHNICAL PROGRAMME FOR THE YEAR 2001-2002

Project 01 : Studies on crop improvement for resistance to biotic and abiotic stress

Project Leader : Dr. M.Y. Samdur

Sub-Project : Biotic Stress
Sub-Project : Abiotic Stress

Project 02 : IPM for groundnut based production system

Project Leader : Dr. V. Nandagopal, Dr. M.P. Ghewande and Dr. S. Desai

Sub-Project : Integrated insect-pest management of thrips and defoliators in groundnut using non-synthetic pesticides, biocontrol, pheromone in CDR production system

Sub-Project : Integrated Management of major diseases (ELS, LLS, rust, Collar rot, Stem rot, PBND) of groundnut

Project 03 : Management of post harvest problems in groundnut

Project Leader : Dr. P.C. Nautiyal

Sub-Project : Seed viability and dormancy
Sub-Project : Storage pests

Project 04 : Integrated Nutrient management in groundnut

Project Leader : Dr. K.K. Pal

Sub-Project : Development of Biofertilizer packages for groundnut
Sub-Project : Mineral disorders of groundnut

Project 05 : Studies on groundnut based cropping system

Project Leader : Dr. Devi Dayal

Sub-Project : Studies on input management in intercropping system
Sub-Project : Studies on sequential cropping system

Project 06 : Cropping system for traditional rabi/summer and spring irrigated situations

Project Leader : Dr. Y.V. Singh

Sub-Project : Physiological studies on abiotic stresses
Sub-Project : Development of cropping system

Project 07 : Development of suitable cropping system for non-traditional areas with special reference on eastern and north eastern parts of India

Project Leader : Dr. A.L. Singh

Sub-Project : Studies on impact of agro-ecology and agro-economy
Sub-Project : Development of suitable cropping system
Sub-Project : Breeding to develop cultivars tolerant to Al toxicity
Sub-Project : Organic farming

Con...

Sl. No.	Project Title	Funding Agency	Scientist handling	Duration From To	Nature of Project	Budget (Rs. in lakhs)
5.	Aflatoxin contamination in groundnut: mapping and management in gujarat, andhra pradesh and adjoining areas	APNL	Dr. S. Desai	May 2000 to November 2003	Research	51.00
6.	Mass Multiplication and Delivery of Biocontrol Systems for Management of Late Leaf spot of Groundnut in Mahboobnagar and Nalgonda districts of Andhra Pradesh	NATP	Dr. S. Desai	April 1998 to December 2003	Research	32.00
7.	Development of weather based forewarning systems for groundnut pests and diseases		Dr. S. Desai Dr. V. Nandagopal	April 2001 to December 2003	Research	44.00

LIST OF EXTERNALLY FUNDED PROJECTS AND CONTRACT RESEARCH AT NRCG

Sl. No.	Project Title	Funding Agency	Scientist handling	Duration From To	Nature of Project	Budget (Rs. in lakhs)
1	Technology Assessment and Refinement through Instt. Village Linkage Programme	ICAR	Dr. M.P. Ghewande Dr. Devi Dayal Dr. V. Nandagopal Dr. M.Y. Samdur Dr. Satish Kumar	April 1999 - December 2003	Research	35.00
2	Identification of efficiently nodulating and nitrogen fixing strains of Bradyrhizobium and their application	DBT	Dr. K.K. Pal Dr. Rinku Dey	Nov.'98 to Oct. 2001	Research	11.6
3	Synthesis of sex pheromone and development of pheromone trap for groundnut leaf miner	AP Cess IICT collaboration	Dr. V. Nandagopal Dr. J.S. Yadav	March'99 to Feb.'2002	Research	22.50
4.	Evaluation of cultivars of major oilseed crops of the production system for moisture and nutrient constraints in different soil types	NATP	Dr. Devi Dayal, Dr. M.Y. Samdur, Dr. Satish Kumar	May 2000 to December 2003	Research	19.86

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Chandran K, K.Rajgopal, T. Radhakrishnan and H.B.Lalwani 2001. *In vitro* multiplication and conservation of Wild *Arachis* germplasm. Presented in the Symposium on Plant Genetic Resources Management: Advances and Challenges 1-4, August, 2001. Indian Society of Plant Genetic Resources, NBPGR Campus, New Delhi.

Chandran K. 2001. Biochemical tools in characterization of groundnut Germplasm. Presented in the Annual rabi/summer Groundnut Workshop, NRCG, Junagadh.

Devi Dayal 2001. Low cost and non-monetary technology for groundnut. A talk delivered in a National Training on Low cost production technology for oilseeds , organized by Directorate of Oilseeds Research, Hyderabad, September 5,2001

Devi Dayal and K.K. Pal. 2001. Studies on soil chemical and microbial properties and productivity of groundnut under groundnut based cropping system. Extended summaries, Natl. symp. On Farming Systems Research in New Millennium, Oct. 15-17,2001, Modipuram, Meerut, India, pp. 278-279.

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Rajgopal K., Chandran K. and H.B. Lalwani, 2001 Preliminary evaluation of groundnut (*Arachis hypogaea* L.) germplasm for yield and related traits, Third National workshop, NATP on Sustainable management of Plant Biodiversity 18-20 April 2001

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4. MSSRF-FAO Expert Consultation on Implementing Farmers' Rights for Conservation and Utilisation of Plant Genetic Resources in Asia-Pacific Region: From Legislation to Action, held at MSSRF, Chennai, 21-23 Jan 2002

Dr. V. Nandagopal

1. Risk management in Agriculture- from 8-10th of March,2002 at Manage, Rajendra Nagar, Hyderabad under IVLP programme.
2. Participated and presented an article on the Red Hairy at the consultative group meeting of AME at CRIDA, Hyderabad on the management of Red Hairy Caterpillars in groundnut on 12th marh,2002
3. Attended a National Seminar on "Emerging Trends in Pests and Diseases and their management" held at TNAU,Coimbatore -11-13 of October,2001.
4. 15. A visit of one week was made in the month of June 2001 at the MAUSUM BHAWAN, New Delhi, for first-hand experience to work on DSSAT model with our own data set.
5. 16. Another visit of one week was made in the month of October 2001 at the IARI New Delhi in the laboratory of Dr P.K. Aggarwal, to develop crop simulation model INFOCROP in collaboration.

Dr. K.K. Pal

1. Attended review meeting of TMOP, May, 25, 2001, New Delhi
2. Attended 4th meeting of Task Force on INM organized by DBT, December, 26-27, 2001, New Delhi

Dr. Chuni Lal

1. Plant Breeding Approaches for Quality Improvement in Crops at TNAU, Coimbatore during 28 January to 17 February 2002.
2. Recent Techniques and Participatory Approaches and Quality Seed Production at TNAU, Coimbatore during 1-30 September 2001.

Dr. Rajgopal / Dr. Chuni Lal

1. IPR & WTO Awareness at CIFE Mumbai during 18-20 September 2001

Dr. Rinku Dey

1. Plant Growth Promoting, Rhizobactoria at IARI, New Delhi during 18-24 March 2002.

Dr. M.Y. Samdur

1. Visited Hyderabad to attend germplasm awareness day organized by NBPGR, Regional Station, from 19-02-2002 to 22-02-2002.
2. Visited IARI, New Delhi to attend Diamond Jubilee symposium on Hundred years of Post-Mendelian Genetics and Plant Breeding Retrospect and Prospects 6-9 Nov. 2001, organized by Indian Society of Genetics and Plant Breeding

VISITS / PARTICIPATION IN WORKSHOPS / SEMINARS / TRAININGS / SYMPOSIA / CONFERENCES / MEETINGS ETC.

Dr. A. Bandyopadhyay

1. 3rd Executive Development Programme in Agril. Research Mgt. at NAARM, Hyderabad during July 15-18 2000

Dr. M.P. Ghewande

1. 37th Staff Research Council Meeting (SRC), April 27-28, 2001.
2. Khedut Sabba on 11.09.001 at Chitrawad Village, Taluka- Talala, District- Junagadh.
3. 4th Research Advisory Committee Meeting (RAC), Sept 24-25, 2001.
4. Departmental Promotion Committee Meeting of NRCG on 07.01.002.
5. 38th SRC Meeting for Rabi-Summer, January, 15,2002
6. National Conference on Frontiers in Biotechnological aspects of Plant Sciences, January, 30-31,2002, Dept. of Botany, Dr. Baba Saheb Ambedkar Marathawada University, Aurangabad-431 004 (MP).
7. District Coordination Committee Meeting of Farmers Training Centre, Junagadh, Dept of Agril. Govt. of Gujarat on 15.03.2002.

Dr. Devi Dayal

1. Attended National Symp. on "Pulses and Oilseeds for Sustainable agriculture", July 29-31, 2001, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu
2. Attended Natl. symp. on "Farming Systems Research in New Millennium", Oct. 15-17,2001, Modipuram, Meerut, India.
3. Attended training programme on " Risk management in Agriculture" , 8 march to 10 Marh,2002, at MANAGE, Hyderabad

Dr. P.C. Nautiyal

1. Modelling to CASS at IARI, New Delhi during 17 March to 7 April 2001

Dr. T. Radhakrishnan

1. Orientation course on bio safety in evaluating transgenic crops from 2nd to 9th Nov 2001, at NBPGR, New Delhi
2. National symposium on "Pulses and Oilseeds for Sustainable Agriculture", held at TNAU, Coimbatore from 29th to 31st July 2001.
3. Meeting on "Implementations of DUS testing system in India" held at Directorate of Maize Research, IARI, New Delhi on 18.9.2001

Shri H.B. Lalwani

1. Maintenance and Management of Seed Bank Facilities at NATP, NBPGR, New Delhi during 30 April to 11 May 2001

Mr. M.V. Gedia

1. "Mass Production Techniques of Biological Control Agents" organized by National Centre for Integrated Pest Management, New Delhi from 4th to 12th April, 2001.
2. "Integrated approach to control Peanut Stem Necrosis Disease (PSND) of groundnut" jointly organized by NBPGR, Hyderabad and ICRISAT, Patancheru, Hyderabad from 1st to 2nd June, 2001.

Smt. V.S. Chaudhary

1. Hindi Training at NAARM, Hyderabad during 6-9 October 2001

Honours, Awards, Recognitions etc.(Dr. M. P. Ghewande)

1. External referee for Ph.D. in Plant Pathology of Swami Ramanand Teerth, Marathwada University, Nanded-431 606 (MS) and Dr. Baba Saheb Ambedkar Marathwada University, Aurangabad-431 004 (MS)
2. Invited to deliver Lead Paper on Aflatoxin Management in Groundnut by Dept. of Botany Dr. Baba Saheb Ambedkar Marathwada University, Aurangabad-431 004 (MS) at the National Conference on Frontiers in Biotechnological aspects of Plant Sciences, January, 30-31,2002.
3. Invited to work on Panel of Judges at Mahila Krishi Mela by the Farmers Training Centre , Junagadh, Dept.of Agril., Govt of Gujarat on 23.03.002.

3. Visited Jalgaon, Dhule, Akola and Khargone for monitoring breeder seed plots and peanut stem necrosis disease survey from 5-09-2001 to 16-09-2001.

Dr. S.K. Bera

1. Recent Trends in Seed Production Management at JNKVV, Jabalpur during 20 November to 10 December 2001.
2. Registance Breeding incrop Plants at PAU, Ludhiana during 18 August to 5 September 2001

Shri G.D. Satish Kumar

1. Attend the Sensitization workshop on Monitoring and Evaluation of rainfed production systems research at CRIDA, Hyderabad from 26/8/01 to 28/8/01.
2. Participated in the central west (zone II) ICAR sports meet from 3-6th November 2001 at CIAE, Bhopal.
3. Attended the 4th RAC meeting held during 24/9/01 to 25/9/01 at NRCG, Junagadh.
4. Attended a 4 day training programme from 12/2/02 to 15/2/02 on "Techniques of improving extension services for farm women" at National Research Centre for Women, Bubaneshwar.
5. Attended a 3 day training programme from 8/3/02 to 10/3/02 on "Risk management in Agriculture" organized by MANAGE, GOI, Hyderabad
6. Attended a meeting organized jointly by IFFCO and GAU at Kathariawari village on 23/10/02 and sensitized the farmers on recent technological findings about groundnut

Shri Y.C. Joshi / Shri Rajeev Lal

1. Vigilance Awareness at IARI, New Delhi on 30 August 2001

Dr. R.S. Tomar

1. Soil Science and Land Evaluation at NBSS&LUP, UAS, Bangalure during July 02 to September 29, 2001

Shri C.P. Singh

1. Farm Machinery Management and Utilization, CIAE, Bhopal during 12-19 September, 2001
2. Identification and Management of Mite Pest and Crops, CIAE, Bhopal during 16 to 23 October, 2001

Shri Virendra Singh / Shri V.K. Sojitra

1. Water Technology, Farm Water Management, IARI, New Delhi during 13-20 February, 2002

Sh. P. V. Zala	Technical Officer, T-5
Mrs. V. S. Chaudhary	"
Sh. B. M. Chikani	"
Sh. Ranvir Singh	"
Sh. Virendra Singh	"
Sh. H. K. Gor	"
Sh. J. R. Dobaria	"
Sh. S. D. Savalia	"
Sh. M. V. Gedia	Technical Assistant, T-4
Sh. D. R. Bhatt	"
Sh. R. D. Padavi	Technical Assistant, T-3
Sh. V. K. Jain	"
Sh. Pitabasdas	"
Sh. Suraj Pal	"
Sh. G. J. Solanki	"
Sh. A. D. Makwana	"
Sh. H. V. Patel	"
Sh. Sugad Singh	"
Sh. Prabhu Dayal	"
Sh. C. B. Patel	"
Sh. A. M. Vakharia	Artist-cum-Photographer
Sh. P. B. Garchar	Electrician
Sh. K. H. Koradia	Driver
Sh. G. G. Bhalani	"
Sh. N. M. Safi	"
Sh. J. G. Kalaria	Tractor Driver
Sh. B. M. Solanki	"
Sh. J. R. Ramani	Assistant Administrative Officer
Ms. Rosamma Joseph	Senior Stenographor
Sh. Balvir Singh	Security Supervisur
Sh. Y. S. Karia	Junior Stenographor
Sh. L.V. Tilwani	"
Sh. J. B. Bhatt	Assistant
Sh. R. T. Thakar	"
Ms. K. A. Vasani	"
Ms. S. Venugopalan	Senior Clerck
Ms. M. N. Vaghasia	"

STAFF LIST OF NRCG, JUNAGADH

Dr. M. S. Basu	Director
Dr. Y. V. Singh	Principal Scientist
Dr. M. P. Ghewande	"
Sh. Y. C. Joshi	"
Dr. J. B. Misra	"
Dr. P. Paria	"
Dr. I. K. Girdhar	"
Dr. Devi Dayal	Senior Scientist
Dr. P. C. Nautiyal	"
Dr. A. L. Singh	"
Dr. T. Radhakrishnan	"
Dr. V. Nandagopal	"
Dr. K. Rajgopal	"
Dr. S. Desai	"
Dr. K. Chandran	Scientist
Sh. S. K. Bera	"
Dr. M. Y. Samdur	"
Dr. A. L. Rathnakumar	"
Dr. Chunilal	"
Dr. K. K. Pal	"
Dr. Rinku Dey	"
Sh. G. D. Satishkumar	"
Sh. Rajeevlal	Administrative Officer
Sh. Prashantkumar	Finance & Accounts Officer
Dr. R. S. Tomar	Farm Superintendent
Sh. M. M. Das	Technical Officer, T-5
Ms. S. M. Chauhan	"
Sh. V. K. Sojitra	"
Sh. V. G. Koradia	"
Sh. D. M. Bhatt	"
Sh. H. B. Lanwani	"
Smt. Veena Girdhar	"
Dr. D. L. Parmar	"
Sh. C. P. Singh	"
Sh. H. M. Hingrajea	"
Sh. P. R. Naik	"
Sh. P. K. Bhalodia	"
Sh. N. R. Ghetia	"

Sh. R. D. Nagwadia	Junior Clerek
Sh. C. G. Makwana	"
Sh. H. S. Mistry	"
Sh. N. M. Pandya	Fild Assisitant
Sh. D. M. Sachania	"
Sh. G. S. Mori	Lab Assisitant
Sh. P. M. Solanki	Auto Cleaner
Sh. C. N. Jethwa	Safaiwala
Sh. B. K. Baria	"
Sh. R. B. Chawada	Chowkidar
Sh. M. B. Sheikh	"
Sh. J.G. Agrawat	"
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Sh. G. D. Moradia	"
Sh. V. N. Kodiatar	"
Sh. R. P. Sondarwa	"
Sh. A. D. Makwana	"
Sh. K. T. Kapadia	Bullockman
Sh. V. M. Chawada	Messenger
Ms. D. C. Sachania	"
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