NRCG

Annual Report 2005-06

भाकृअनुप
ICAR

National Research Centre for Groundnut

(Indian Council of Agricultural Research)

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

ANNUAL REPORT
2005-06

National Research Centre for Groundnut
(Indian Council of Agricultural Research)
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Preface

It gives me an immense pleasure and satisfaction in bringing out the annual report of the National Research Centre for Groundnut for the year 2004-05. During the year, we had attempted several crosses and developed about 35 new advanced cultures. More than six genotypes developed were identified to be having higher yield potential or better water use efficiency. Four advance cultures developed at the centre are under National varietal evaluation. Under the AICRP-G'nut screening of germplasm accessions was undertaken at the hot-spots for foliar and viral diseases. We had supplied segregating materials to 13 AICRP-G centres. During the year we could test some of our IPM modules for it efficiency and cost effectiveness. We also had very effective screening programme at the Centre for *Aspergillus flavus* and insect pests as well. We were also successful in identifying a few consortia of non-fluorescent pseudomonads resulted in higher pod yield and better plant growth in field. The crop production scientists have undertaken nutrient management studies and identified P and Ca efficient genotypes. Our working collection of groundnut germplasm was enriched by assembling 31 accessions. A total of 1362 accessions were supplied to different indenters. We could develop a simple procedure was developed for comparing groundnut genotypes for their blanching attribute. During this year, NRCG could develop a repository of isolates of *Aspergillus* spp.

The pace of research that was set in the past was further accelerated towards achieving the set goals as per the mandate. I am sure the concerted efforts by the dedicated scientists and staff members will certainly contribute towards groundnut development remarkably.

The sincere assistance from various corners for the preparation of this report is thankfully acknowledged. We shall be grateful to receive suggestions for further improvement on the quality of our work and also the content of the future reports.

Director

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सारांश

- बेहतर शस्यीय परिस्थितियों में विभिन्न जैविक एवं अजैविक दबावों के प्रति प्रतिरोधकता / सहिष्णुता को सन्निहित करने के लिए 22 संकर बनाने का प्रयास किया गया।
- वर्ष के दौरान विभिन्न जैविक एवं अजैविक दबावों के प्रति प्रतिरोधकता / सहिष्णुता युक्त कारकों वाले, जो कि फसल की उपज को सीमित करते हैं, 35 अग्रिम कल्चर विकसित किए गए।
- दो वर्षों के मूल्यांकन में सर्वोत्तम चेक SB XI की तुलना में मूंगफली के दो स्पैनिश जननद्रव्यों PBS 30051 एवं PBS 30086 ने फली उत्पादन में क्रमशः 67 एवं 64% की वृद्धि दर्ज करायी । दो अन्य जननद्रव्य PBS 24030 एवं PBS 29017 पी.बी.एन.डी. एवं थ्रिप्स के विरुद्ध आशाजनक पाए गए।
- कम से कम नुकसान (फली एवं दाना क्रमशः 4 एवं 6%) के साथ जननद्रव्य PBS 18062 को शीघ्र पकने वाला पाया गया जब कि इसे पकने की सामान्य अवधि 105 DAS की तुलना में 95 DAS में काट लिया गया।
- विशिष्ट पर्ण क्षेत्र (SLA) जो कि जल उपयोग क्षमता को बढ़ाने का एक अप्रत्यक्ष उपाय है, के लिए उत्तम चेक GG 2 की तुलना में अग्रिम प्रजननिक वंशक्रमों PBS 13021, PBS 19012, एवं PBS 30159 में SLA सार्थक रूप से कम पाया गया। PBS 13021 में SCMR- मूल्य, जो कि जल उपयोग क्षमता को बढ़ाने का एक अन्य अप्रत्यक्ष उपाय है, भी सार्थक रूप से अधिक दर्ज किया गया जो कि जल उपयोग क्षमता विकसित होना दर्शाता है।
- पत्तियों के ऊतकों में पोषक तत्वों (Ca, N, K, Mg, Mn एवं Fe) की मात्रा के आनुवांशिक नियन्त्रण का आंकलन प्रथम बार किया गया। Ca, N, K_2, एवं Mg की मात्रा को उन जीनों के नियन्त्रण में पाया गया जो कि प्रभावी रूप से एडीटिव प्रकृति के हैं जब कि Fe को नान-एडीटिव जीनों के नियन्त्रण में पाया गया। Mn की मात्रा के मामले में एडीटिव एवं नान-एडीटिव दोनों प्रकृति के जीनों का समान महत्व पाया गया।
- पत्तियों के ऊतकों में पोषक तत्वों की मात्रा हेतु सामान्यतया अच्छे संयोगों की पहिचान की गयी जो इस प्रकार हैं: Ca (CSMG 84-1), Mn (Chico एवं ICGV 86031), N (TAG 24), K (ICG 4747), तथा Mg (CSMG 84-1 एवं TMV 2 NLM).
- जल की कृत्रिम कमी की दशा में अग्रिम प्रजननिक कल्चरों के मूल्यांकन के परिणामों ने दर्शाया कि सूखा सहिष्णुता की छंटनी के लिए जननद्रव्यों की अपनी उपलब्धिता के साथ सामान्य सिंचित दशाओं की तुलना में उपज प्रतिशत में कमी जैसे पैमानों और सूखा संवेदनशील सूचकांक को भी ध्यान में लेना चाहिए।
- मूंगफली पर अखिल भारतीय समन्वित अनुसंधान परियोजना के राष्ट्रीय प्रजातीय मूल्यांकन परीक्षणों के अन्तर्गत केन्द्र पर चार अग्रिम कल्चरों यथा: IVT [PBS 24004 (HYB), PBS 12160 (VUL) एवं JUN 27 (HYB)] तथा AVT [PBS 24030 (HYB)] को विकसित किया गया। मूंगफली पर अखिल भारतीय समन्वित अनुसंधान परियोजना के अन्तर्गत प्रजातीय मूल्यांकन हेतु नई प्रविष्टि के प्रस्ताव के लिए बीज की आवश्यकता पूर्ति हेतु अन्य आशाजनक अग्रिम प्रजननिक कल्चरों के बीजों का बहुगुणन किया गया।
- मूंगफली पर अखिल भारतीय समन्वित अनुसंधान परियोजना के 13 केन्द्रों पर विभिन्न प्रजननिक उद्देश्यों के लिए 49 संकरों के F_3 से F_6 पीढ़ियों के पृथकीकृत पदार्थ को भेजा गया। इसके अलावा सूखा सहिष्णुता के लिए बनाए गए 12 संकरों के F_4 पीढ़ी के पृथकीकृत पदार्थ को परिस्थिति विशिष्ट में चयन हेतु मौसम के मध्य रुणं अन्त में सूखा की परिस्थिति हेतु क्रमशः दुर्गापुरा एवं जलगांव भेजा गया।
- बीजों के आकार को बढ़ाने के लिए नये संकर बनाने का प्रयास किया गया। पृथकीकृत पीढ़ियों में फलियों के बड़े आकार एवं / या फली उत्पादन के लिए आकारकीय आधार पर 93 चयन किए गए। बीजों के आकार या बेहतर उपज के आधार पर पृथकीकृत पीढ़ियों से 49 अग्रिम प्रजननिक वंशक्रमों को विकसित किया गया।
- उत्तम चेक GG 20 की तुलना में बड़े बीजाकार वाले अग्रिम प्रजननिक वंशक्रमों PBS 29077, PBS 29078, एवं PBS 29080 में उच्च फली उत्पादन दर्ज किया गया। सभी चेकों की तुलना में PBS 29077 में 100-बीजों का भार सार्थक रूप से उच्च दर्ज किया गया।

- बेहतर निष्पादता के आधार पर अग्रिम प्रजननिक वंशक्रम ICGV 99101 को मूंगफली पर अखिल भारतीय समन्वित अनुसंधान परियोजना के अन्तर्गत प्रजातीय मूल्यांकन हेतु प्रस्तावित किया गया और बीज की आवश्यक मात्रा को बहुगुणित किया गया।

- गुणवत्ता वाले गुणों जैसे कि फली एवं बीजों के आकार तथा पूर्ण परिपक्व दानों को नियन्त्रित करने वाले एडीटिव एवं नान-एडीटिव जैसे प्रकृति के जीनों का महत्व समान पाया गया जब कि प्रति पौधा दानों एवं फलियों की संख्या तथा फलियों की उपज और सेलिंग प्रतिशत पर नान-एडीटिव जीनों का नियन्त्रण पाया गया।

- क्रत्रिम निष्पर्णन के प्रयोग में वानस्पतिक अवस्था के अलावा सभी अवस्थाओं एवं उनके संयोगों में निष्पर्णन बढ़ने के साथ-साथ उपज की हानि में सार्थक बढ़ावा हुआ। यद्यपि सभी अवस्थाओं एवं उनके संयोगों में निष्पर्णन बढ़ने के साथ-साथ तेल, सेलिंग प्रतिशत तथा पूर्ण परिपक्व दानों में सार्थक भिन्नता पायी गई लेकिन निष्पर्णन का कोई सीधा संबंध नहीं पाया गया।

- केरीडॉन सेर्रेटस (ब्रुचिड) के विरुद्ध उपचार एवं अन्य वानास्पतिक परीक्षणों की तुलना में 0.25% कारी मिर्च के पाउडर (औसतन 4.33 वयस्क पैदा हुए) के बाद 0.25% नीम के बीजों के पाउडर (औसतन 2.0 वयस्क पैदा हुए) के प्रयोग से कम से कम वयस्क पैदा हुए।

- केरीडॉन सेर्रेटस (ब्रुचिड) के प्रबन्धन हेतु भण्डारण के लिए मूल्यांकित किए गए विभिन्न साधनों में से अन्य साधनों की अपेक्षा पॉलीथीन के बोरे सर्वाधिक उपयुक्त पाये गये क्यों कि इनमें अण्डों एवं वयस्कों के उत्पन्न होने की संख्या (औसतन 0.7 अण्डे प्रति १०० ग्राम फलियां एवं 18 वयस्क प्रति किलोग्राम फलियां) अन्य की तुलना में कम पाई गई।

- मूंगफली की खेती में लागत और उपज तथा अन्तरशस्यन के आधार पर आइ.पी.एम. के प्रयोग में मूंग के अन्तरशस्यन ने सी.बी.आर. (1:4.05) अरन्डी ने (1:4.25) के बाद अधिकतम सी.बी.आर. (1:4.30) अरहर के अन्तरशस्यन ने दिया। उत्पादन के आर्थिक विश्लेषण ने दर्शाया कि अन्य अन्तरशस्यों की तुलना में अरन्डी की फसल से हुई आय (रु. 44,598 प्रति हेक्टेयर) के बाद अरहर की फसल से अधिकतम आय (रु. 45,132 प्रति हेक्टेयर) हुई। मूंगफली में अन्तरशस्यन का सेलिंग, पूर्ण परिपक्व दानों एवं तेल प्रतिशत पर कोई सार्थक प्रभाव नहीं हुआ।

- खेत में दीमक के विरुद्ध छोटे गए 9 जननद्रव्यों में से CO-1 में 17.18% की अपेक्षा TMV-2 में दीमक का प्रकोप कम (1.78%) दर्ज किया गया।

- खेत में जैसिड की प्रतिरोधकता के लिए छोटे गए 31 जननद्रव्यों में से CS-101, 102 तथा 109 को अन्य की अपेक्षा प्रतिरोधक और CS-247, 251 तथा 254 को सहिष्णु (10 जैसिड/5 स्वीप से अधिक) पाया गया। थ्रिप्स के विरुद्ध परीक्षण किए गए जननद्रव्यों में से CS-101, 102 तथा 258 को अन्य की अपेक्षा प्रतिरोधक और CS-108, 243 तथा 247 को सहिष्णु (15 अण्डे/10 पत्तियों से अधिक) पाया गया। तीन जननद्रव्यों यथा: CS-101, 102 तथा 147 ने थ्रिप्स तथा जैसिड दोनों के प्रति प्रतिरोधकता दर्शायी और बहुप्रतिरोधक होने का संकेत दिया।

- प्रयोगशाला की परिस्थिति में केरीडॉन सेर्रेटस (ब्रुचिड) के विरुद्ध छोटे गए 11 जननद्रव्यों में से अन्य की अपेक्षा प्रति 100 ग्राम फलियों में अण्डों एवं वयस्कों की औसतन संख्या CS-189 में न्यूनतम क्रमशः (73.33 एवं 53.67) तथा GG-2 में अधिकतम क्रमशः (158.67 एवं 93.33) पायी गयी।

- केरीडॉन सेर्रेटस (ब्रुचिड) के विरुद्ध परीक्षण की गई विभिन्न वनस्पतियों में से अन्य वनस्पतियों एवं उपचार की अपेक्षा प्रति 100 ग्राम फलियों में अण्डों की औसतन संख्या 0.5 % अन्नोना चूर्ण से 3.33 के बाद 1% पारथेनियम चूर्ण से न्यूनतम 0.67 अण्डे प्रति 100 ग्राम फलियां पाई गई।

- खेत की परिस्थिति में PBND के विरुद्ध छोटे गए 70 जननद्रव्यों में से ग्रीष्मकाल, 2005 में 8 जननद्रव्यों में प्रभाव शून्य पाया गया जब कि अन्यों में इसके प्रभाव का औसत 0-17.46% तक पाया गया।

- छंटनी के द्वितीय वर्ष में जननद्रव्य PBS-25001 में बहुरोग-प्रतिरोधकता दर्ज की गयी और खरीफ, 2005 में छंटनी के प्रथम वर्ष के दौरान NRCG-CS-277 ने अगेती एवं पछेती पर्णधब्बा तथा रस्ट के प्रति बहुरोग-प्रतिरोधकता दर्शायी।

- चार जननद्रव्यों यथा: PBS 24008, PBS 25003, PBS 29080 एवं CS-19 ने कंक्रीट ब्लॉक में रोगी मिट्टी की परिस्थितियों में *S. rolfsi* के विरुद्ध प्रतिरोधक प्रतिक्रिया दर्शायी।

- इन-विट्रो परिस्थितियों के अन्तर्गत छंटनी किए गए 32 जननद्रव्यों में से 6 जननद्रव्यों यथा: NRCG-CS nos. 334, 352, 316, 350, 272 एवं 331 ने *A. niger* के विरुद्ध प्रतिरोधकता (10% या उससे कम बीज उपनिवेशन) दर्शायी।
- ट्राइकोडर्मा प्रजाति के दो आइसोलेट्स यथा: T 170 एवं T 219 तना एवं कंद सड़न दोनों के रोगजनकों के विरुद्ध पाये गये।
- मक्का के साथ अन्तरशस्यन एवं पुष्पण के समय 500 किलोग्राम प्रति हेक्टेयर की दर से जिप्सम का अनुप्रयोग तथा ट्राइकोडर्मा हार्जेनियम द्वारा बीजोपचार +जिप्सम के अनुप्रयोग द्वारा फफूंदीजनित पर्णीय रोगों की सघनता में सार्थक रूप से कमी पायी गई।
- रोग के प्रथम बार दृष्टिगोचर होने पर 50% तनुता के *V. lecanii* के छनित कल्चर के पर्णीय अनुप्रयोग के बाद 15 दिन के अन्तराल पर दो छिड़काव करने पर पर्णधब्बा एवं रस्ट में सार्थक कमी पाई गई।
- करंज की पत्तियां, जिप्सम, सल्फर तथा चूने के तत्वीय रूप में अनुप्रयोग करने से तना सड़न के प्रकोप में सार्थक कमी पाई गई।
- पत्ती की कोशिका की झिल्ली की ताप-स्थिरता (लीफ सेल मेमब्रेन थर्मोस्टेबिलिटी-एल.सी.एम.टी.) तथा हीट एक्लीमेशन पोटेन्शियल में प्रजननिक एवं मौसमी भिन्नता दर्ज की गई और ICGS 44 को ताप सहिष्णु एवं Chico को ताप संवेदनशील जननद्रव्यों के रूप में पहिचाना गया।
- फसल के फली उत्पादन, एल.सी.एम.टी तथा जड़ के तन्त्र के आधार पर प्रजाति ICGS 44 को वर्षा आधारित प्रणाली एवं सीमित जलापूर्ति में खेती के लिए सर्वाधिक उपयुक्त पाया गया।
- सामान्य तथा पानी की कमी की परिस्थितियों के अन्तर्गत जड़ के तन्त्र में प्रजननिक भिन्नता दर्ज की गई और ICG V 86031 ने जड़ की लम्बाई की सघनता अधिकतम दर्शायी जब कि दबाव की स्थिति में जड़ की अधिकतम लम्बाई TAG 24 में पाई गई।
- मूंगफली की प्रजाति GG 2 एवं JL 24 के साथ खेत में किए गए परीक्षणों में नान-फ्लुओरिसेन्ट स्यूडोमोनाड्स के कन्जोरटियम के उपनिवेशन के परिणाम स्वरूप पौधों की वृद्धि अच्छी एवं अधिक फली उत्पादन प्राप्त हुआ। बड़े दानों वाली मूंगफली की प्रजातियों में पी.जी.पी.आर. कल्चर को बीज उपनिवेशन के रूप में अनुप्रयोग करने पर मूंगफली की वृद्धि, उपज एवं पोषक तत्वों को लेने में बढ़ोत्तरी हुई। पी.जी.पी.आर., पी.एस.एम. तथा राइजोबिया के कन्जोरटिया के परीक्षण किए गए और मूंगफली की प्रजाति GG 2 की उपज बढ़ाने में पी.एस.एम. तथा राइजोबिया के कन्जोरटिया आशाजनक पाए गए। सिंचित परिस्थितियों में ग्रीष्मकाल में मूंगफली की प्रजाति TG 26 में पी.जी.पी.आर कल्चर के उपनिवेशन से मूंगफली की वृद्धि एवं उपज बढ़ोत्तरी हुई।
- फसल प्रणालियों के परीक्षणों में मूंगफली-गेहूं-मूंग के चक्र में मूंगफली का अधिकतम उत्पादन (1105 किलोग्राम प्रति हेक्टेयर) पाया गया।
- कटाई के समय तना सड़न के असर को दर्ज किया गया जो कि बिना FYM के अनुप्रयोग वाले उपचार में (3.79%) तथा केवल मूंगफली में (3.43%) की अपेक्षा FYM के अनुप्रयोग वाले उपचार में (5.28%) तथा मूंग+अरहर के अन्तरशस्यन वाले उपचार में (5.38%) पाया गया जो कि प्रथम दो उपचारों की तुलना में अधिक था। मूंग +बाजरे में तना सड़न का असर सबसे कम (0.01%) पाया गया।
- किसी एक फसल की अपेक्षा मूंगफली+अरहर का अन्तरशस्यन अधिक उत्पादक (LER 1.40-1.45) पाया गया। मोनो-फॉस्फेट की अपेक्षा डाइ-फॉस्फेट के अन्तर्गत फ़ॉस्फोरस का लेना एवं कुल उत्पादकता तुलनीय पाई गई और इससे इस संभावना का संकेत मिला कि डाइ-फॉस्फेट जो कि फ़ॉस्फोरस का सस्ता स्रोत है, आर्थिक रूप से उपयोगी है।
- उपचार (बिना नमी संरक्षरण) की तुलना में आइ.आर.डब्ल्यू.एच. (IRWH) के कारण फली उत्पादन में 26.2% बढ़ोत्तरी हुई।
- आइ.आर.डब्ल्यू.एच. (IRWH) के अन्तर्गत डब्ल्यू.यू.ई. (WUE) का औसत 5.44- 8.48 kg/ha/mm रहा जब कि उपचार में यह 5.60 kg/ha/mm पाया गया।
- आइ.आर.डब्ल्यू.एच. (IRWH) के अन्तर्गत उर्वरता क्षेत्र की प्रतिक्रिया चार गुनी रही जो दर्शाती है कि आइ.आर.डब्ल्यू.एच. (IRWH) के अन्तर्गत उर्वरकों को कम करने की गुंजाइश है।
- शुष्क परिस्थितियों में बोई गई मूंगफली के बीज मानसून के प्रारम्भ होने पर की गई बुआई की तुलना में 4-6 दिन पहले अंकुरित हुए।
- शुष्क परिस्थितियों एवं मानसून के प्रारम्भ होने पर की गई बुआई के कारण पौधों के निकलने में कोई सार्थक अन्तर नहीं पाया गया।

- मानसून प्रारम्भ होने के 5 दिन पूर्व बुआई करने पर अधिकतम फली उत्पादन प्राप्त किया गया। उपचारों में कैल्शियम सल्फेट, रॉक फॉस्फेट, एवं गोबर द्वारा बीज पर पुट देने पर भी कुछ समर्थता दर्शाई।

- नमी के दबाव की मात्रा बढ़ाने पर फली उत्पादन में सार्थक कमी पाई गई। हांला कि नमी के दबाव की मात्रा बढ़ाने पर उपचार में फली उत्पादन में 67% की कमी की तुलना में K में 56% तथा Ca+K में 45% कम फली उत्पादन पाया गया।

- मध्यम दबावों की परिस्थिति में पोटेशियम से डब्ल्यू.यू.ई. (WUE) में वृद्धि (60% FC पर 7.45 kg/ha/mm) हुई जब कि अधिक दबाव पर अन्य तत्वों की तुलना में Ca+K में 80% FC पर डब्ल्यू.यू.ई. (WUE-5.52 kg/ha/mm) बेहतर पाया गया।

- मूंगफली एवं मूंगफली पर आधारित फसल चक्रों में लवणीय पानी के उपयोग पर चार वर्षों तक खेत में किए गए अध्ययनों से संकेत मिले हैं कि 2 dS/m की लवणतायुक्त जल को सिचाई हेतु उपयोग करके खरीफ में मूंगफली की खेती की जा सकती है जब कि 4 dS/m की लवणतायुक्त जल को सिचाई हेतु उपयोग करके रबी में गेहूं तथा सरसों की खेती की जा सकती है। काली लवणीय मृदा में उच्च लवणता स्तर, मूंगफली एवं सरसों दोनों में तेल, नत्रजन तथा प्रोटीन की मात्रा को प्रभावित करता है। काली लवणीय मृदा में लवणीय पानी के उपयोग करने पर मूंगफली-गेहूं तथा मूंगफली- सरसों चक्र की तुलना में मूंगफली-मूंगफली चक्र को आर्थिक दृष्टि से अच्छा नहीं पाया गया है।

- मूंगफली के 31 अभिगमनों को एकत्र करके जननद्रव्यों के कार्यसाधक संग्रहण को समृद्ध बनाया गया। विभिन्न मांगकर्ताओं को कुल 1362 अभिगमनों की आपूर्ति की गयी।

- दीर्यकालीन भण्डारण के लिए 322 अभिगमनों को राष्ट्रीय जीन बैंक में जमा किया गया।

- दो मौसमों में विमोचित प्रजातियां उगाई गई तथा 20 गुणों के लिए राष्ट्रीय परीक्षण मार्गदर्शनों को विकसित किया गया और DUS परीक्षण सुनिश्चित किए गए।

- O/L अनुपात मूल्य के लिए मूल्यांकित की गई 63 किस्मों में से 14 किस्मों के दानों के नमूनों के मूल्य 2.0 से अधिक पाए गए जब कि 18 किस्मों के दानों के नमूनों के मूल्य 1.2 से कम पाए गए।

- ब्लैंचिग प्रवृत्ति हेतु मूंगफली के जननद्रव्यों की तुलना करने के लिए एक साधारण तरीका विकसित किया गया।

- पारा (Hg) तथा तांबा (Cu) के 5mm सान्द्रण द्वारा क्षारीय प्रोटिएजेज, जो कि बैसिलस की किस्म P5 तथा एसपर्जिलस ओराइजी की किस्म F6 द्वारा उत्पादित होता है, के उत्पादन की गतिविधि को पूर्णतः निषिद्ध कर दिया जाता है।

- एसपर्जिलस फ्लैवस के विरुद्ध शुष्क बीजों में प्रतिरोधकता के लिए छांटे गए 127 जननद्रव्यों में से 15 जननद्रव्यों ने इन-विट्रो बीज उपनिवेशन के विरुद्ध आशा दर्शाई।

- तीन अग्रिम प्रजननिक लाइनों यथा: NRCG- CS nos. 333, 350, 354 तथा दो विमोचित प्रजातियों B 95 तथा BAU 13 ने खरीफ 2005 में एसपर्जिलस फ्लैवस और बाद में एफ्लॉटॉक्सिन प्रदूषण के प्रति सहिष्णुता प्रदर्शित करके एफ्लॉटॉक्सिन संदूषण के विरुद्ध आशा दर्शाई।

- इन-विट्रो परिस्थितियों में एसपर्जिलस फ्लैवस के विरुद्ध ट्राइकोडर्मा प्रजाति के दो आइसोलेट्स यथा: T 71 तथा T 29 ने उच्च विरोध समर्थता दर्शाई।

- ट्राइकोडर्मा प्रजाति के कुल 42 आइसोलेटों को पृथकीकृत करके शुद्ध किया गया और उन्हें सिंगिल स्पोर कल्चर, जिन्हें कि वर्ष 2005-06 में गुजरात के विभिन्न जिलों के मृदा नमूनों से एकत्रित किया गया था, के रूप में अनुरक्षित किया गया।

- एन.आर.सी.जी. में चार प्रजातियों नामतः *A. flavus, A. ochraceus, A. terrus* तथा *A. nidulans*, से सम्बन्धित एसपर्जिलस प्रजाति के 400 अभिगमनों के साथ आइसोलेटों की एक रिपोजिटरी विकसित की गई।

- वर्ष 2005 के ग्रीष्मकाल में माइकोटॉक्सिन उत्पन्न करने वाली फफूंदी के वितरण-पैटर्न के अध्ययन से स्पष्ट हुआ कि *A. flavus* जूनागढ़ तथा अमरैली जिलों में (क्रमशः 39.29% एवं 37.78%) प्रभावी पायी गई जब कि भुज, भावनगर तथा आनन्द जिलों में *A. terrus* प्रभावी पायी गई। खरीफ 2005 में अधिकतर जिलों में अन्य प्रजातियों की अपेक्षा *A. flavus* प्रभावी पाई गई जिससे स्पष्ट हुआ कि ग्रीष्मकाल की

अपेक्षा खरीफ की मूंगफली में एफ्लॉटॉक्सिन का संदूषण अधिक पाया जाता है।

- बुआई के एक महीने बाद तथा कटाई के तुरन्त पहले मृदा के नमूनों में *A. flavus* की संख्या में भिन्नता क्रमशः 0.33-68.7 x 10^3 स्पोर से 2.50-47.8 x 10^3 स्पोर प्रति ग्राम मृदा के बीच पाई गई। फसल की परिपक्वता के साथ यह संख्या बढ़ती हुई पाई गई जो कि कुछ जिलों में अधिकतम 70 x 10^3 स्पोर प्रति ग्राम मृदा तक दर्ज की गई।
- जूनागढ़, भावनगर तथा भुज जिलों की मृदा में यह संख्या कम (70 x 10^3 स्पोर प्रति ग्राम से कम) पायी गई। खरीफ २००५ में किसानों के खेतों के नमूनों एवं ओन-स्टेशन परीक्षणों में *A. flavus* के प्राकृतिक संदूषण में इस संख्या की भिन्नता 0.0-4.5% तक दर्ज की गई। लगभग 90% नमूनों में संदूषण का स्तर शून्य पाया गया।
- विष उत्पन्न करने वाली *A. flavus* की विभेदों के विरुद्ध विपरीत सामर्थ्य के लिए परीक्षित की जा रही *A. flavus* की विष न उत्पन्न करने वाली विभेदों की पहिचान की गई ताकि कटाई के पूर्व एफ्लॉटॉक्सिन के संदूषण को कम किया जा सके।
- एसपर्जिलस फ्लैवस के डी.एन.ए. जीनोम के पृथकीकरण के लिए प्रोटोकॉल का मानकीकरण किया गया और को रैंडम प्राइमर के साथ आर.ए.पी.डी. के द्वारा पी.सी.आर. के लिए डी.एन.ए. का उनकी उपयुक्तता के लिए परीक्षण किया गया जो किएम्लीफाईड पाए गए।
- किसानों की तुलना में विकसित प्रबन्धन तकनीकों से कटाई से पूर्व एफ्लॉटॉक्सिन के संदूषण को 90% से अधिक रोका जा सका है।

Summary

- Twenty-two fresh crosses were attempted during the season to incorporate resistance/tolerance of different biotic and abiotic stresses in the superior agronomic background.
- A total of 35 new advance cultures possessing resistance/tolerance of different biotic and/or abiotic stress factors that limit the crop yield were developed during the year.
- Two Spanish groundnut genotypes, PBS 30051 and PBS 30086, registered 67 and 64% pod yield advantage, respectively over the best check SB XI over two years of evaluation. Two other genotypes, PBS 24030 and 29017, were found to be promising against PBND and thrips.
- Genotype PBS 18062 was found to be early maturing with minimum reduction in yield (4 and 6% pod and kernel) when harvested at 95 DAS compared to normal harvest at 105 DAS.
- Advance breeding lines PBS 13021, PBS 19012 and PBS 30159 possessed significantly lower SLA, a surrog te measure of enhanced WUE over the best check GG 2 for this trait. PBS 13021 also recorded significantly higher SCMR value, another surrogate measure of enhanced WUE, thus exhibiting improved WUE.
- Genetic control of content of nutrients (Ca, N, K, Mg, Mn and Fe) in leaf tissue was worked out for the first time. Contents of Ca, N, K and Mg were found to be under the influence of genes that are predominantly additive in nature, while Fe was under the control of non-additive genes. In case of content of Mn both additive and non-additive genes were equally important.
- Good general combiners were identified for the content of Ca (CSMG 84-1), Mn (Chico and ICGV 86031), N (TAG 24), K (ICG 4747) and Mg (CSMG 84-1 and TMV 2NLM) in the leaf tissue.
- Results of evaluation of advance breeding cultures under simulated water deficit patterns signified that while screening for drought tolerance, parameters like percent reduction in yield over the normally irrigated conditions and drought susceptibility index should be considered along with the performance *per se* of genotypes.
- Four advance cultures developed at the centre are under National varietal evaluation trials *viz*., IVT [PBS 24004 (HYB), PBS 12160 (VUL) and JUN 27 (HYB)] and AVT [PBS 24030 (HYB)] of AICRP-G. Seed of other promising advance breeding cultures was multiplied to meet seed requirements for proposing fresh entries for varietal evaluation under AICRP-G.
- Segregating materials ($F_3 - F_6$ generation) of 49 crosses attempted for different breeding objectives were supplied to 13 AICRP-G centres. Besides, segregating material in F_4 generation of 12 crosses attempted for imparting drought tolerance was sent to Durgapura and Jalgaon locations for situation specific selections for mid-season and end-of season drought situations, respectively.
- Fresh crosses were attempted for increasing seed size. Phenotypic selections were operated for large pod size and/or pod yield in segregating generations and 93 selections were made. Forty-nine new advanced breeding lines were developed from the segregating generations based on pod size or yield superiority during the season.
- Large seeded advanced breeding lines PBS 29077, PBS 29078 and PBS 29080 recorded numerically higher pod yield over the best check, GG 20. PBS 29077 recorded significantly higher 100-seed mass compared to all the checks.
- Based on the superior performance, advanced breeding line ICGV 99101 was proposed for testing

under AICRP-G trial after multiplying the seed in required quantity.

- Both additive and non-additive gene actions were found to be important in the control of quality traits such as pod and seed size, and recovery of sound mature kernels, while control of number of pods and kernels per plant, pod yield per plant and shelling outturn was under non-additive genes.
- In artificial defoliation experiment there was significant increase in yield loss with increase in percentage defoliations in all the stages and in their combinations except during vegetative stage. Though there was significant variation in the percent oil content, shelling percentage and per cent sound mature kernel (SMK) with increase in percentage defoliations in all the stages and in their combinations but no linear relationship was observed with respect to percentage defoliation.
- Adult emergence was minimum in 0.25% neem seed powder (2 mean number of adults emerged) followed by 0.25% black pepper powder (4.33 mean number of adults emerged) compared to control and other botanicals tested against *Caryedon serratus*.
- Among different receptacles evaluated for the management of *Caryedon serratus* polythene bags were found suitable as oviposition and mean number of adults emerged was low compared to other receptacles tested (0.7 mean no of eggs/100g pods and 18 mean no. of adults emerged/kg pod).
- In IPM experiment based on the cost of cultivation and the yields of groundnut and the intercrop, intercropping with pigeonpea gave highest CBR (1:4.3) followed by castor (1:4.25) and green gram (1:4.05). The yield economics worked out has shown that intercrop with pigeonpea gave the highest income of Rs.45, 132/ha followed by castor (Rs.44,598) compared to other intercrops. Intercropping has no significant effect on shelling percentage, sound mature kernel (%) and oil percentage of groundnut.
- Out of nine genotypes screened against termites under field condition, TMV-2 recorded lowest incidence (1.78%) as against 17.18% in CO-1.
- Out of 31 genotypes screened for resistance against jassids under field conditions, CS-101, 102 and 109 were found resistant and CS-247, 251 and 254 were found susceptible (recording >10 jassids/ 5 sweeps) compared to other genotypes tested. Against thrips, CS-101, 102 and 258 were found resistant and CS-108, 243 and 247 were found to susceptible (recording >15 mean no. of eggs/10 leaves) compared to other genotypes tested. Three genotypes *viz*., CS-101, CS-102 and CS-147 showed resistance against both jassids and thrips indicating their multiple resistance.
- Out of 11 genotypes screened against *C. serratus* under laboratory conditions mean no. of eggs/100g pods and mean no. of adults emerged was minimum (73.33 and 53.67) in CS-189 and maximum in GG-20 (158.67 mean no of eggs/100g pods and 93.33 mean no. of adults emerged) compared to other genotypes tested.
- Among different botanicals tested against *C. serratus*, oviposition was minimum in 1% Parthenium powder (0.67 mean number of eggs/100g pod) followed by 0.5% Annona seed powder (3.33 mean number of eggs/100g pod) compared to control and other botanicals tested against *C. serratus*.
- Out of seventy genotypes screened under field conditions during summer 2005 against peanut bud necrosis (PBND), eight genotypes recorded zero incidence. The incidence ranged from zero to 17.46%.
- The genotype PBS 25001 recorded multiple disease resistance during second year screening and the genotype NRCG-CS 277 showed multiple disease resistance against ELS, LLS and rust in the first year screening during *kharif* 2005.

- Four genotypes, *viz*., PBS 24008, PBS 25003, PBS 29080 and CS 19 showed resistant reaction against *S. rolfsii* under sick soil concrete block conditions.
- Out of 32 genotypes screened under *in vitro* conditions, six *viz*., NRCG-CS nos. 334, 352, 316, 350, 272 and 331 showed resistance against *A. niger*, recording <10 % seed colonization.
- The two isolates of *Trichoderma* spp. *viz*., T 170 and T 219 was found to be highly antagonistic for both stem rot and collar rot pathogens.
- There was significant reduction in disease intensity of foliar fungal diseases by intercropping with maize, application of gypsum @ 500 kg/ha at flowering stage and by the seed treatment with *Trichoderma harzianum* + application of gypsum.
- Foliar application of culture filtrate of *V. lecanii* at 50% dilution on the first appearance of the disease followed by two sprays at 15 days interval reduced leaf spots and rust significantly.
- The stem rot incidence was significantly reduced by application of karanj leaves, gypsum, elemental sulphur and lime.
- Genetic and seasonal variability in leaf cell membrane thermostability (LCMT) and heat acclimation potential was noticed and heat tolerant (ICGS 44) and susceptible (Chico) genotypes were identified.
- Based on the performance of the crop in pod yield, LCMT and root architecture cv. ICGS 44 seems to be suitable for cultivation in rain-dependent system or limited water supply.
- Genetic variability in root architecture under normal and water-deficit conditions were noticed and ICGV 86031 showed highest root length density, whereas root length was highest in TAG 24 under stress conditions.
- Inoculation of a consortium of non-fluorescent pseudomonads resulted in higher pod yield and better plant growth in field trials with groundnut cultivars GG 2 and JL 24. Application of PGPR cultures as seed inoculants resulted in improved growth, yield and nutrient uptake of bold seeded groundnut varieties. Consortia of PGPR, PSM and rhizobia were tested and a consortia of PSM and rhizobia was found promising for enhancing yield of groundnut (GG 2). Inoculation of PGPR cultures enhanced the growth and yield of summer groundnut (TG 26) under irrigated conditions.
- Among the cropping systems evaluated, the maximum pod yield (1105 kg/ha) of groundnut was in groundnut-wheat-green gram sequence.
- Stem rot incidence recorded at the time of harvest was more in FYM applied treatment (5.28%) and in G+PP intercropping treatment (5.38%) than in no FYM treatment (3.79%) and sole groundnut (3.43%). G+PM recorded the lowest incidence of stem rot (0.01%).
- Intercropping of groundnut +pigeonpea was more productive (LER 1.40-1.45) than either of the sole crop. Total productivity and P uptake under Di-phospate were comparable with that under mono phosphate indicating possibility of economic use of Di-phosphate, a cheap source of P.
- Pod yield increased by 26.2% due to IRWH over the control (no moisture conservation).
- WUE under IRWH ranged from 5.44 to 8.48 kg/ha/mm whereas it was 5.60 kg/ha/mm under the control.
- Response to fertility regime under IRWH was quadratic which showed some scope to reduce fertilizer doze under IRWH.
- Groundnut seed under dry sowing germinated 4-6 days earlier than under onset of monsoon.

- Seedling emergence did not vary significantly due to dry and onset of monsoon sowing.
- The pod yield was the maximum when dry seeding was done 5 days before onset of monsoon. Among the treatments, seed coating with $CaSO_4$, Rock phosphate and cow dung showed some potential.
- Increasing the degree of moisture stress reduced pod yield significantly. However, as degree of moisture stress increases, reduction in yield was less under K (56%) and Ca+K (45%) than under control (67%).
- K improved WUE under moderate stress (7.45 kg/ha/mm at 60% deficit of FC) while at more severe stress, Ca+K was found to be better with regard to WUE (5.52 kg/ha/mm) at 80% deficit of FC as compared to the other nutrients.
- Four years field studies conducted on use of saline water in groundnut and in groundnut based crop rotation indicate that *kharif* groundnut can be grown safely using saline water irrigation of 2 dS/m salinity whereas wheat and mustard can be grown in winter using saline water of 4 dS/m salinity. Oil content, nitrogen and protein content both in groundnut and in mustard were also affected by the high salinity level in saline black soils. It was also found that groundnut – groundnut rotation is not economical in comparison to groundnut – wheat and groundnut – mustard rotation in saline black soils using saline water.
- Working collection of groundnut germplasm was enriched by assembling 31 accessions. A total of 1362 accessions were supplied to different indenters.
- Three hundred and twenty-two accessions were deposited in National genebank for long-term storage.
- Released varieties were grown for two seasons and National Test Guidelines developed for 20 traits for DUS testing were confirmed.
- Amongst the 63 cultivars evaluated for O/L ratio value, kernel samples of 14 cultivars were found to have value greater than 2.0 while the samples of 18 cultivars were found to value less than 1.2.
- A simple procedure was developed for comparing groundnut genotypes for their blanching attribute.
- The activities of alkaline proteases produced by *Bacillus* sp. P5 and *Aspergillus oryzae* F6 were almost fully inhibited by Hg and Cu at 5 mM concentration.
- Out of 127 genotypes screened for dry seed resistance against *A. flavus*, 15 showed promise against *in vitro* seed colonization.
- Three advanced breeding lines *viz*., NRCG-CS nos - 333, 350, 354, and two released varieties, B 95 and BAU 13 showed promise against aflatoxin contamination during *kharif* 2005 showing tolerance to *A. flavus* infection and subsequent aflatoxin contamination.
- The two isolates of *Trichoderma* spp. *viz*., T 71 and T 29 showed high antagonistic potential against *A. flavus* under *in vitro* conditions.
- A total of 42 new isolates of *Trichoderma* spp. was isolated, purified and is being maintained as single spore culture from the soil samples collected from various districts of Gujarat during 2005-06.
- A repository of isolates of *Aspergillus* spp. was developed at NRCG with an accession of about 400 isolates belonging to four species, namely *A. flavus, A. ochraceus, A. terreus* and *A. nidulans*.
- The study of distribution pattern of the mycotoxigenic fungi revealed that *A. flavus* was dominant in Junagadh (39.29%) and Amreli (37.78%) districts where as *A. terreus* was dominant in Bhuj, Bhavnagar

and Anand during summer 2005. During *kharif* 2005, in most of the districts *A. flavus* dominated over other species resulting in more aflatoxin contamination of groundnuts during *kharif* than in summer.

- The soil population of *A. flavus* in samples taken one month after sowing and just before harvest varied between 0.33 – 68.7 x 10^3 spores/g soil and 2.50- 47.8 x 10^3 spores/g soil, respectively. The population increased towards the maturity of the crop recording a maximum of about 70 x 10^3 spores/g soil in some districts.
- The district which recorded low soil population (below 10 x 10^3 spores/g soil) is Junagadh, Bhavnagar and Bhuj. Natural infection of *A. flavus* in *kharif* 2005 samples from farmers field and of on-station trials varied between 0.0 - 4.5%. About 90% of the samples showed zero infection level.
- Non-toxigenic strains of *A. flavus* identified are being tested for antagonistic potential against toxigenic *A. flavus* so as to reduce pre-harvest aflatoxin contamination.
- Standardization of protocol for isolation of genomic DNA of *Aspergillus flavus* was done and the DNA was tested for their suitability for PCR by RAPD with random primers and was found to be amplifying.
- More than 90% prevention of pre-harvest aflatoxin contamination was recorded in improved management practices over farmers' practice.

Research Accomplishments

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

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Hybridization

During *kharif* 2005, 16 crosses were attempted for imparting resistance to different biotic, and six for abiotic stresses. Out of the total 7214 hand pollinations made, about 38% resulted in the recovery of probable hybrid pods at the time of harvest.

Selections and generation advancements

A total of 686 single plant selections were made in different filial generations of 74 crosses attempted in the previous years for incorporating resistance to different biotic stresses. In case of breeding programmes aimed at incorporation of resistance to different abiotic stresses, about 180 single plant/bulk selections were made in 97 crosses. These selections effected were based on plant characters particularly the yield and plant type at the time of harvesting.

Multiplication and maintenance of advancebreeding lines

During *kharif* 2005, seed enhancement of six advance cultures each of Spanish and Virginia type groundnut developed for different biotic stresses was carried out, whereas 35 Spanish and 18 Virginia type advance cultures were maintained for future use. A total of 22 new advancebreeding lines (4 Spanish and 18 Virginia) were developed during the season. In case of breeding programmes undertaken for the incorporation of resistance to abiotic stresses, seed enhancement of 22 Spanish and 21 Virginia cultures was taken up and 84 Spanish and 60 Virginia cultures were maintained. Besides, 48 WUE cultures and 51 mutants of groundnut variety Girnar 1 were maintained. Eight advance breeding lines were multiplied for entering in AICRP-G trials. Of the 35 new advance cultures developed, 8 were Spanish and 27 were Virginia types.

Screening of advancebreeding lines at hotspot centres

A total of 10 promising advancebreeding lines were evaluated at hotspot locations for PBND (at Junagdh and Raichur) and thrips (at Jalgaon) during rabi/summer seasons of 2003-04 and 2004-05 continuously to assess the disease and insect pests' reaction of these lines. Though the genotypes did not exhibit resistance for insect pests, two genotypes, PBS 24030 and 29017, had some promise against PBND and thrips (Table 1).

Table 1. Screening for thrips and PBND during rabi/summer 2003-04 and 2004-05

Genotype	Thrips (%)	PBND (%)	
	Jalgaon 2004-05	Junagadh 2003-04	Raichur 2004-05
PBS 24030	17.0	0.53	6.3
PBS 29017	18.3	1.80	6.9
Susceptible Check	30.6 (TAG 24)	8.3 (GG 2)	19.0 (JL 24)

IX International Short Duration Groundnut Trial – 2001

IX International Short Duration Groundnut Trial – 2001 comprising 14 test entries was conducted along with two check varieties, Chico and GG 2, in a triple lattice square design in *kharif* 2004 and 2005 seasons. The comparison of genotypic means showed that the check variety GG 2 was superior for pod yield and kernel yield per hectare and hundred kernel weight (HKW), while Chico was a superior check for days to maturity and SMK in both the years. GG 2 was a better check for final plant stand and shelling percentage in *kharif* 2004; however, in *kharif* 2005, Chico was a better check for these traits.

Final plant stand was less in all the genotypes in both the years as compared to the recommended one. In *kharif* 2004 two entries (ICGV 97245 and ICGV 96390) had even less than 1, 00,000 plants per hectare. In both the years no test entry out-performed the best check GG 2 for pod as well as kernel yield. In *kharif* 2004, ICGV 96390 gave highest pod and kernel yields, whereas in *kharif* 2005, ICGV 96399 gave the highest pod and kernel yields. ICGV 96399 was also the third higher yielder in *kharif* 2004. When pooled over years, this entry was highest performer for these traits.

Chico took least time (89 days) to mature in both the years, and when statistically compared no test entry was found to be superior over this check variety. Over two years Chico performed better for shelling percent and no test entry was found to out-perform this check for shelling percent. Only one test entry, ICGV 97245, registered significantly higher HKW over the best check GG 2 when the data was pooled over two years. In *kharif* 2005 very high CV (30.9%) was observed for SMK, which resulted in pooling of data over two years to arrive at a conclusion for this trait. Oil content, which was measured only in *kharif* 2004, ranged between 51 and 53%.

X International Short Duration Groundnut Trial – 2005

This trial comprising of 14 test entries was conducted at NRCG along with two check varieties, Chico and GG 7, in a triple lattice square design in *kharif* 2005. Chico was found to be the best check for all the traits studied. No test entry out-performed this best check for any of the traits studied except ICGV 00321 which gave significantly superior HKW (37 g) over the best check. This trial will be repeated for one more year at Junagadh location.

Evaluation of groundnut genotypes for early maturity in summer season

A set of 20 genotypes was evaluated in summer 2005. ANOVA revealed significant differences both due to genotypes and stages of harvest for pod yield, kernel yield, 100-kernel weight and shelling percent. Reductions in pod (57%) and kernel (66%) yields observed across the genotypes at 85 DAS compared to 105 DAS were very high as compared to the corresponding figures 32 and 33%, respectively at 95 DAS. The performance of variety JL 24 was very poor, as this variety is known to be highly sensitive to higher temperature. Yield reductions were also very high (52 for pod and 59% for kernel yields) at 95 DAS. Genotypes PBS 29063, PBS 12074, PBS 21031, PBS 14050 and PBS 11026 gave very good yields at 95 DAS but the yield reduction observed was also very high. In genotype PBS 18062, though yield levels observed were very low (557 kg pods and 281 kg kernels per ha) like JL 24 but resulted in least yield reductions (4 and 6% pod and kernels) at 95 DAS. This genotype needs further testing for identifying it as a donor for early maturity.

Gene action for nutrient accumulation in leaf tissues in groundnut

Gene action for content of each of the six nutrients *viz*., Calcium, Manganese, Nitrogen, Potassium, Iron and Magnesium was worked out in a 6 x 6 diallel using Griffing's (1956) Model I, Method I. Analysis of variance revealed significant genotypic differences for all the traits studied. Bar

ring iron, variances due to GCA were significant for all the traits. Variances due to SCA were significant for Calcium, Manganese and Iron. Reciprocal differences were observed for Manganese and Potassium, signifying the crucial role of maternal parent in the inheritance of accumulation of these two nutrients. GCA to SCA ratio was more than unity for Calcium, Nitrogen, Potassium and Magnesium, indicating that additive gene action was predominant in the inheritance of these traits, whereas this ratio was less than unity for Iron, thereby, suggesting the role of non-additive genes in the genetic control for this nutrient. In case of content of Manganese, both additive and non-additive genes were equally important.

Good general combiners were identified for the accumulation of Calcium (CSMG 84-1), Manganese (Chico and ICGV 86031), Nitrogen (TAG 24), Potassium (ICG 4747) and Magnesium (CSMG 84-1 and TMV 2 NLM). Similarly, good specific cross combinations were identified for each nutrient studied for its accumulation in the leaf tissue (Table 2).

TABLE 2. Good General and Specific Combiners Identified for Content of Different Nutrients in the Leaf Tissue

Nutrient	Good General combiners	Good specific combiners
Calcium	CSMG 84-1	CSMG 84-1 x TAG 24, TAG 24 x CSMG 84-1
Manganese	Chico, ICGV 86031	CSMG 84-1 x TAG 24, ICG 4747 x TMV 2 NLM, CSMG 84-1 x Chico, ICGV 86031 x ICG 4747, TMV 2 NLM x Chico
Nitrogen	TAG 24	CSMG 84-1 x TMV 2 NLM, TAG 24 x TMV 2 NLM, ICG 4747 x Chico
Potassium	ICG 4747	CSMG 84-1 x TMV 2 NLM, ICGV 86031 x TAG 24, ICG 4747 x CSMG 84-1, TMV 2 NLM x ICG 4747
Magnesium	CSMG 84-1, TMV	ICGV 86031 x Chico, ICGV 86031 x ICG 4747, TAG 24 x Chico 2 NLM

Station trials for yield evaluation

Advancebreeding lines developed in the plant breeding section for different biotic and abiotic stresses were evaluated in the replicated trials in a RBD with three replications in two row plot size each of 3 m length in preliminary yield evaluation trial for one year and in four row plot size in advance yield evaluation trial for two years. Three checks, GG 2 (Local check, LC), SB XI (Zonal check, ZC) and JL 24 (National check, NC) were used for comparison in Spanish group and four checks, namely GG 20, Kaushal, M 335 and Somnath were used in Virginia group. Observations were recorded in different trials on SLA and SPAD chlorophyll content at 55 DAS. Fodder and biological yields were recorded in five randomly selected plants in each genotype from each replication at the time of harvesting and expressed in g/plant. Days to maturity were assessed at the time of harvesting. Post harvest observations were recorded on HI (%), SMK (%), HKW (g), pod yield (kg/ha), kernel yield (kg/ha) and shelling percent.

Preliminary yield evaluation trial of breeding lines of Spanish groundnut

Thirty advance breeding lines were evaluated along with three checks in *kharif* 2005. Mean performance of genotypes revealed that the variety SB XI was the best check for SMK and kernel yield, whereas GG 2 was the best check for HI, SLA and SPAD. JL 24 was the best check for fodder yield, biological yield, HKW and pod yield. For shelling percent both GG 2 and SB XI were equally good checks.

When compared to the best check, the test entries giving significantly higher superiority were: PBS 11057, 16031, 16032, 16035, 17015 and 18055 for fodder yield; PBS 11075, 16032, 16035 and 17015 for biological yield; PBS 16038 for HI; PBS 16040 for HKW; PBS 16031, 16038 and 16040 for pod yield. In case of SPAD, ten genotypes were found to be superior. For kernel yield, shelling percent and SLA no genotype could outperform the respective best check statistically.

Advance yield evaluation trial of breeding lines of Spanish groundnut - I

Twenty-seven advancebreeding lines of Spanish groundnut were tested along with three checks in *kharif* 2005. No test entry surpassed the best check for SMK and fodder yield, however, PBS 30067 was found to be statistically superior over the best check SB XI for biological yield. Four test entries (PBS 12018, 30046, 30051 and 30079) were statistically significant over the best check GG 2 for HI. No test entry was significantly early in maturity when compared to the best check for this attribute. Test entries PBS 12018, 16020, 19012, 30051 and 30112 were significantly superior over the best check JL 24 for HKW. Only two test entries gave significantly higher pod yield over the best check SB XI. These entries were PBS 30051 and PBS 30086. For remaining traits (kernel yield, shelling percent, SLA and SPAD) no test entry was found to perform superior over the respective best checks for these traits.

Advance yield evaluation trial of breeding lines of Spanish groundnut – II

Eighteen advancebreeding lines of Spanish groundnut were tested along with three checks in *kharif* 2004 and 2005 seasons. Statistical analysis was performed by subjecting replication-wise mean values to RBD analysis over two years. Mean performances over two years were used for comparisons. No test entry was found to perform significantly superior over the respective best checks for the traits SMK, fodder yield, biological yield, HI, days to maturity, HKW, kernel yield, SP, days to flower initiation and 50% flowering. Two genotypes PBS 30051 and PBS 30086 gave significantly superior pod yields over the best check SB XI (Table 3). Significantly lower SLA was observed in the test entries PBS 13021, PBS 19012 and PBS 30159 over the best check GG 2 for this trait. PBS 13021 also resulted in significantly higher SPAD values.

Table 3. Performance of selected advance breeding lines and checks

Genotype	PY (kg/ha)	KY (kg/ha)
PBS 30051	2950*	1780
PBS 30086	2903*	1668
GG 2	1412	931
JL 24	1547	955
SB XI	1769	1214
General Mean	1799	1075
CV (%)	20.4	22.1
SEm	150.0	96.2
CD (5%)	422.7	271.1

Preliminary yield evaluation trial of breeding lines of Virginia groundnut

Nineteen advancebreeding lines of Virginia groundnut were evaluated for preliminary yield performance along with four check varieties. No test entry established superiority over the check variety

for SMK. However, PBS 26019 and PBS 26020 gave the highest SMK among the entries tested. Though no test entry was found superior over the best check for fodder and biological yield, but PBS 26010 gave numerically highest values for these traits across the checks and test entries. Highest HI was observed in PBS 26020, which was significantly higher over the best check Kaushal. PBS 26021 gave numerically highest value for HKW though it was lower compared to the best check GG 20. Only one test entry PBS 26010 gave significantly higher pod yield over the best check Somnath. In case of kernel yield, SP and SPAD no test entry was significantly superior over the respective best check for these traits. PBS 26006 gave significantly less SLA compared to the best check Somnath.

Advance yield evaluation trial of breeding lines of Virginia groundnut – I

Eighteen advancebreeding lines of Virginia groundnut were evaluated along with four check varieties in *kharif* 2005. Two test entries, PBS 22042 and PBS 30162, were found to be significantly superior over the best check GG 20 for SMK. No test entry performed significantly superior over the respective best check for the traits fodder and biological yield, HI, days to maturity, HKW, pod and kernel yields, SLA and SPAD. Highest numerical values among the test entries were observed for remaining traits in PBS 24085 and ICGV 93157 (for fodder yield), PBS 24085 (for biological yield), PBS 25003 (for HI, days to maturity, pod and kernel yields), PBS 30162 (for HKW) and PBS 22042 (for SPAD).

Advance yield evaluation trial of breeding lines of Virginia groundnut – II

Twelve advancebreeding lines of Virginia groundnut were tested along with four checks in *kharif* 2004 and 2005 seasons. Statistical analysis was performed by subjecting replication-wise mean values to RBD analysis over two years. Mean performances over two years were used for comparisons. Three entries, namely ICGV 00394, PBS 21052 and PBS 25003 gave significantly higher HI over the best check variety GG 20 for this trait. PBS 24040 gave significantly higher SPAD values. The test entry PBS 30162 was found to be early both for days to flower initiation and 50% flowering. In addition, ICGV 00394 was early in days to 50% flowering. For rest of the studied traits, no test entry surpassed the respective best check for these traits. The test entries which were numerically better performers compared to the respective best checks were: PBS 13020 and PBS 30162 for SMK; ICGV 93157 for fodder and biological yields; PBS 24085 and PBS 30162 for pod yield; PBS 13020 and PBS 25003 for SP.

Evaluation under simulated water-deficit stress conditions at early, mid and late season in summer 2005

Forty-eight genotypes along with two released varieties, ICGS 44 and ICGS 76, were evaluated in a split-plot design with irrigation patterns as main plot treatment and genotypes as sub-plot treatments. Main plot treatments were: i) regularly irrigated, ii) irrigation withheld from 10 to 35 DAS (Early-season drought, ESD), iii) irrigation withheld from 35 to 75 DAS (Mid-season drought, MSD) and iv) irrigation withheld from 75 to 105 DAS (Late-season drought, LSD), while 50 genotypes were taken as sub-plot treatment. Significant differences were observed due to main plot treatment, genotypes and interactions between them for pod and kernel yields. Pod yield ranged from 721 to 2152, 536 to 1586, 222 to 1158 and 65 to 849 kg/ha with average of 1229, 996, 688 and 409 kg/ha across the genotypes under regularly irrigated, ESD, MSD and LSD conditions, respectively. JUN 7 registered highest pod yield under ESD (1586 kg), MSD (1158 kg) and LSD (849 kg/ha), whereas it ranked second (2039 kg) the first being JUN 9 (2152 kg) under irrigated conditions. Highly significant positive correlations were observed among the ranks for pod yields obtained under irrigated, ESD, MSD and LSD conditions. This indicates that a genotype performing better under irrigated condition is likely to perform better under water deficit stress conditions also. Rank correlations between yields obtained under MSD and LSD and corresponding

extent reduction under these drought patterns revealed highly significant positive correlations, indicating more the yields obtained under these environments lesser is the extent of reduction in yield. But yields obtained under irrigated conditions were negatively correlated with the percent reduction under ESD and MSD, however it was independent under LSD. Rank correlations between percent reduction and Drought Sensitivity Index (DSI) were highly significant under all the drought patterns. The findings of the experiment suggest that while screening for drought tolerance, parameters like percent reduction and DSI should be considered along with the *per se* yield performance of genotypes under different drought patterns.

The same set of 48 advance cultures was also evaluated under regularly irrigated and rainfed situations in *kharif* 2005. The yields obtained in all the genotypes were very low. No differences were observed between yields obtained in rainfed situations compared to the irrigated situations.

Comparative studies on the seasonal effects on selections

Under this study ten top performing advancebreeding lines selected in F_7 generation each of a cross Chico x R 33-1 and its reciprocal in *kharif* 2004, and equal number in summer 2005 were raised in replicated trial in *kharif* 2005 primarily for seed enhancement. This trial will be repeated in two *kharif* and two summer seasons to find out whether selection in segregating generations for development of groundnut varieties for *kharif* and summer seasons is more rewarding when selection is done in the respective seasons or otherwise.

Advance cultures under AICRP-G trials

Two advance cultures were tested in AICRP-G trials. JUN 21 was in Initial Drought Varietal Trial in *kharif* seasons of 2004 and 2005. This culture did not qualify for Advance Varietal Trials. Another advance culture PBS 24030 (Virginia bunch) will be repeated in AVT in Zone I in ensuing *kharif* season (*kharif* 2006).

Three advance cultures, PBS 24004 (Virginia bunch), PBS 12160 (Spanish bunch) and JUN 27 (Virginia bunch) accepted as fresh proposals are being tested in Initial Varietal Trial of Virginia bunch, Spanish bunch and drought tolerance, respectively in AICRP-G.

Supply of segregating material to AICRP-G centres

Information on the availability of segregating material in different generations was circulated among all the AICRP-G centres. Segregating materials ($F_3 - F_6$ generation) of 49 crosses attempted for different breeding objectives were supplied to 13 (Udaipur, Latur, Rahuri, Vriddhachalam, Jalgaon, Jagtial, Junagadh, Chintamani, Aliyarnagar, Almora, Durgapura, Tirupati and Jalgaon) AICRP-G centres. Besides, segregating material in F_4 generation of 12 crosses attempted for imparting drought tolerance was sent to Durgapura and Jalgaon locations for situation specific selections at these locations for mid-season and end-of season drought situations, respectively.

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

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

Subproject - 1: Integrated insects and non-insect pest management in Complex, Diverse and Risk-Prone (CDR) groundnut based production system (V. Nandagopal and T.V. Prasad)

Yield loss in groundnut due to artificial defoliation

A field experiment was conducted during post-rainy season of 2005 to understand the yield loss mechanism when a definite portion of leaf area is removed, which in turn simulated the damage by insects. Cultivar GG 2 was sown in 3 rows of 2m length at 45 cm spacing between rows and 10 cm between plants in a row. There was a gap of 2m all around the plot. The treatments (defoliations) include five levels of defoliations *viz*., 0, 2, 5, and 10 at different phenophases of crop such as vegetative, pegging, maturity and their combinations. The defoliation was carried out in such way that 60% of the upper leaves and 40% of the lower leaves were removed representing a particular percentage defoliation. Each treatment was replicated thrice. Oil content was estimated in collaboration with Biochemistry section.

Table 1. Effect of different per cent artificial defoliation on yield attributes of groundnut at various growth stages and their combinations

Treatment	Stage	% defoliation	Yield (kg/ha)	% increase / decrease in yield	Shelling (%)	SMK (%)	Oil (%)
T1	V	2	1740.88	5.33	65.93	87.14	51.17
T2	V	5	1723.59	4.33	67.33	86.68	50.17
T3	V	10	1817.43	10.01	65.64	82.44	51.50
T4	P	2	1326.03	-19.73	64.50	82.57	52.00
T5	P	5	1177.87	-28.70	65.98	78.74	52.00
T6	P	10	1360.60	-17.64	64.90	87.65	51.00
T7	M	2	1584.08	-4.11	67.58	80.33	52.00
T8	M	5	1329.74	-19.50	65.06	81.73	51.83
T9	M	10	1326.03	-19.73	66.10	85.74	51.67
T10	V+P	2	1474.19	-10.76	66.27	80.76	51.50
T11	V+P	5	1471.72	-10.91	64.88	78.57	51.00
T12	V+P	10	1205.03	-27.06	66.27	81.70	51.83
T13	V+M	2	1496.42	-9.48	64.97	81.08	51.00
T14	V+M	5	1537.16	-6.95	65.17	86.70	52.67

T15	V+M	10	1518.64	-8.07	66.36	87.40	52.50
T16	P+M	2	1229.73	-25.56	66.47	85.27	52.17
T17	P+M	5	1242.07	-24.81	65.80	81.89	52.00
T18	P+M	10	1048.23	-36.55	66.19	81.59	52.67
T19	Control	0	1651.98	—	65.12	78.63	51.67
	S.Em.±		142.1696		0.9101	4.3078	0.584
	C.D. (at 5 %)		408.1079		2.6125	12.3658	1.6764
	C.V. (%)		17.16		2.4	8.99	1.96

Results (Table 1) indicated that, there was significant increase in yield loss with increase in percentage defoliations in all the stages and in their combinations except during vegetative stage. The pod yield ranged from 1724 kg/ha to 1817 kg/ha at 2 to 10% artificial defoliation during vegetative stage compared to control which recorded 1652 kg/ha. The percent loss in pod yield ranged from 17.6 to 28.7 during pegging stage and from 4.1 to 19.7 during maturity. During vegetative + pegging the yield loss ranged form 27 to 10.9, during vegetative + maturity it was from 6.9 to 9.4 and during pegging + maturity the loss ranged from 24.8 to 35.6% at 2 and 10% defoliation respectively compared to control. The results also indicated that defoliation at any stage of the groundnut crop results in loss in yield except at vegetative stage. Though there was significant variation in the per cent oil content, shelling percentage and per cent sound mature kernel (SMK) with increase in percentage defoliations in all the stages and in their combinations but no linear relationship was observed with respect to percentage defoliation.

Fig. 1. Per cent increase/decrease in pod yield over control at different phenophases due to artificial defoliation

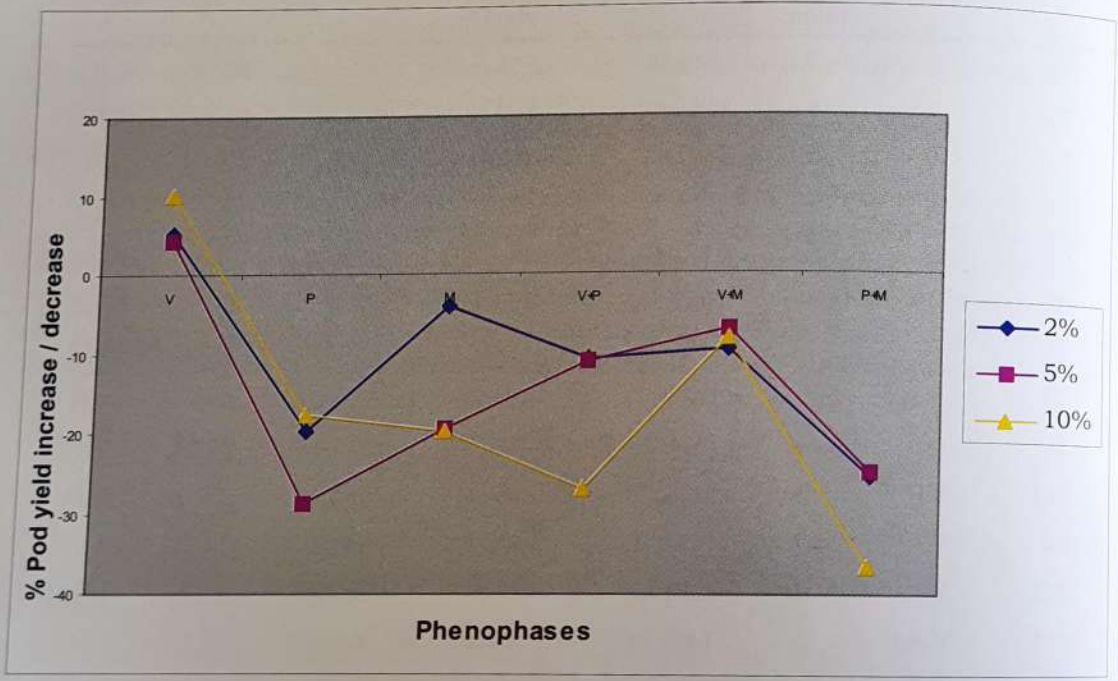
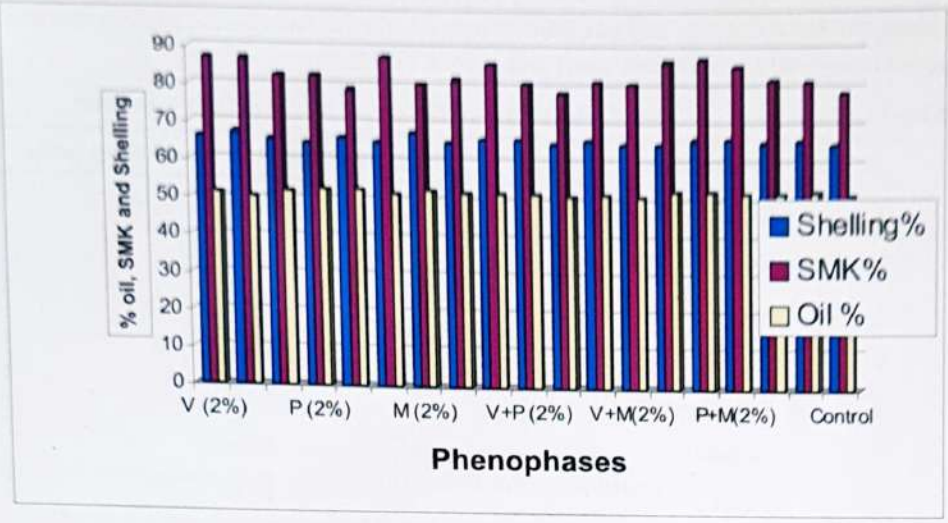


Fig 2. Effect of artificial defoliation on oil content (%), SMK (%) and Shelling (%) during various growth stages and their combinations



Evaluation of botanical powders for the management of storage insect pest, *Caryedon serratus*

Results showed that adult emergence was minimum in 0.25% neem seed powder (2 mean number of adults emerged) followed by 0.25% black pepper powder (4.33 mean number of adults emerged) compared to control and other botanicals tested against *Caryedon serratus* (Table 2).

Table 2. Effect of botanical powders on adult emergence of *Caryedon serratus*

Sl.No.	Treatments	Mean no. of adults emerged
1	Neem seed powder 0.25%	2.00
2	Neem seed powder 0.5 %	11.67
3	Neem seed powder 1%	28.67
4	Castor seed powder 0.25%	27.67
5	Castor seed powder 0.5%	18.33
6	Castor seed powder 1%	18.00
7	Turmeric powder 0.25%	18.00
8	Turmeric powder 0.5%	18.33
9	Turmeric powder 1%	26.33
10	Black pepper powder 0.25 %	4.33
11	Black pepper powder 0.5 %	8.67
12	Black pepper powder 1%	6.33
13	Control	6.67
	S.E.m	9.38
	CD	NS

Evaluation of botanical oils and Endosulfan for the management of storage insect pest, *Caryedon serratus*

Among the botanical oils and Endosulfan tested for adult emergence, Endosulfan at 0.07% was found superior compared to other treatments and control (Table 3).

Table 3. Effect of botanical oils and Endosulfan on the mean no. of adults emerged

Sl. No.	Treatments	Mean no. of adults emerged/kg pods
1	Endosulphane 0.07%	0.7
2	Neem oil 2%	13.0
3	Neem oil 5%	47.7
4	Karanj oil 2%	82.3
5	Karanj oil 5%	51.0
6	Control	32.0
	S.E.m	1.36
	CD	4.25

Evaluation of receptacles for the management of storage insect pest, *Caryedon serratus*

Among different receptacles evaluated for the management of *Caryedon serratus*, polythene bags were found suitable as oviposition and mean number of adults emerged was low compared to other receptacles tested (0.7 mean no. of eggs/100g pods and 18 mean no. of adults emerged/kg pod) (Table 4).

Table 4. Effect of different receptacles on oviposition preference and mean no. of adult emergence of *Caryedon serrratus*

Sl. No.	Treatment	Eggs/100g pods	Adults emerged/kg pod
1	Polythene line gunny bags	4.3	50
2	Cotton bags	9.0	58
3	Polythene bags	**0.7**	**18**
4	Ordinary gunny bags (control)	5.7	91

Screening of genotypes for termite resistance under field conditions

Out of nine genotypes screened against termites under field condition during Rabi/summer 2005, TMV 2 recorded lowest incidence (1.78%) as against 17.18% in CO 1 (Table 5).

Table 5. Per cent incidence of termites on different genotypes

Sl. No.	Genotypes	% incidence
1	NRCG-6686	12.2
2	J-11	7.2
3	ICG-11721	3.8
4	JL-24	4.76
5	CO-1	**17.18**
6	TMV-2	**1.78**
7	TAG-24	5.36
8	GG-7	7.96
9	GG-2	5.17

Integrated Pest Management in groundnut based intercropping system

An IPM experiment in groundnut based intercropping system was taken up during *kharif* 2005 with groundnut variety GG 20 and intercrops *viz*., **Bajra** (Mh 179), **Sorghum** (local), **Maize** (local), **Castor** (GAUCH-1), **Pigeonpea** (BDN-2), **Cowpea** (local), **Green gram** (local) , **Black gram** (local) and **Sesamum** (local) were used in the ratio of 3:1 with three replications. Plot size was 6 x 5 m^2 size.

The intercrop maize was found to be suitable in reducing the jassid population compared to other intercrops (Table 6). The intercrops like sesamum and green gram also shown promise in reducing the population of jassids. The black gram as an intercrop increased the thrips population while sesamum reduced the thrips population at 70 days after sowing (Table 7).

Table 6. Effect of intercrops on the incidence of Jassids

Treatment	30 DAS	55 DAS	70 DAS
Groundnut + Maize	0.67	4.67	4.33
Groundnut + Sesamum	0.00	6.00	2.33
Groundnut + Green gram	0.00	6.00	5.67
Groundnut alone	0.00	**14.67**	8.67
S.Em.±	0.11	2.77	2.33
C.D. (at 5 %)	NS	NS	NS

Table 7. Effect of intercrops on the incidence of thrips per 5 sweeps/5m length

Treatment	30 DAS	55 DAS	70 DAS
Groundnut + Sesamum	0.67	1.67	1.67
Groundnut + Black gram	0.00	0.67	10.67
Groundnut alone	0.00	0.00	2.33
S.Em.±	0.31	0.69	1.76
C.D. (5 %)	NS	NS	NS

The defoliation in general was very low and there was no significant difference in the damage levels in different intercropping system on groundnut as well as on intercrops.

Based on the cost of cultivation and the yields of groundnut and the intercrop, the CBR was worked out. Intercropping with pigeonpea gave highest CBR (1: 4.3) followed by castor (1: 4.25) and green gram (1:4.05). The yield economics worked out has shown that intercrop with pigeonpea gave the highest income of Rs.45, 132 followed by castor (Rs.44, 598) compared to other intercrops (Table 8).

Table 8. Effect of groundnut based intercropping system on the yield and yield economics

Treatment	Ground nut Pod (kg/ha)	Intercrop (kg/ha)	Cost of cultivation (Rs./ha)	Gross Monitory return(Rs./ha)	Net Return/ CBR
Groundnut + Bajra	1492.33	*	8610	29847	1 : 3.47
Groundnut + Sorghum	1458.67	*	8610	29173	1 : 3.39
Groundnut + Maize	1678.00	82.33	8610	34054	1 : 3.96
Groundnut + Sesamum	1444.67	212.44	9400	34201	1 : 3.64
Groundnut + Castor	1506.67	964.33	10500	44598	**1 : 4.25**
Groundnut + Pigeonpea	967.33	1718.66	10500	45132	**1 : 4.30**
Groundnut + Cowpea	1385.00	294.55	9400	31526	1 : 3.35
Groundnut + Green gram	1563.67	296.11	9400	38081	**1 : 4.05**
Groundnut + Black gram	1379.67	505.99	9400	36195	1 : 3.85
Groundnut alone	2625.67	-	8200	52513	1 : 6.40
S.Em.±	117.18				
C.D. (at 5 %)	348.17				
C.V. (%)	13.09				

Basic cost of cultivation of groundnut Rs. 8200/ha * No yield could be recorded due to damage by birds

Table 9. Effect of groundnut based intercropping system on yield attributing characters

S.No	Treatment	Shelling (%)	SMK (%)	Oil (%)
1	Groundnut + Bajra	68.33	90.74	51.33
2	Groundnut + Sorghum	70.33	90.39	51.33
3	Groundnut + Maize	67.66	81.77	51.16
4	Groundnut + Sesamum	72.00	93.00	51.33
5	Groundnut + Castor	67.66	86.42	51.50
6	Groundnut + Pigeonpea	69.00	85.56	50.50
7	Groundnut + Cowpea	68.33	93.70	51.33
8	Groundnut + Green gram	66.66	91.56	51.16
9	Groundnut + Black gram	69.00	88.84	51.83
10	Groundnut alone	71.00	95.75	50.50
	S.Em. ±	1.23	3.08	0.77
	C.D. (0.05 %)	NS	NS	NS
	C.V. (%)	3.09	5.93	2.60

There was no significant difference between shelling percentage, sound mature kernel (%) and oil percentage in groundnut intercropping system (Table 9).

Screening of segregating and stabilized lines of groundnut against major insect pests

Screening of genotypes against sucking pests under field conditions

Out of 31 genotypes screened for resistance against jassids under field conditions during the rainy season of 2005, NRCG-CS nos. 101, 102 and 109 were found resistant and 247, 251 and 254 were found susceptible (recording >10 jassids/5 sweeps) compared to other genotypes tested. Against thrips NRCG-CS nos' 101, 102 and 258 were found resistant and 108, 243 and 247 were found to be susceptible (recording >15 mean no. of eggs/10 leaves) compared to other genotypes tested. Three genotypes *viz;* NRCG-CS nos'101, 102 and 147 showed resistance against both jassids and thrips indicating their multiple resistance.

Evaluation of various plant products against *Caryedon serratus*

Results showed that oviposition was minimum in 1% Parthenium powder (0.67 mean number of eggs/100 g pod) followed by 0.5% Annona seed powder (3.33 mean number of eggs/100 g pod) compared to control and other botanicals tested against *Caryedon serratus* (Table 10).

Table 10. Effect of botanicals on oviposition of *Caryedon serratus*

S. No.	Treatment	Mean of eggs/100gm pod
1	Methi Powder 0.5%	25.00
2	Methi Powder 1.0%	9.00
3	Annona seed powder 0.5%	**3.33**
4	Annona seed powder 1%	32.00
5	Lantana Leaf powder 0.5%	27.33
6	Lantana Leaf powder 1.0%	31.33
7	Eucalyptus leaf powder 0.5%	3.67
8	Eucalyptus leaf powder 1%	9.00
9	Parthenium powder 0.5%	14.67
10	Parthenium powder 1.0%	**0.67**
11	Neem seed powder 0.5 %	11.67
12	Neem seed powder 1.0%	12.33
13	Control	27.67
	SEM	7.56
	CD	22.08

Screening of genotypes against *C. serratus* under laboratory conditions

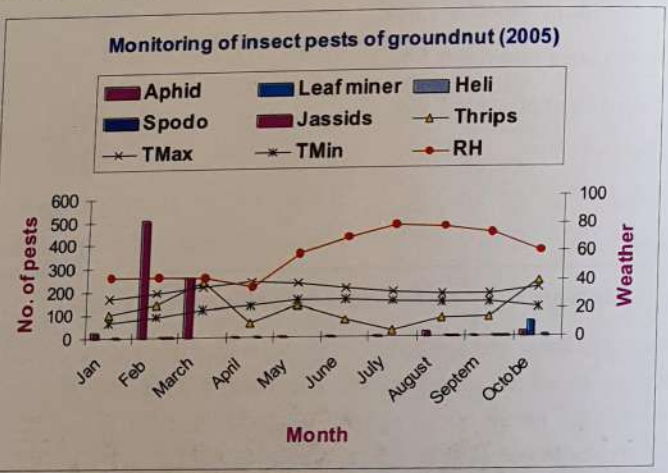
Out of 11 genotypes screened against *C. serratus* under laboratory conditions mean no. of eggs/ 100 g pods and mean no. of adults emerged was minimum (73.33 and 53.67) in NRCG-CS 189 and maximum in GG 20 (158.67 mean no of eggs/100 g pods and 93.33 mean no. of adults emerged) compared to other genotypes tested (Table 11).

Table 11. Oviposition preference and adult development of *C. serratus* on different genoty

Genotypes	Mean No of eggs/100 g pods	Mean no. of adults emerged
NRCG-CS 58	103.67	67.67
NRCG-CS 54	79.00	54.67
NRCG-CS 195	100.33	77.00
NRCG-CS 189	73.33	53.67
NRCG-CS 52	104.33	58.67
NRCG-CS 187	109.67	74.00
NRCG-CS 192	134.33	67.00
NRCG-CS 57	131.67	76.67
NRCG-CS 60	100.33	53.00
NRCG-CS 56	156.33	89.67
GG20	**158.67**	**93.33**
SEm	39.95	23.95
CD	NS	NS

Monitoring of the major insect pests of groundnut

In the monitoring programme of the major insect pests of groundnut such as *Helicoverpa armigera*, *Spodoptera litura* and *Aproaerema modicella* were monitored using pheromone traps. Aphids like *A craccivora,* and *Hysteroneura setariae* were monitored using cylindrical sticky trap. The jassids and thrips were monitored using the sweep net in monthly sown crops. The aphid population was highest during February, March and tends to decline from there onwards. Thrips population started building up from February and decreased from March onwards and highest population of thrips was observed during October. Groundnut leaf miners continued to present in low numbers probably in the alternate host plants with sudden hike in October, *Helicoverpa* and *S. litura* moth catches were very low in number.



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

(M. P. Ghewande and Vinod Kumar)

Disease resistance

A total of 70 genotypes were evaluated against peanut bud necrosis disease (PBND) vis-à-vis yield of groundnut during summer 2005 under field conditions. The results indicated that the incidence of PBND ranged from 0 to 17.46%. Zero percent incidence of PBND was observed in eight genotypes, *viz.*, TIR 17 and NRCG-CS 24, NRCG-CS 164, NRCG-CS 86, NRCG-PBS 19012, NRCG-PBS 12160, NRCG-CS 186 and NRCG-CS 251 as against the highest in NRCG-PBS 11024 (17.46%) followed by GG 2 (11.56%). The genotype NRCG-PBS 11037 recorded the highest yield (305.0 g) followed by NRCG-PBS 30073 (227.5 g) and NRCG-PBS 11072 (223.5 g) per 3m row.

Thirty-seven genotypes were evaluated against stem rot (*S. rolfsii*) in concrete block in artificially inoculated condition during the summer season of 2005. Out of these five, genotypes *viz.*, Code 1-1, Code 1, NRCG-CS 115, NRCG-CS 168 and NRCG-CS 19 showed below 30% incidence as against 100% in NRCG-PBS 24002, NRCG-PBS 29080 and NRCG-PBS 30158 and 80.4% in GG 20. NRCG-CS 19 showed resistant reaction (13.2%) against *S. rolfsii.*

A total of 90 genotypes including susceptible (GG 2) and resistant check (J 11) were evaluated against collar rot pathogen (*Aspergillus niger*) under laboratory condition by adopting dry seed resistance technique during summer 2005, out of which 17 genotypes *viz.*, NRCG-CS 101, NRCG-CS 104, NRCG-CS 113, NRCG-CS 164, NRCG-CS 188, NRCG-CS 192, NRCG-CS 245, NRCG-CS 53, NRCG-CS 58, NRCG-CS 64, NRCG-CS 65, S 76, NRCG-CS 78, NRCG-CS 79, NRCG-CS 81, ICR 12 and JAL 05 showed resistant reaction against *A. niger* recording < 10% seed colonization as against 32.85% in GG2.

A total of 295 genotypes (second year screening of 192 genotypes and preliminary screening of 103 genotypes) along with susceptible checks (GG 20) were evaluated against early leaf spots (ELS), late leaf spots (LLS), rust and stem rot diseases under field conditions during the rainy season of 2005. In case of stem rot, each genotype was artificially inoculated with *Sclerotium rolfsii* pathogen at 30 days of emergence. Observations on foliar fungal diseases were recorded by adopting a 1-9 modified scale, while in the case of stem rot, the percentage of incidence was recorded before and after harvest. Observations on pod yield (g/3m row length) were also recorded.

Second year screening of the 192 genotypes (Table 1) revealed that three genotypes *viz.*, CS 222, PBS 22008 and PBS 25001 showed promise against ELS recording below 4.5 grade of disease intensity, four genotypes *viz.*, NRCG-CS 105, NRCG-CS 257, PBS 22008 and PBS 25001 showed promise against LLS recording = 4.5 grades of disease intensity as against 8.5 in susceptible check (GG 20). Seven genotypes *viz.*, NRCG-CS nos' 105, 144, 158, 223, 257 and PBS 22008 and PBS 25001 showed resistance against rust recording below 3.5 grade of disease intensity as against 7.83 in susceptible check. The incidence of stem rot ranged from 0.0 to 52.7%. A total of 31 genotypes recorded below 5.0 % incidence of stem rot as against 29.1% in susceptible check, GG 20. Sixteen genotypes *viz.*, NRCG-CS nos' 106, 137, 140, 141, 144, 19, 239, 250, 27, 47, 56, 63, 90, 91 and ICGV 94357 and PBS 25001 were free from stem rot infection. Thus, the genotype PBS 25001 showed multiple disease resistance during second year screening.

A total of 103 new genotypes were also screened for multiple disease resistance in the first year under field conditions. The results showed that the genotypes NRCG-CS 277, 303 and 311 possessed

resistance against ELS; genotypes NRCG-CS 154, 277, 303, 308 and 311 against LLS and genotypes NRCG-CS 277 and NRCG-CS 306 against rust (Table 2a and 2b). Thus, the genotype NRCG-CS 277 possessed multiple disease resistance against ELS, LLS and rust. The percent incidence of stem rot varied from 0 to 87.5. The genotypes which showed promising resistance against stem rot were NRCG-CS nos. 15, 272, 286, 300, 306, 307, 315, 319, 327, 334, 343, 347 and 350 recording below 10.0% disease incidence.

The comparative data of field screening from 2003 to 2005 is presented in Table 3. Based on two/three year results it is concluded that the genotypes NRCG-CS nos. 156,159, 160, 196, 222, 257, 85 144 and PBS 25001 possessed multiple disease resistance.

A total of 20 genotypes including susceptible and resistance checks were screened against stem rot pathogen (*S. rolfsii*) under artificially inoculated sick soil condition in concrete blocks during rainy season of 2005 out of which four genotypes, *viz.*, PBS 24008, PBS 25003, PBS-29080 and NRCG-CS 14 showed resistant reaction against *S. rolfsii.* Also, a total thirty-two genotypes along with susceptible (GG 2) and resistance line (J 11) were screened for resistance against *A. niger* under laboratory condition through dry seed resistance technique. Out of these lines six genotypes viz., NRCG-CS nos. 334, 352, 316, 350, 272 and 331 showed resistance against *A. niger* and recorded < 10 % seed colonization.

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

Antagonistic activity of 20 isolates of *Trichoderma* belonging to eight species were studied under *in-vitro* conditions (bangle method) against collar rot (*Aspergillus niger*) and of 29 isolates against stem rot (*Sclerotium rolfsii*) pathogen of groundnut under laboratory condition. The range of inhibition of growth of *A. niger* varied between 13 to 34% (Table 4a) and that of *Sclerotium rolfsii* was between 43% to 85% (Table 4b). The growth habit, sporulation and overgrowing ability of the antagonists over the pathogen was considered to compare the antagonistic ability. The isolates T 04, T 72, T 93, T 170, T 219 shown promising antagonistic activity against *A. niger* (Plate1) and the isolates T 22, T 28, T 93, T 170, T 219, T 267 and T 362 against *S. rolfsii* (Plate2). The two isolates *viz.*, T 170 and T 219 were found to be highly antagonistic for both the pathogens.

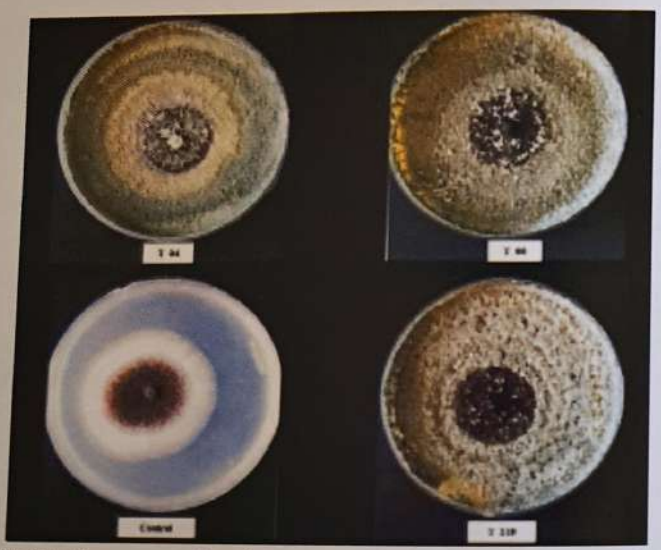


Plate 1. Isolates of *Trichoderma* sp. showing promising antagonistic activity against *Aspergillus niger* under *invitro* conditions

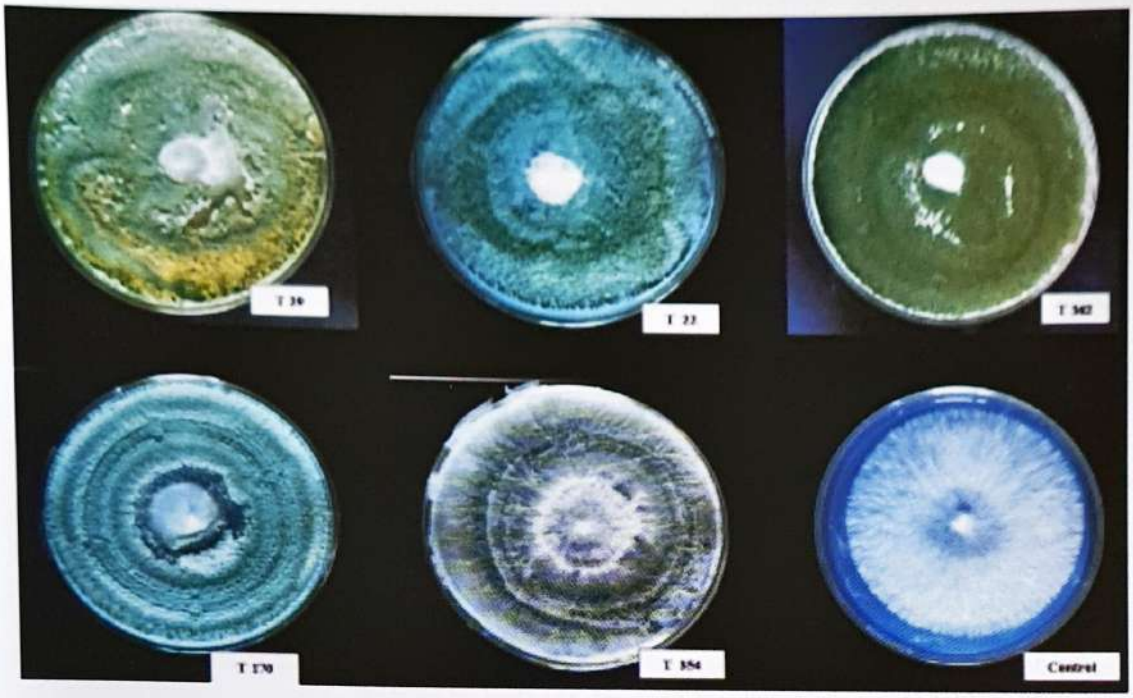


Plate 2. Isolates of *Trichoderma* sp. showing promising antagonistic activity against *Sclerotium rolfsii* under *in vitro* conditions

Integrated Disease Management

A field trial in RBD with 3 replications and 7 treatments was conducted during *kharif* 2005. Observations on major fungal diseases *viz.*, ELS, LLS, rust and stem rot and pod rot were recorded.

The maximum disease intensity of ELS, LLS and rust were 8.39, 7.56 and 8.44 respectively in control (Table 5). There was significant reduction in disease intensity of ELS by intercropping with maize, application of gypsum @ 500kg/ha at flowering stage and by the seed treatment with *Trichoderma harzianum* + application of gypsum. Though the disease intensity of LLS was reduced by all the treatments, only the foliar application of chlorothalonil 0.2% a.i. could reduce the disease significantly. No significant differences were observed between the treatments with regard to reduction in the intensity of rust. The maximum stem rot (13.07%) and pod rot (42.0%) incidence was observed in control. Seed treatment with *Trichoderma harzianum* @ 4g/kg seed alone as well as in combination with intercropping with maize reduced the disease significantly. Minimum pod rot (30.67%) was observed in seed treatment with *T. harzianum* followed by foliar application with clorothalonil 0.2% a.i. (31.33%) and the intercropping with maize (32.0%) at 3:1 ratio.

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

A field experiment was conducted during *kharif* 2005 to see the effect of seed treatment and soil application of *Trichoderma harzianum* and foliar application of culture filtrate of *Verticillium lecanii, Trichoderma* sp. and aqueous extract of *Euphorbia* sp. on soil borne and foliar fungal diseases of groundnut. There were reduction in the disease intensity of early leaf spots (ELS), late leaf spot (LLS) and rust by the treatments (Table 6). The maximum reduction of ELS was by the seed treatment with *Trichoderma harzianum* @ 4g/kg seed and foliar application of culture filtrate of *V. lecanii* at 50% dilution on the first

appearance of the leaf spots followed by two sprays at 15 days interval. The maximum reduction of L was by the foliar spray of culture filtrate of *V. lecanii* and maximum reduction in intensity of rust recorded by foliar spray of culture filtrate of *V. lecanii* at 50% dilution. Interestingly, growth promoting activity of *Trichoderma* seems to enable the plants to defend them better against the leaf spots. The incidence of collar rot was quiet low (< 2%) and the reduction in incidence was insignificant by different treatments. The maximum incidence of stem rot and pod rot were 12.7% and 45.33% respectively. The soil application of commercial formulation of *Trichoderma harzianum* (2.5 kg/ha) mixed with castor cake (500 kg/ha) as carrier and applied in furrow at the time of sowing reduced stem rot incidence significantly. The maximum reduction in stem rot and pod rot incidence was recorded by seed treatment with *T. harzianum* in combination with soil application (2.5 kg/ha) mixed with castor cake and applied in furrow at the time of sowing.

Effect of organic soil amendments on incidence of soil borne diseases

A field trial in RBD with 3 replications and a susceptible variety GG 20 was conducted during the rainy season of 2005 to study the effect of soil application of fresh leaves of karanj (*Pongamia pinnata*), banyan, *Eucalyptus* @ 500 kg/ha each and application of bajra flour (120 kg/ha), castor cake (500 kg/ha), cotton seed cake (500 kg/ha), gypsum (500 kg/ha) and lime @ 100 kg/ha in furrow at the time of sowing for the management of stem rot. Also, the effect of application of elemental sulphur @ 20 kg/ha was studied for the management of stem rot. The maximum disease incidence of collar rot (15.11%), stem rot (15.26%) and pod rot (40%) was observed in control (Table 7). The reduction in disease incidence of collar rot was found to be statistically insignificant. The stem rot incidence was significantly reduced by application of karanj leaves, gypsum, elemental sulphur and lime. Except the soil application of bajra flour and cotton seed cake all other treatments reduced the pod rot incidence significantly.

Effect of foliar application of plant and animal products on disease intensity of major foliar fungal disease

A field experiment in RBD was conducted during *kharif* 2005 to see the effect of foliar application of some plant products like aqueous extract of turmeric, garlic, *Euphorbia* leaves and neem seed kernels as well as some animal products like cow urine, cow dung, cow milk and curd and their combinations on severity of major foliar fungal diseases. The results showed that there was significant reduction in the intensity of ELS, LLS and rusts by some treatments. The intensity of ELS, LLS and rust was significantly reduced by the foliar application of curd (25%) and water extract of *Euphorbia* leaves. The other treatments which had significantly reduced the ELS and LLS were application of turmeric powder and that of LLS and rust by neem seed kernel extract.

Table 1. **Promising genotypes against ELS, LLS and rust under field conditions during rainy season of 2005 (Old)**

Sr. No.	Genotypes	Disease intensity (1-9) scale		
	ELS	LLS	Rust	
1.	CS 105	4.67	3.67	1.00
2.	CS 144	6.17	4.67	1.00
3.	CS 158	6.00	4.83	1.17
4.	CS 222	4.50	5.17	4.33
5.	CS 223	5.83	4.83	3.17
6.	CS 257	4.83	3.67	3.33
7.	PBS 22008	4.50	3.33	1.17
8.	PBS 25001	3.50	3.67	2.17
	GG 20*	**8.50**	**8.50**	**7.83**

*Susceptible check No. of genotypes screened: 192

Table 2a. **Promising genotypes against ELS, LLS and rust under field conditions during rainy season of 2005 (New)**

Sr. No.	Genotypes	Disease intensity (1-9) scale		
		ELS	LLS	Rust
1	CS 154	5.50	4.83	5.67
2	CS 277	4.17	4.33	2.67
3	CS 303	4.17	4.17	7.17
4	CS 311	4.50	4.00	8.00
	GG 20*	**8.50**	**8.50**	**8.00**

*Susceptible check No. of genotypes screened: 103

Table 2b. Promising genotypes against stem rot under field conditions during rainy season of 2005 (New)

Sl. No.	Genotypes	Stem rot (%)	Yield g/3 m row
1	CS 15	3.33	56.00
2	CS 272	6.25	300.50
3	CS 286	5.56	28.50
4	CS 300	8.82	96.50
5	CS 306	8.06	171.50
6	CS 307	7.14	52.00
7	CS 311	7.14	140.50
8	CS 315	7.69	132.00
9	CS 319	0.00	114.50
10	CS 327	0.00	85.00
11	CS 334	7.27	208.00
12	CS 343	7.18	187.50
13	CS 347	7.56	47.00
14	CS 350	9.61	152.50
	GG 20*	**29.1**	**247.50**

* Susceptible check No. of genotypes = 103 + GG 20

TABLE 3. Genotypes showing multiple disease resistance during 2003 to 2005 under field conditions

Sr. No.	Genotype	ELS			LLS			Rust			Stem rot (%)		
		2003	2004	2005	2003	2004	2005	2003	2004	2005	2003	2004	2005
1	CS 159	5.5	3.8	4.0	3.5	4.0	4.0	1.3	1.7	2.5	29.4	17.2	3.1
2	CS 160	4.7	3.3	4.3	2.7	3.2	4.2	1.2	1.5	2.8	26.3	17.9	0.0
3	CS 168	5.0	3.0	7.7	2.7	2.2	6.7	1.0	1.5	7.2	4.2	18.9	11.9
4	PBS 25001	-	3.7	3.5	-	3.7	3.7	-	2.8	2.2	-	14.2	0.0
5	CS 156	-	4.0	5.2	-	4.0	4.8	-	1.8	4.3	-	4.2	10.0
6	CS 196	-	5.5	6.0	-	5.5	5.2	-	2.8	2.5	-	11.0	10.0
7	CS 222	-	3.3	4.5	-	3.3	5.2	-	1.5	4.3	-	13.1	16.7
8	CS 257	-	4.8	4.8	-	4.8	3.7	-	1.8	3.3	-	11.0	23.8
9	CS 85	-	4.0	4.8	-	4.0	5.3	-	2.0	4.2	-	21.0	4.2
10	CS 144	-	5.0	6.2	-	5.0	4.7	-	3.3	1.0	-	13.5	0.0
	GG 20	7.2	7.5	8.5	6.7	7.5	8.5	5.2	6.3	8.2	28.5	33.7	29.1

Table 4a. Inhibition of growth of *Aspergillus niger* by different isolates of *Trichoderma* spp. (bangle method)

Isolate No.	*Trichoderma* spp.	Growth of *A. niger* after 48 h (in mm) (y)	Inhibition *A. niger* over control (%)	Over Growth of *Trichoderma* spp.	Sporulation
T 00	*Trichoderma* spp.	28.67	30.10	F	+
T 04	*T. viride*	27.33	33.34	F	++
T 18	*T. aureoviride*	32.33	21.15	N	+
T 28	*Trichoderma* spp.	30.00	26.83	N	++++
T 29	*T. koningii*	29.00	29.27	N	+++
T 71	*T. viride*	31.33	23.59	N	+
T 72	*Trichoderma* spp.	27.67	32.54	P	+++
T 93	*T. hamatum*	29.00	29.27	P	++++
T 115	*T. viride*	27.33	33.34	F	+
T 126	*T. harzinum*	31.33	23.59	N	+++
T 134	*T. hamatum*	32.33	21.15	F	++++
T 170	*T. harzianum*	27.67	32.54	N	+
T 219	*T. viride*	27.67	32.54	P	+++
T 226	*T. viride*	34.67	15.46	N	+
T 257	*T. harzianum*	28.67	30.10	P	+++
T 292	*T. hamatum*	35.00	14.63	F	+++
T 354	*T. hamatum*	35.33	13.83	P	+++
T 362	*T. oiluliferum*	30.00	26.83	N	+++
T 390	*T. harzianum*	28.00	31.71	N	+
T 425	*Trichoderma* spp.	32.00	21.95	N	+
Control* (*A. niger*)		41.00			

** Qualitative Scale for categorization of sporulation:

\+ = Poor/ scanty, ++ = Moderate, +++ = Good, ++++ = Very Good

Overgrowth: F= fully overgrown, P= partially overgrown, N= not overgrown

Table 4b.	Inhibition of growth of *Sclerotium rolfsii* by different isolates of *Trichoderma* spp. (bangle method)				
Isolate No.	*Trichoderma* spp.	Growth of *S. rolfsii* after 48 hr (in cm) (y)	Inhibition *S. rolfsii* over control (%)	Over Growth of *Trichoderma* spp.	Sporulation
T 00	*Trichoderma* spp	22.67	49.63	F	+
T 04	T. viride	12.67	71.85	F	++
T 18	*T. aureoviride*	12.67	71.85	P	+
T 19	*Trichoderma* spp.	15.00	66.67	N	+
T 22	*T. viride*	11.00	75.56	P	+++
T 28	*Trichoderma* spp.	10.33	77.04	P*	+++
T 29	*T. koningii*	20.33	54.81	P*	++++
T 43	*T. hamatum*	14.67	67.41	P	++
T 57	*Trichoderma* spp.	14.33	68.15	P	++
T 71	*T. viride*	14.33	68.15	N*	++
T 93	*T. hamatum*	12.50	72.22	P*	+++++
T 115	*T. viride*	16.00	64.44	P	+++
T 126	*T. harzianum*	11.67	74.07	P*	+++
T 127	*Trichoderma* spp.	20.83	53.70	P*	+++
T 134	*T. hamatum*	15.00	66.67	P	+++
T 166	*Trichoderma* spp.	16.33	63.70	P	+++
T 170	*T. harzinum*	11.67	74.07	P	++
T 219	*T. viride*	13.00	71.11	P*	++++
T 226	*T. viride*	23.83	47.04	N	+
T 257	*T. harzianum*	11.17	75.19	P	++++
T 267	*Trichoderma* spp.	7.00	84.44	F	+++
T 292	*T. hamatum*	14.00	68.89	P	+++
T 354	*T. hamatum*	19.00	57.78	P	+++
T 356	*Trichoderma* spp.	14.67	67.41	P *	+++
T 360	*Trichoderma* spp.	13.33	70.37	P*	++++
T 362	*T. oiluliferum*	7.33	83.70	F	++++
T 382	*Trichoderma* spp.	20.33	54.81	N	++
T 390	*T. harzianum*	20.67	54.07	P	+
T 425	*Trichoderma* spp.	25.50	43.33	N	++
Control* (*S. rolfsii*)		45.00			

** Qualitative Scale for categorization of sporulation:

\+ = Poor/ scanty, ++ = Moderate, +++ = Good, ++++ = Very Good

Overgrowth: F= fully overgrown, P = partially overgrown, P* =mycelium of *S. rolfsii* coming out of growth of *Trichoderma,* N = not overgrown

Table 5. Integrated disease management of groundnut during *kharif* 2005

Treatment	Disease score (1-9) scale			Collar Rot (%)	Stem Rot (%)	Pod Rot (%)
	ELS	LLS	Rust			
T-1	8.28	7.00	8.00	0.43 (2.99)	5.83 (13.74)	30.67 (33.61)
T-2	8.00	6.78	8.00	0.60 (4.15)	9.23 (17.63)	32.00 (34.41)
T-3	8.00	7.06	8.33	0.39 (3.47)	8.44 (16.71)	39.00 (38.63)
T-4	8.11	7.00	8.33	0.47 (3.01)	10.00 (18.01)	34.67 (36.06)
T-5	8.11	6.56	8.33	0.25 (2.86)	7.52 (15.35)	31.33 (34.01)
T-6	8.33	6.67	8.22	0.63 (4.53)	5.14 (12.86)	39.67 (39.02)
T-7	8.00	6.89	8.11	0.58 (4.11)	9.14 (16.88)	38.00 (38.04)
T-8	8.11	6.89	8.33	0.59 (3.58)	7.16 (14.92)	39.33 (38.83)
T-9	8.11	6.78	8.00	0.38 (3.49)	9.78 (18.21)	41.33 (40.0)
T-10	8.33	7.11	8.33	0.18 (1.40)	8.08 (16.45)	35.33 (36.45)
T-11	8.39	7.56	8.44	0.67 (4.60)	13.07 (21.09)	42.00 (40.37)
C.D (5 %)	**0.39**	**0.92**	**0.59**	**3.30**	**6.48**	**4.05**
C.V.(%)	**2.85**	**7.77**	**4.25**	**55.78**	**23.86**	**6.38**

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

T2 – Intercropping with maize (3:1 ratio)

T3 – Application of gypsum @ 500kg/ha at flowering stage

T4 – Foliar spray of 5% turmeric powder, three sprays at 15 days interval starting from appearance of disease.

T5 – Foliar application of Chlorothalonil 0.2% a.i., two spray at 15 days interval, 1st spray at appearance of symptoms, 2nd at 15 days after 1st spray

T6 - T1 + T2

T7 – T1+ T3

T8 - T1 + T4

T9 - T1 + T5

T10 -T1 + T2 + T3 + T4

T11 -Control

Table 6. Biological control of soil borne and foliar fungal diseases of groundnut during kharif 2005

Treatment	Disease score (1-9) scale			Collar Rot	Stem Rot	Pod rot (%)
	ELS	LLS	Rust			
T-1	8.11	7.22	8.22	0.84 (5.25)	4.87 (12.73)	30.67 (33.61)
T-2	8.22	7.78	8.00	0.71 (4.78)	3.76 (10.88)	28.00 (31.94)
T-3	8.11	6.44	6.67	0.82 (5.11)	9.15 (15.86)	38.00 (38.03)
T-4	8.33	7.00	8.11	1.01 (5.70)	5.60 (13.41)	34.00 (35.65)
T-5	7.11	6.56	7.89	0.68 (4.71)	5.95 (14.02)	33.33 (35.24)
T-6	7.89	7.67	8.22	0.69 (4.48)	7.05 (15.39)	34.67 (36.04)
T-7	8.11	7.22	7.78	0.44 (3.73)	10.80 (17.91)	34.67 (36.06)
T-8	8.56	8.11	8.33	0.92 (5.54)	5.05 (13.04)	35.33 (36.46)
T-9	8.33	6.78	7.89	0.53 (4.14)	6.43 (14.17)	34.67 (36.06)
T-10	8.33	7.78	7.89	1.03 (5.72)	12.70 (20.84)	45.33 (42.32)
C.D $_{(5\%)}$	0.73	0.64	0.69	2.11	8.37	6.36
C.V.(%)	5.22	5.15	5.11	27.19	33.48	23.80

T1 - Seed treatment with *Trichoderma* @ 4g/kg seed (Seed coating)

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

T3 - Foliar spray of *V. lecanii* (CF) 50% dilution - Two spray at 15 days interval, 1st spray starting from appearance of diseases

T4 - T1+ T2

T5 - T1 + T3

T6 - T2 + Two foliar spray of *V. lecanii* (CF) 50% dilution; 1st spray at appearance of disease and 2nd spray 65 days after sowing

T7 - Foliar application of *Trichoderma* (T-004) CF (50% dilution)

T8 - Foliar spray of *Trichoderma* (T-004) @ 1.5x 10^6 CFU/ml

T9 - Foliar spray of aqueous dry leaf powder of *Euphorbia* sp.

T10-Control

Table 7. Effect of organic soil amendment on the incidence of soil borne diseases of groundnut during *kharif* 2005

Treatment	Collar rot (%)	Stem rot (%)	Pod rot (%)
T -1	12.90 (20.98)	11.04 (18.79)	32.00 (34.42)
T -2	12.57 (20.70)	7.15 (15.51)	32.00 (34.41)
T -3	11.69 (19.72)	10.39 (18.30)	30.67 (33.55)
T -4	11.95 (20.19)	10.62 (18.80)	36.67 (37.25)
T -5	11.84 (19.99)	9.73 (17.47)	33.33 (35.25)
T -6	13.36 (21.30)	11.27 (19.21)	40.67 (39.61)
T -7	14.40 (22.18)	7.27 (14.96)	31.33 (34.02)
T -8	14.36 (22.01)	5.39 (12.98)	29.33 (32.77)
T -9	10.99 (19.27)	6.63 (14.67)	32.67 (34.84)
T -10	15.11 (22.87)	15.26 (21.20)	40.00 (39.23)
C.D. (at 5 %)	**4.48**	**5.25**	**3.28**
C.V.(%)	12.52	**18.44**	**5.37**

** Data in parenthesis are arc sine transformed values

T1 – Soil application of banyan tree leaves @ 500kg/ha

T2 – Soil application of karanj leaves @ 500kg/ha

T3 - Soil application of Eucalyptus leaves @ 500kg/ha

T4 - Soil application of Bajra flour @ 120kg/ha

T5 - Soil application of castor cake @ 500kg/ha

T6 - Soil application of cotton seedcake @ 500kg/ha

T7 - Soil application of gypsum @ 500kg/ha

T8 - Soil application of elemental sulphur @ 20 kg/ha

T9 - Soil application of lime @ 100 kg/ha

T10 – Control

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

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

Heat stress

Water-deficit induced high temperature stress

Field trials were conducted during summer and *kharif* seasons to find out the effect of simulated soil-water-deficit on plant canopy and soil temperatures, leaf cell membrane thermostability (LCMT), total biomass and pod yield. Fifteen cultivars belonging to Spanish, Valencia and Virginia groups were subjected to simulated drought condition by withholding irrigation water during flowering phase. However, during *kharif* crop experienced drought during flowering in the rain-dependent treatment. In summer season, both soil and leaf temperatures increased by 2-3°C due to water-deficit as compared to control. The leaf expansion i.e. leaf growth from bud stage to fully developed and expanded form was found to be most sensitive physiological process under water-deficit. In general, under water-deficit total biomass and pod yield decreased, however, HI increased in some of the cultivars, for example in TG 32 the increase was up to 13%. Though the increase in other cultivars i.e. Girnar 1, ICGV 86031 and ICGS 44 was marginal (2-3%). Decrease in total biomass was least in Gangapuri, JL 24 and ICGS 44 (between 8 and 13%) and highest in Chico (45%), due to water-deficit. There was not much significant effect of drought on number of single seeded-pod in majority of cultivars except Gangapuri, indicating thermosensitivity of the reproductive parts and processes in this cultivar.

Genetic variation in leaf cell membrane thermostability (LCMT)

LCMT test was conducted in laboratory after 60 days of sowing and wide genetic variability in maintenance of cell membrane thermostability was noticed. The relative injury index (RI %) ranged between 12 and 32%, being least in TAG 24, and highest in CSMG 84-1. Based on RI values cv. TAG 24, ICGV 86031, ICGS 44, Girnar 1, GG 20 and GAUG 10 were found tolerant to heat stress, while cv. GG 7, Chico (Fig. 1) and CSMG 84-1 (Fig. 2) were susceptible. Heat acclimation potential showed that plants under goes through a process of acclimation for heat stress, even exposed to conditions of drought. Genotypic variation in heat acclimation potential was also noticed, however the process of acclimation for heat and drought may be interrelated and need detailed investigation on cross tolerance mechanism.

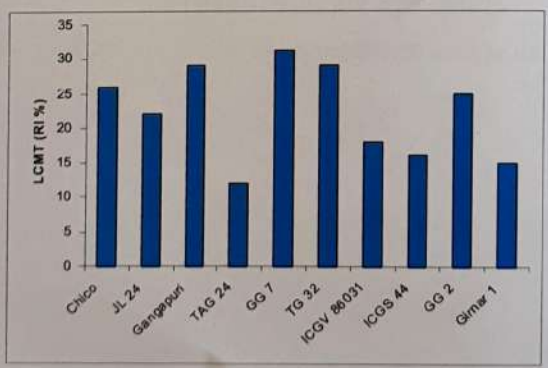


Figure 1. Leaf cell membrance thermostability in Spanish and Valencia groundnut

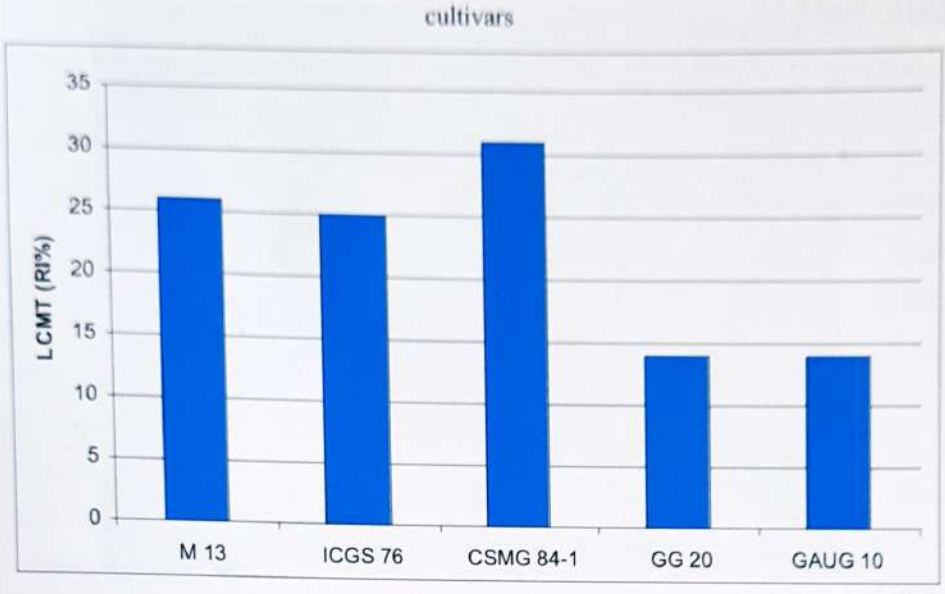


Figure 2. Leaf cell membrane thermostability in Virginia cultivars

Seasonal variation in leaf cell membrane thermostability

Experiment conducted in laboratory on LCMT with nine cultivars during summer and *kharif* seasons showed seasonal variation in the response of genotype to heat injury. In general, leaf injury was higher in the summer crop at various stages of development than the *kharif* season. Such response of crop shows environmental influence on development of leaf cell membrane and its thermostability.

Root architecture

An efficient, deep and penetrating root system is essential for a genotype to survive under limited water supply; therefore, a drought tolerant genotype must possess a desired root system along with maintenance of leaf water content. In groundnut a little information is available on root architecture and growth under limited water-supply. However, variation in root architecture under normal and water-deficit conditions was evident in our previous studies. This experiment was conducted in summer season with ten groundnut cultivars *viz.,* Gangapuri (Valencia), ICGS 44, ICGV 86031, GG 2, GG 7, TG 32, TAG 24, JL 24, Girnar 1 and Chico (all Spanish). Water deficit was created by drying the soil to 14% (control) and 5% (stress) moisture levels. Seeds of single genotype were sown in one block, immediately after sowing each block was supplied with 2 liters of water day^{-1}, until emergence. Afterwards, the control and stress blocks were replenished with 100% and 50% of the E-pan daily, respectively. Root architecture was studied 55 days after sowing by removing the soil with the help of jet of water as shown in Figure 3. After completely taking out the whole root system of individual plant in one block, plant samples were brought to the laboratory and various observations were recorded (Table 1). Root architecture varied significantly under control and stress conditions. For example, tap root length was highest in TAG 24, whereas the secondary root length was highest in ICGS 44, both under control and stress conditions. Root length density was highest in ICGS 44 under control and in ICGV 86031 under stress, though Gangapuri was able to maintain root thickness under both the conditions. Total root weight was highest in JL 24. In conclusion, a penetrating and efficient root system exists in cv. TAG 24, ICGS 44, ICGV 86031, JL 24 and Gangapuri, however, root characteristics related with drought tolerance is yet to be identified.

Figure 3. Removing the soil from root zone in root-block with the help of water-jet

Figure 4. Root growth under normal and water-deficit conditions at 55 days after sowing in root blocks

Table 1. Root characteristics under normal and water-deficit conditions in ten groundnut cultivars

Sr. no.	Parameter	Rank under control		Rank under stress	
		1	10	1	10
1.	Tap root length (cm)	TAG 24	Gangapuri	TAG 24	Gangapuri
2.	Secondary root length (cm)	ICGS 44	Chico	ICGS 44	TG 32
3.	Root volume (ml)	ICGV 86031	TAG 24	JL 24	Chico
4.	Specific root length (cmroot g^{-1} m^{-2} soil)	Gangapuri	Chico	Gangapuri	Chico
5.	Tap root length density (cm root m^{-3} soil)	TAG 24	Gangapuri	TAG 24	Gangapuri
6.	Secondary root length density (cm root m^{-3} soil)	ICGS 44	Chico	ICGV 86031	TG 32
7.	Root weight density (g root m^{-3} soil)	JL 24	Chico	JL 24	Chico
i.	0-15 cm depth	JL 24	Chico	Gangapuri	Chico
ii.	15-30 cm depth	JL 24	Chico	JL 24	Chico
iii.	30-onward depth	GG 2	Chico	GG 2	Chico
8.	Tap root length (cm root m^{-2} soil)	TAG 24	Gangapuri	TAG 24	Gangapuri
9.	Secondary root length (cm root m^{-2} soil)	ICGS 44	Chico	ICGS 44	Girnar 1
10.	Root weight (g root m^{-2} soil)	JL 24	Chico	JL 24	Chico
i.	0-15 cm depth	JL 24	Chico	Gangapuri	Chico
ii.	15-30 cm depth	JL 24	Chico	JL 24	Chico
iii.	30-onward depth	GG 2	Chico	JL 24	Chico
11.	Root:shoot	Gangapuri	Girnar 1	JL 24	GG 2

PROJECT 04 : INTEGRATED NUTRIENT MANAGEMENT IN GROUNDNUT

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

Sub-project 01: Development of biofertilizer packages for groundnut

(K. K. Pal and R. Dey)

Plant Growth Promoting Rhizobacteria (PGPR)

Effect of consortia of PGPR on the growth and yield of groundnut

Consortium of beneficial rhizosphere microorganisms may contribute significantly to the enhancement of growth, yield and nutrient uptake of crop plants. 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.

With cultivar JL 24

The consortia of compatible PGPR cultures were tested to study the inoculation effects on the growth and yield of groundnut, cultivar JL 24. Seed bacterisation of groundnut with PGPR consortia resulted in significant enhancement in shelling out-turn, root length, dry shoot mass, root mass and nodule mass. Inoculation with consortium A (consortium of non-fluorescent pseudomonads) had better effects on the plant growth and yield as compared to consortium B (fluorescent). Seed bacterisation with consortium A resulted in 11% higher pod yield as compared to consortium B (Table 1).

With cultivar GG 2

Seed bacterisation of groundnut with PGPR consortia resulted in increase in growth and yield with cultivar GG 2 during *kharif*, 2005. Seed inoculation with both consortium A and B resulted in significant increase in shoot length and shoot dry mass and shelling outturn. While inoculation with consortium A resulted in increase in pod yield (11%), inoculation with consortium B resulted in yield at par with control. Inoculation with consortium A also resulted in significant increase in haulm yield, hundred-kernel weight, nodule mass and root length (Table 1).

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

A field trial was conducted during the *Kharif* season of 2005 to study the effect of inoculation of PGPR on the growth and yield of bold seeded groundnut varieties. A total of five bold seeded groundnut varieties were taken to study the inoculation effects of three PGPR cultures, namely PGPR1, PGPR2 and PGPR4. In general, inoculation with PGPR cultures resulted in significant increase in root length, shoot length, nodule mass, haulm yield, shelling percentage and hundred kernel mass. Inoculation with all the PGPR cultures resulted in significant enhancement in pod yield, the maximum was obtained with PGPR2 (13.5%) (Table 2). It was at par with PGPR 1 and PGPR 4.

The five bold seeded varieties differed with each other significantly with respect to the parameters tested. The maximum pod yield was obtained with variety TKG 19A followed by M13, though they were at par. The highest haulm yield was obtained in BAU 13 followed by M 13. The maximum shelling out-turn, hundred kernel mass and sound mature kernels was obtained in TKG 19A.

Effect of consortia of PSM, groundnut-rhizobia and PGPR on growth and yield of groundnut

Phosphate solubilizing bacteria, groundnut-rhizobia and plant growth-promoting rhizobacteria were tested within and pair-wise for compatibility. On the basis of compatibility tests, a total of soven combinations of consortia were identified. These consortia were evaluated in pot and field trials.

A total of seven consortia, different combinations of PGPR, PSM and rhizobia, were tested for their effects on growth and yield of groundnut (var. GG 2). Most of the consortia had significantly better effects on the various parameters tested. The best consortium was consortium BC (PSM+rhizobia), inoculation of which resulted in maximum pod yield (13.5% higher than control), haulm yield, nodule number and mass, etc. (Table 3).

Population of the individual members of the consortia was determined in the rhizosphere on the basis of intrinsic antibiotic resistance patterns. In case of PGPR consortium, the population of *Pseudomonas fluorescens* BHU1 and S1 (6) increased in the rhizosphere from 30 DAS to 60 DAS, irrespective of combinations, with few exceptions. Similar trend was also noticed in case of PSM strains. In dual inoculation of two consortia, population of individual strain sometimes decreased. In case of rhizobia, co-inoculation either with PSM or PGPR improved nodule occupancy from 10-34% both at 30 and 60 DAS.

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

The effect of seed inoculation of groundnut with PGPR cultures was tested in a field trial during the rabi-summer season of 2005 using TG 26 cultivar. Inoculation with *Pseudomonas fluorescens* PGPR1, *Pseudomonas fluorescens* PGPR 2, *Pseudomonas fluorescens* PGPR4 and consortia of the PGPR cultures enhanced the growth and yield of groundnut, cultivar TG 26 under irrigated conditions. There was about 7-15% increase in pod yield as a result of inoculation with PGPR cultures (Table 4). The maximum pod yield was recorded as a result of seed inoculation with consortium A (mixture of non-fluorescent pseudomonads).

Groundnut rhizobia

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

Two newly identified strains of groundnut-rhizobia viz; NRCG 4 and NRCG 9 were evaluated for nodulation and growth parameters of groundnut cultivar GG 2 under field conditions along with NC92, IGR6, IGR 40, during Rabi/summer of 2005. Inoculation resulted in significant increase in pod yield with IGR6 (19%), NC92 (10%), NRCG 4 (14%) and NRCG 9 (15%), all at par with each other. There was also improvement in shelling out-turn, 100 seed mass and haulm yield as a result of inoculation with groundnut rhizobia.

Studying the role of groundnut genotypes on the rhizodeposition

Two parental lines of groundnut, i.e. GG 2 and ICGV 86031 and six progenies of the cross between these two parental lines were taken up to study the role of groundnut genotypes on rhizodeposition. Among these, three progenies *viz*; JUG_22, JUG_24 and JUG_48 were high yielding and rest three progenies JUG_43, JUG_46 and JUG_47 were low yielding as compared to parental lines. It was hypothesized that through breeding process it is possible to enhance the population of both beneficial and deleterious microorganisms in the rhizosphere *vis-à-vis* yield enhancement or reduction coupled with enhancement of nutrient uptake/impairment. A replicated trial in the Kharif 2005, indicated that in lines wherein yield was more, fluorescent pseudomonad population was maintained at low level and the number of cyanogenic fluorescent pseudomonads was less as compared to low yielding lines where

fluorescent pseudomonad population upto 40 DAS was several times more and majority of them were cyanide producing. In the parental lines, however, the population of fluorescent pseudomonads was less than the low yielding lines.

Table 1. Effect of PGPR consortia on the growth, yield and nutrient uptake of groundnut cultivars GG 2 and JL 24

Treatments	GG 2		JL 24	
	Pod yield (kg/ha)	Haulm yield (kg/ha)	Pod yield (kg/ha)	Haulm yield (kg/ha)
Consortium A	1360	2863	1600	2487
Consortium B	1306	2427	1518	2323
Control	1227	2463	1436	2280

Table 2. Effect of PGPR on the growth, yield and nutrient uptake of bold seeded groundnut during *Kharif*, 2005

Treatments	Pod yield (kg/ha)	Haulm yield (kg/ha)	Oil (%)	Nodule number at 45 DAS / plant
A. Culture				
PGPR1	1890	5712	50.97	57.8
PGPR2	1985	6353	51.03	61.2
PGPR4	1922	5978	50.70	64.0
Control	1748	5432	50.43	54.8
B. Variety				
M 13	1834	5863	50.71	61.4
Somnath	1758	5684	50.75	63.3
B 95	1698	5757	51.37	48.3
BAU 13	1804	6455	52.21	61.6
TKG 19A	1948	5685	48.87	63.3

Table 3. Effect of consortia of PGPR, PSM and rhizobia on the growth, yield and nutrient uptake of groundnut, cultivar GG 2, during *Kharif*, 2005

Treatments	Pod yield (kg/ha)	Haulm yield (kg/ha)	Nodule number at 45 DAS
Con A	1245	2685	39.0
Con B	1182	3307	38.5
Con C	1084	2525	45.4
Con AB	1258	3187	49.3
Con AC	1191	2547	46.3
Con BC	1262	3040	53.1
Con ABC	1219	3285	47.2
Control	1112	2470	35.4

Table 4. Effect of PGPR on the growth, yield and nutrient uptake of groundnut, cultivar TG 26, under irrigated condition during rabi-summer 2005

Treatments	Pod yield (kg/ha)	Haulm yield (kg/ha)
PGPR1	2308	3280
PGPR2	2224	3390
PGPR4	2360	3210
Consortium A	2402	3100
Consortium B	2383	3307
Consortium C	2307	3246
Control	2086	2993

PROJECT 05 : STUDIES ON GROUNDNUT BASED CROPPING SYSTEM

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

Cropping system

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

Meager information is available on cumulative as well as residual fertility build up in the lon run for whole cropping systems. A long-term experiment with five popular groundnut based croppin system, *viz*., mono cropping of groundnut (G), two intercropping systems (with pearl millet, PM an pigeon pea, PP) and two sequential cropping systems (groundnut-wheat W and groundnut-wheat-gree gram, GG) was initiated during *Kharif* 1998 under different combinations of organic and inorgani fertilizer regimes to study the nutrient dynamics and crop sustainability. One additional treatment o groundnut-groundnut (G-SG) was added during 2005 summer season. After eight years of completion the following changes in yield of groundnut and soil properties were observed:

- Among the cropping systems evaluated, the maximum pod yield (1105 kg/ha) of groundnut was in groundnut-wheat-green gram sequence.
- Stem rot incidence recorded at the time of harvest was more in FYM applied treatment (5.28%) and in G+PP intercropping treatment (5.38%) than in No FYM treatment (3.79%) and sole groundnut (3.43%). G+PM recorded the lowest incidence of stem rot (0.01%).
- Available nutrients and microbial activities were more in G+PP intercropping system than in sole groundnut.
- Under irrigated system, G-W-GG was more productive (GEY 3685 kg/ha) than G-W (GAY 2800 kg/ha) and G-SG (2586 kg/ha).
- Reducing fertilizer dose than the recommended to wheat crop significantly reduced grain yield of wheat. However, if FYM @5t/ha was applied to either Kharif groundnut or wheat, application of 50% of the recommended dose of fertilizer to the wheat gave grain yield at par (3752 kg/ha) with the RDF (3810 kg/ha)

Phosphorus dynamics in groundnut+ pigeonpea intercropping system

Two sources of P (mono and di-phosphate) were evaluated under four levels of P (25, 50, 75 and 100% of RDP) in groundnut+pigeonpea intercropping system. All the P was applied at the time of sowing. Observations on dry matter production, yield and yield attributes of both the crops were recorded. P content in groundnut and pigeonpea plants at harvest were determined and P uptake was computed. The significant observations are given below:

- Sole groundnut yielded 8.4% less under di-phosphate than under mono-phosphate. However, no such reduction in pod yield of inter crop groundnut and grain yield of pigeonpea were observed due to P sources in intercropping system
- Intercropping system gave LER more than unity indicating higher biological efficiency than sole system of either crop. At lower doses, mono phosphate gave higher LER than Di-phosphate. However, both the sources were equally effective at higher doses and gave LER of 1.4-1.45

- P uptake by pigeonpea was reduced under Di-phosphate compared with that under mono phosphate. However, not such difference in P uptake by groundnut between two sources of P, especially under higher doses of P, was observed.
- The values of Agronomic Efficiency (AE), Physiological Efficiency (PE) and Apparent P Recovery (APR) were higher or comparable under Di-Phosphate (10-79-12.91; 209.75-235.60 and 4.58-6.16, respectively) with those under Mono Phosphate (10.83-11.08;155.44-183.37 and 5.90-7.12, respectively) applied at 75 or 100% recommended doses to the system (Table 1)
- Based on LER, AE, PE and APR, Di-Phosphate may be considered a potential source of P fertilizer in groundnut+ pigeon pea intercropping system

***In situ* moisture conservation**

Plant density and fertilizer response under *in situ* moisture conservation in rainfed groundnut

Our earlier data indicated that in-situ moisture conservation through Inter Row Water Harvesting (IRWH) increases pod yield of rainfed groundnut significantly over the control (no moisture conservation). However, groundnut response to plant density and fertility regime varied with the availability of soil moisture in the root zone. The results obtained during Kharif 2005 are briefly summarized below:

- Crop ET varied from 261.5 mm to 283.5 mm under IRWH compared with 270.5 mm in the control. ET increased linearly with increasing plant density.
- Available soil moisture in soil profile (0-40 cm) was higher under IRWH than under control during the vegetative growth of the crop. However, during pod development stage, nod difference in available soil moisture was observed mainly because of excess rain received during the later period of crop growth.
- Pod yield increased by 26.2% due to IRWH over the control (no moisture conservation)
- The increase in pod yield under IRWH was mainly due to facilitating drainage during excess rainfall through dead furrow, rather than due to more conservation of soil moisture.
- WUE under IRWH ranged from 5.44 to 8.48 kg/ha/mm whereas it was 5.60 kg/ha/mm under the control.
- Response to fertility regime under IRWH was quadratic which showed some scope to reduce fertilizer doze under IRWH

Dry seeding of groundnut in rainfed conditions

A field experiment was conducted during *Kharif* 2005 on dry coating of groundnut seed with different chemicals/materials before sowing. Treated seeds were sown under dry conditions 15 days before (8 June, 2005) and 5 days before (18 June, 2005) onset of monsoon (22 June). The normal sowing after onset of monsoon was done on 25 June. The results are briefly summarized below:

- Groundnut seed under dry sowing germinated 4-6 days earlier than under onset of monsoon.
- Seedling emergence did not vary significantly due to dry and onset of monsoon sowing.
- Incidences of collar rot and stem rot varied significantly due to treatments. Collar rot incidence was the maximum (15.66%) under wheat flour treatment, while it was the lowest under $CaSO_4$ treatment. The stem rot incidence was the maximum under control and the minimum under pearl millet flour treatment.

- The pod yield was the maximum when dry seeding was done 5 days before onset of monsoon. Among the treatments, seed coating with $CaSO_4$, Rock phosphate and cow dung showed some potential. The results need confirmation.

Yield water relation in groundnut as influenced by Calcium and Potassium

Our earlier studies revealed that relationship of ET with pod yield of groundnut was linear but the degree of relationship varied with the genotype. The sensitive cultivar (TG 26) had low value of coefficient at reduced water level compared to tolerant cultivar (TAG 24). The effect of nutrients especially K and calcium was studied on WUE and the yield of groundnut under varied moisture regimes. The one year's results are briefly mentioned below:

- Increasing the degree of moisture stress reduced pod yield significantly. However, as degree of moisture stress increases, reduction in yield was less under K (56%) and Ca + K (45%) than under control (67%).
- Application of Ca without correcting K balance yielded significantly less under moisture stress condition.
- Water use Efficiency showed sigmoid curve with increasing degree of moisture stress (highest 7.45 kg/mm/ha under 60% deficit of FC).
- K improved WUE under moderate stress (7.45 kg/ha/mm at 60% Deficit of FC) while at ore severe stress, Ca + K was found to be better with regard to WUE (5.52 kg/ha/mm) at 80% deficit of FC as compared to the other nutrients (Figure 1 and 2).

Table. 1 LER and P use efficiency under different sources of P fertilizers in groundnut+ pigeonpea inter cropping system

Treatment	LER		AE (kg/kg P applied)		PE (kg/kg P uptake)		APR (%)	
	Mono phosphate	Dipho-sphate	Mono phosphate	Dipho-sphate	Mono phosphate	Dipho-sphate	Mono phosphate	Dipho-sphate
Sole crop	1.00	0.96	13.46	10.44	20.71	234.78	6.67	4.49
Inter-cropping system								
Fertilizer dose								
D0	1.05	1.05	0					
D1	1.10	1.02	6.95	-3.54	158.43	-429.75	4.38	0.82
D2	1.22	1.10	10.48	2.92	169.85	81.90	6.17	3.57
D3	1.27	1.37	11.08	12.91	155.44	209.74	7.12	6.15
D4	1.45	1.45	10.82	10.79	183.37	235.60	5.90	4.58

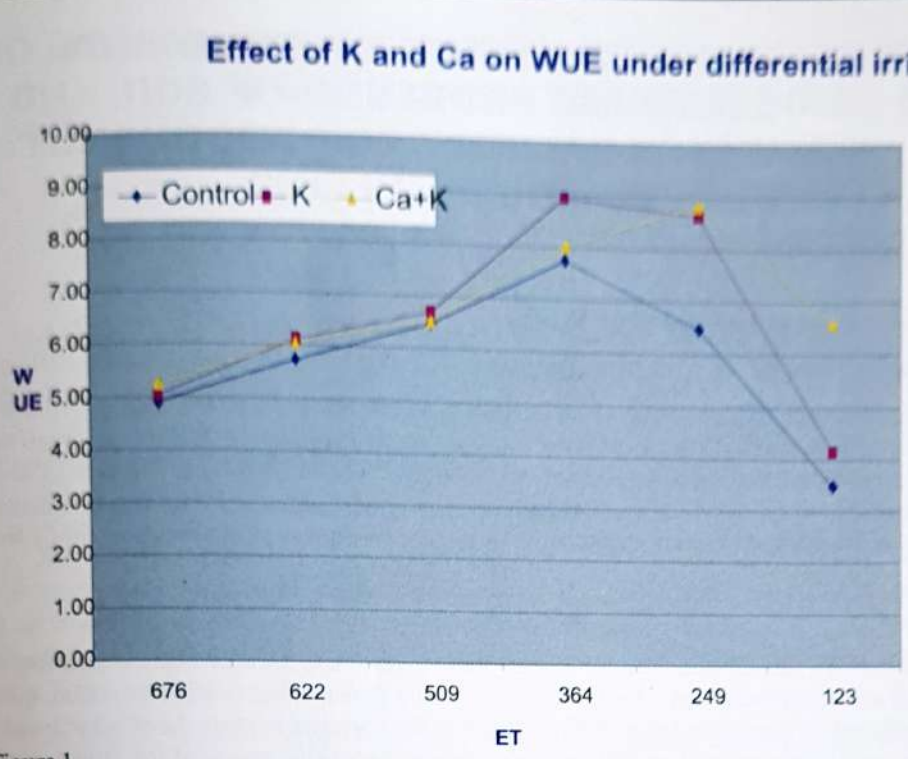


Figure 1

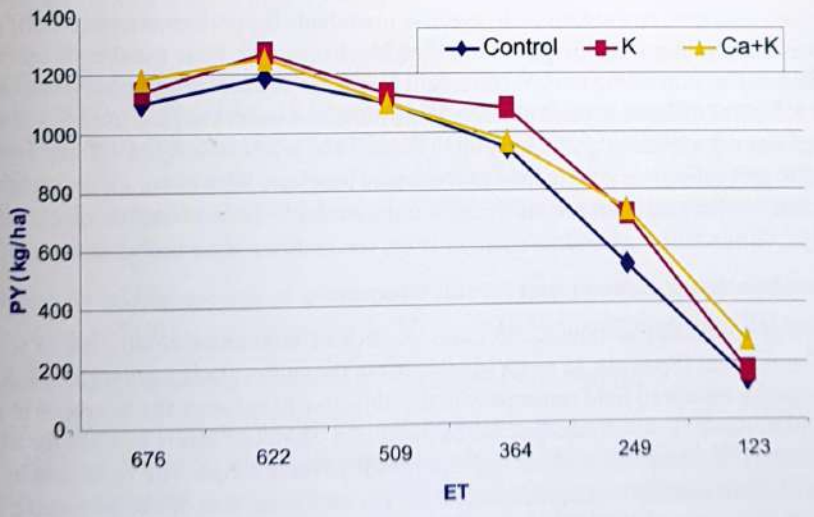


Figure 2

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

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

Use of saline water in groundnut and mustard crop

Summer groundnut 2005

Pod yield significantly decreased with an increase in salinity (0.5 to 6 dS/m) of irrigation water and soil salinity (1.6 to 9.4 dS/m). The yield reduction was greater than 50% at 2 dS/m salinity of the irrigation water over control whereas this quality of irrigation water can safely be used in Kharif groundnut mainly because the soil salinity build up in Kharif season and irrigation requirement was much lower in the latter season. Hence, use of saline irrigation water in summer groundnut is not economically feasible.

***Kharif* groundnut**

In order to utilize saline black soils using saline water irrigation in the area where availability of canal irrigation is a limiting factor and Kharif groundnut is being grown under rain fed condition. Field studies were conducted for four years during 2002 to 2005 with the objective to study the effect of supplemental irrigation with saline water at critical moisture stress and sensitive stages of the crop growth. During this four years experimentation, one to four number of saline water irrigation was applied depending upon the quantum and distribution of rainfall in that year. In this year also, the results concludes that Kharif groundnut produced economical pod yield by using saline water of 2 dS/m in saline black soil at a critical moisture stress and sensitive stages of the crop growth. High soil and water salinity affect the pod and oil yield significantly.

Mustard 2005-06

Field study was conducted on mustard with objective to evaluate the performance of Kharif groundnut – mustard rotation using saline water irrigation in saline black clay soil. Nine number of saline water irrigation were applied during Nov. 2005 to Feb. 2006. Soil salinity in the root zone at harvest of mustard was increased from 1.2 to 7.3 dS/m as a result of irrigation with saline water ranging from 0.5 to 6 dS/m. Seed yield of mustard was not affected significantly up to the soil and water salinity of 4 dS/m. Hence, the tolerance of mustard to soil salinity is greater than groundnut. Therefore, Kharif groundnut – mustard and groundnut – wheat rotation are much more economical to grow on saline black soil using saline water irrigation. Groundnut – groundnut rotation is not recommended on such saline soil.

Evaluation of released varieties of groundnut for salt tolerance

Experiment was conducted in June, 2005 under controlled laboratory conditions to screen 72 released varieties of groundnut (Spanish: 36 and Virginia: 36) in the saline environment (0.5, 4, 8 and 12 dS/m) for further use in the advanced field research with the objective to enhance the tolerance to salinity and to increase crop production. It was found that saline water of 4 dS/m can safely be used for irrigation in majority of the varieties of groundnut without any significant adverse effect. The reduction in the dry matter yield at 8 and 12 dS/m salinity was significant but the per cent reduction due to increasing salinity was greater in Spanish group than in Virginia group. Threshold salinity for different varieties was estimated and relative salinity tolerance for different varieties of groundnut was also worked out at 90, 75 and 50 % relative yield in relation to control.

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, D.P PATEL, G.C. MUNDA, M. DUTTA, N.P. SINGH, K.A PATHAK, A. K. VISHWAKARMA, RAMESH SINGH, K. S. SARANGI AND MOUSUMI RAYCHOUDHURY)

Experimentations in North-Eastern Hill regions

Evaluation of recently released cultivars and nutrient efficient lines

Thirty-six groundnut genotypes comprising of recently released cultivars and nutrient efficient lines were evaluated for their yield, and tolerance of Al- and Fe-toxicities and Ca and P deficiencies in field under rainfed condition in NEH region at Basar (Arunachal Pradesh), Kolasib (Mizorum) and Lembucherra (Tripura). The details of the yield and yield parameters at various places in NEH region are given in Tables 1 and 2.

At Tripura, the cultivars M 13 and TAG 24 were high yielders showing significantly high yield than JL 24. Among the nutrient efficient lines, most of them showed higher yield than JL 24 though the increase in pod yield ranged from 18.4 to 60.6% . The groundnut genotypes NRCG 7599, NRCG 6450, NRCG 6155 and NRCG 6820 could produce more than 1500 kg pod yield ha^{-1} which were appreciably higher over JL 24 (1238 kg ha^{-1}) and hence, these could be good genotypes for NEH region.

At Basar the high yielding genotypes were JL 24, GG 7 and TKG 19A among the cultivars and NRCG 1308 and 7599 among the nutrient efficient genotypes. It was noticed that these two nutrient efficient cultivars showed more than 1500 kg pod yield ha^{-1} and significantly higher yield than JL 24 (Table 1).

At Kolasib in Mizorum, where soil is highly eroded and acidic, the high yielding groundnut cultivars were ICGV 86590, TKG 19A and CSMG 84-1 during the current year. The three years data reveals that TKG 19A, GG 20, ICGS 76, ICGV 88448, JL 24, JL 220, CSMG 84-1, ICGV 86590 and M 13 were high yielding groundnut cultivars. Among the nutrient efficient genotypes NRCG 1308, 7206, 7471, FeESG 10-1, and FeESG 10-3 were promising which showed more than 1500 kg ha^{-1} pod yield and more than 1000 kg ha^{-1} seed yield.

The high yielding groundnut genotypes were also tolerant of Al-toxicity, resistant to ELS, LLS and rust diseases and hence can be grown in Mizorum and adjacent areas of NEH region.

Evaluation of confectionary groundnut genotypes in NEH region

Eight groundnut genotypes having comparatively large seeds were evaluated for their yield potential in NEH region under high management conditions (manures FYM 10t/ha + PSM + PGPR and all fertilizers). The perusal of data reveals that the high yielding genotypes were M13, ICGV 86590, ICGS 76 and CSMG 84-1 and any one of that could be used (Table 3).

Table 1.Performance of groundnut varieties at Basar (Arunachal Pradesh) during *kharif* season

S. N.	Groundnut genotypes	Root length (cm)	Shoot Length (cm)	Secondry roots/ plant	Nodules /plant	Root wt. (g)/ 5 plants	Shoot wt (g)/ 5 plants	Nodule wt/ 5 plants	Pods/ plants	Pod yield (kg/ha)
1	BG-3	8.39	59.73	22.5	82.5	8.73	181.49	1.04	18.5	709
2	NRCG-1308	8.25	56.05	26.0	181.0	9.08	166.58	1.02	25.0	1796
3	GG-20	8.22	69.14	20.5	87.5	5.05	184.63	0.79	17.5	664
4	GG-2	9.08	40.84	16.0	98.5	4.46	61.35	0.45	15.5	729
5	FeESG-8	9.10	54.285	22.0	139.0	6.10	89.37	1.06	25.5	1062
6	M-13	10.33	57.27	34.5	104.0	8.72	165.81	0.61	18.5	732
7	GG-7	8.34	51.42	22.0	140.5	7.43	109.45	0.83	21.0	1236
8	NRCG-3498	7.98	54.95	17.5	119.5	5.02	87.85	0.60	19.0	1013
9	ICGV-86590	9.10	55.92	18.0	96.0	6.89	114.94	0.57	13.5	813
10	FeESG-10-1	9.55	50.46	13.5	70.0	4.20	59.07	0.72	12.5	586
11	ICGS-76	8.14	48.71	16.5	109.0	5.19	87.00	0.67	19.0	1185
12	NRCG-7472	9.36	61.35	19.5	133.0	7.89	144.09	1.43	12.0	622
13	TKG-19A	7.75	50.77	24.0	91.0	5.81	98.77	0.63	27.0	1117
14	NRCG-7599	10.84	58.89	22.0	199.0	5.97	99.66	0.95	17.5	1853
15	NRCG-6155	9.30	51.7	27.0	162.0	7.61	82.81	1.50	20.5	1023
16	JI-24	10.60	70.49	31.0	209.0	10.21	102.07	1.21	27.5	1450
17	SEm ±	0.84	3.61	2.66	29.34	1.34	32.04	0.18	3.98	239
18	CD (0.05)	2.53	10.88	8.01	ns	Ns	ns	0.53	ns	71.3

Table 2. Yield and yield parameters of Groundnut grown in Tripura

Variety	Pod yield (kg/ha)	Haulm yield (q/ha)	100-pod weight (g)	100-seed weight (g)
SG 84	1239	1943	107	27
VRI 3	1466	2220	90	25
M 13	1554	4995	185	26
JSP 19	1243	5217	115	31
TAG 24	1610	3330	110	27
NRCG 162	1582	3996	90	27
Fe ESG 8	1366	2498	83	29
NRCG 4659	1688	3885	167	18

NRCG 5513	1616	3663	72	24
NRCG 6131	1038	4107	104	35
PKVG 8	1844	2886	96	28
NRCG 7599	1988	6383	143	40
NRCG 7206	1588	3774	85	28
NRCG 6820	1655	2775	67	23
NRCG 6450	1788	4995	96	29
NRCG 6155	1782	3719	170	42
JL 24 (check)	1238	3441	80	29

Table 3. Evaluation of confectionary groundnut genotypes in Mizorum

Sl No.	Varieties	Plant Height (cm)	Branches/ plant	Pods/ plant	Pod Yield (kg/ha)	Kernel Yield (kg/ha)	Shelling (%)
1	ICGV 86590	84.00	6.00	31.33	2462	1592	64.66
2	GG 20	75.66	10.33	26.66	2037	1265	62.10
3	ICGS 76	59.33	10.66	33.00	2314	1481	64.00
4	GG 7	54.66	8.33	27.33	2037	1209	59.35
5	TKG 19 A	68.33	7.66	24.66	2129	1450	68.10
6	CSMG 84-1	55.66	11.33	37.33	2500	1500	60.00
7	TPG 41	48.33	7.00	17.66	1698	1080	63.60
8	M 13	61.33	10.66	31.66	2592	1760	67.90
CD (P=0.05)		5.72	1.36	5.23	2.72	2.00	

Screening and evaluation of germplasm lines

A set of 100 groundnut germplasm lines were grown from 2004 onward in acid soils having nearly pH 5.0, under fertilized (50 kg/ha P + 2500 kg/ha lime) and unfertilized (control) conditions and assessed for pod yield and their tolerance of Al and Fe toxicities, Ca and P deficiencies at the hot spots identified for screening for soil acidity and Al-toxicity (foot hill upland of ICAR Res. Complex, Mizorum) and at Lembucherra (Tripura). The tolerant genotypes identified were NRCG 11860, 5422, 11881, 7492, 7109 7175, 7007 5513, 6820, 4659, 3498 and 7734.

Also the performance of 100 genotypes was evaluated during Rabi season under polythene mulch as well as under control conditions at Barapani where the grounnut genotypes NRCG 7325, 7244, 6820, 3892, 162, 7599 and ICGV 96333 performed well under cold season.

Integrated nutrient management in groundnut

The organic and inorganic nutrients (P, Ca, K, Mo and B) and biofertilizers, PSM and PGPR (PPB) were compared through field experiments on groundnut production in acid soils.

PGPR enhanced the pod yield to 1667 kg/ha as against 1369 kg/ha in control in Tripura. Application of P and K50 along with PGPR caused 1964 kg/ha yield which was highest and 43% more than the control. At Barapani, during Rabi season under polythene mulch, the PGPR 4 was found beneficial and increased yield with groundnut variety ICGS 76, however, the pronounced effect was not observed (Table 4).

Table 4. PGPR trial of groundnut variety ICGS 76 at barapani during pre-rabi season under polythene mulch

Treatments	Pod yield (kg/ha)
T1= PGPR-4	1300
T2= PGPR-4+ RDF (20:60:40 NPK kg/ha)	1310
T3= RDF (20:60:40 NPK kg/ha)	1310
T4= PGPR-2	1200
T5= PGPR-2+ RDF (20:60:40 NPK kg/ha)	1380
T6= Control	1140
CD	NS

Experiment on organic farming

As groundnut cultivation is new in NEH region, various organic farming approaches were tested where organic fertilizers always showed its superiority over inorganic one. The FYM (at 10 t/ha) alone was the best for highly eroded soils of NEH region and helped in alleviating Al-toxicity (Table 5).

Table 5. Response of different organic manures on groundnut Variety ICGS 76 at Kolasib

Sl No.	Treatments	Plant Height (cm)	Branches/ plant	Pods/ plant	Pod Yield (kg/ha)	Kernel Yield (kg/ha)	Shelling (%)	Test weight (g)
1	Control	44.33	5.33	13.00	1030	592	57.39	50.78
2	N30P50K40 + Lime 2.5 t/ha	60.33	13.66	35.66	2345	1413	60.30	53.26
3	FYM, 10 t/ha	65.00	11.66	32.33	2237	1382	61.78	55.20
4	Neem cake, 500 kg/ha	52.00	8.66	25.66	1697	1033	60.81	53.50
5	Pig slurry, 10 t/ha	57.66	10.00	30.33	1805	1095	60.57	53.13
6	Biofertilizers PSM+PGPR	49.33	6.33	19.00	1188	740	62.32	55.80
7	Vermicompost, 5 t/ha	59.00	13.33	33.66	2191	1345	61.40	53.33
8	Poultry manure	55.66	10.33	31.66	2083	1280	61.52	55.83
9	VAM alone	52.66	7.33	24.00	1481	935	63.07	56.73
CD (P=0.05)		4.53	1.77	4.45	169	111	1.62	1.31

In Mizorum the biofertilizers containing PSM+PGPR increased 25% kernel yield, whereas the VAM alone increased 58% kernel yield. The Neem cake (500 kg/ha), Pig slurry (10 t/ha), vermi-compost (5 t/ha) and poultry manure could increase 75, 85, 127 and 116% kernel yield, respectively as against 133% increase due to FYM application. In Tripura, the promising organic sources in descending order were

cowdung (10t/ha), compost, mustard oil cake (1 t/ha), and *Gliricidia* green leaf. The green leaf of *Gliricidia* and subabul also showed residual effect.

Nutrient management in bold seeded groundnut

Groundnut expresses its full genetic potential in NE region, where water is not a limiting factor and hence NEH has a lot of potential area for growing confectionary groundnut. However, there are reports that when planted in highly leached acid soils there is no proper kernel formation. Thus, to be ready with the consequences, experiments are being conducted to study the nutrient management in large-seeded groundnut with various combinations of nutrients.

It was observed that in acid soils of NEH region application of P and lime is essential as P50 and Lime 2.5 t/ha increased 28% and 48% seed yield (Table 6). The role of B was also noticed. In Mizoram application of P50+K100+Lime 2.5 t/ha+FYM (10t/ha) showed maximum pod yield of 2114 kg/ha as against 996 kg/ha in control. The next highest yield of 1913 kg/ha was obtained with P50+K100+Borax.

At Barapani, two years of experimentation showed that, in general the bold seed groundnut showed high yield and highest pod yield was recorded with N20 + P50 + K100 + Lime (2.5 t/ha) + FYM (10 t/ha) (3244 and 3302 kg/ha, respectively) which was significantly superior over all the treatments. Here also the next highest yield was obtained with N20 + P50 + K100 + Lime + Borax. Thus, it is essential to fertilize the large-seeded groundnut with essential elements.

Table 6. Nutrition of large-seeded groundnut variety GG 7 at Kolasib

Sl No.	Treatments	Plant Height (cm)	Branches/ plant	Pods/ plant	Pod Yield (kg/ha)	Kernel Yield (kg/ha)	Shelling (%)
1	Control	38	4.50	19	996	577	56
2	P50	50	5.83	23	1153	740	64
3	K100	48	5.00	21	1129	688	61
4	Lime 2.5 t/ha	46	5.50	26	1314	851	65
5	P50+Lime2.5 t/ha	53	6.66	31	1574	1033	66
6	P50+K100+Lime 2.5t /ha	58	6.50	36	1688	1067	63
7	P50+K100+Borax	60	6.33	39	1913	1203	63
8	P50+K100+Lime 2.5 t/ha+ FYM 10t /ha	62	6.83	44	2114	1333	63
	CD (P=0.05)	3.91	0.65	3.69	1.50	0.82	

Basic studies on Al-toxicity at NRCG

Screening of groundnut genotypes

Fifty-five groundnut genotypes were screened for their tolerance of Al-toxicity where most of the groundnut genotypes tolerated 1000 µM of Al (as $AlCl^3$) till 25-30 days after sowing (DAS), but later on Al-toxicity symptoms on roots and subsequently on plant growth were noticed causing reduction in growth and yields. Based on these parameters and relative performance of the genotypes under normal and Al-stress conditions, the genotypes ICG 11882, GG 3 and NRCG 1038, 3498 and, 6919 showed comparatively more tolerance than others.

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

Bradyrhizobium and PSM cultures isolated from the acidic soils showed good solubilisation of Tricalcium phosphate. However, these material will be shared with scientist working on acid soils. These two phosphate solublising bacteria (one fluorescent and another non-fluorescent Pseudomonas) showed good solubilisation of tricalcium phosphate.

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

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

Acquisition of germplasm

The working collection was enriched by assembling 31 accessions from various sources. These accessions included nine wild *Arachis* species; germplasm submitted for registration from BARC (2), UAS, Dharwad (3) and JAU, Junagadh (2); 13 genotypes collected through a local exploration undertaken to collect farmers' varieties from Junagadh and Jamnagar areas; and landraces collected through NBPGR, Ranchi station.

Supply of germplasm

To support the ongoing research programmes, a total of 1362 accessions were supplied to 24 indenters from NRCG, other ICAR Institutes and State Agricultural Universities. This included wild *Arachis* species, released varieties and a few high yielding and promising accessions.

Multiplication of germplasm for conservation

Being one of the National Active Germplasm Sites (NAGS), one set has to be deposited in National genebank for long-term conservation after regenerating sufficient quantity of seeds. Hence, multiplication of 713 accessions of working collection was undertaken, which included repatriation material from ICRISAT, exotic accessions and accessions kept in MTS that are yet to be deposited. Sufficient quantity of seed was regenerated in 322 accessions and these were deposited in National genebank at NBPGR, New Delhi. This included 18 wild *Arachis* species also. About 1900 accessions were processed for conservation in MTS at the centre.

Characterization of germplasm

Characterization of released varieties under DUS programme

During summer season, 116 released varieties (VUL: 59, FST: 4, HYB: 28 and HYR: 25) were grown for confirmation of National Test Guidelines (NTG). These varieties were also scored for other agronomic traits to assess the performance during the summer season. The test guidelines developed for 20 traits were confirmed. The collection showed significant difference for most of the traits. The expression was poor in varieties belonging to var. *hypogaea*. The mean, range and test of significance for some selected traits are given in Table 1.

Characterization of released varieties

During *kharif* season, 120 released varieties of all four habit groups (VUL: 60, FST: 4, HYB: 32 and HYR: 24) were sown in a Randomized Block Design with three replications with a row length of 5m. The varieties were characterized for 19 qualitative and 27 quantitative traits. Observations on four randomly selected plants were recorded for leaflet length and width, length of main axis and primary branch, number of primary and secondary branches, number of immature and mature pods etc. The varieties were

also confirmed for their traits as per DUS test guidelines. Some of the varieties with distinguishing traits that will help in identification are given in Table 2. The quantitative traits showed significant differences (Table 3). The C.V. values were higher for number of mature pods, one and three seeded pods, and pod weight/plant. Among the released varieties the yield performance of ICGS 5, LGN 2, M 145, MA 16, GAUG 10 and GG 11 was better compared to other varieties, and the yield/m² ranged from 175.1 to 219.5 g.

Mini-core collection

During *kharif* season, 184 groundnut accessions (VUL: 64, FST: 38, HYB: 42, and HYR: 40) received from ICRISAT under mini-core trials programme were sown with respective controls *viz.*, GG 2, JL 24, Gangapuri, MH 2, GAUG 10, M 13, GG 20 and Kadiri 3. The collection was characterized for 19 qualitative and 27 quantitative traits. Randomly selected four plant observations on leaflet length-width, length of main axis, numbers of primary-secondary branches, and numbers of immature-mature pods were recorded.

The same set was evaluated at Oilseeds Research Station, Jalgaon for most of these traits and the qualitative traits showed variability for most of the traits representing all notes of variability. High variation as indicated by higher C.V. was recorded for pod yield and 100-seed mass at Junagadh, whereas at Jalgaon variation was reported for other traits also like seed length in addition to the traits reported at Junagadh (Table 4).

Variability museum

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

High-oil lines

Twenty-two germplasm accessions identified as high oil lines during previous season were grown for further confirmation of the findings. The oil content analyzed showed a range of 48.0-53.0%. The accessions that recorded above 52% oil in the kernels were NRCG 11918, 6677, 4781, 13126 and 13167, and GG 20.

Evaluation of large seeded accessions

Thirty-two accessions belonging to all the habit groups (HYB: 17, HYR: 10, VUL: 4 and FST: 1) were evaluated for second year to identify promising accessions. High pod yield was recorded in NRCG 988, 10081, 10089 and 12133, which ranged from 123.0 to 144.1 g/m². The accessions NRCG 5405 (VUL), 9036 (HYB), 12074 (HYB) and 12157 (HYB) recorded 100-seed mass above 50 g and mean values ranged from 51.1 to 55.9 g. The mean values and range for some of the traits are given in Table 5. The trial will be discontinued, as the 100-seed mass was too low.

Screening of wild *Arachis* species for salinity tolerance

Fifteen accessions of seed bearing wild *Arachis* species were screened for salinity tolerance in pots with three replications during summer season. Three levels of salinity treatment (8, 12 and 16 dS/m) were used and germination per cent was recorded after 15 days of sowing. Twelve accessions germinated at 8 dS/m salinity recording a maximum of 67% germination in NRCG 11800 (*A. monticola*), NRCG 12031 (*A. batizogaea*) and NRCG 11806 (*A. duranensis*). Only eight accessions could germinate under

12 dS/m salinity level recording maximum germination percent of 33% in NRCG 11800 (*A. monticola*) and NRCG 11789 (*A. monticola*). At 16 dS/m salinity none of the accessions could germinate indicating that the level may be lethal.

Maintenance of Wild *Arachis* Species

Ninety-six accessions representing five sections *viz.*, *Procumbentes* (06), *Erectoides* (04), *Arachis* (49), *Heteranthae* (02) and *Rhizomatosae* (35) were maintained. Out of 60 wild *Arachis* accessions received from ICRISAT, 15 new accessions were sown but only seven could survive. The harvesting of about 38 accessions was carried out. The shelling percentage, 100-seed mass and sound mature kernel percentage were also recorded in the accessions having sufficient quantity of seeds. The available collection is as under:

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

Present status of germplasm

The present status of germplasm available at NRCG and NBPGR, New Delhi is as follows.

Place of storage	Status	No. of accessions
NRCG, Junagadh	Working collection	8934
-do-	Wild *Arachis* species	96
NBPGR, New Delhi	Base collection	6833

Documentation

The data generated on all germplasm accessions grown during *kharif* season have been documented using the fox-base programme. A database of conserved accessions in MTS was also prepared for easy retrieval of the accessions.

Development of Genetic Resources Information System (GRIS)

The information generated on 775 accessions characterized in *kharif* 1998 and 525 accessions in *kharif* 1999 has been reoriented using MySQL database server. Various types of searches have been developed based on identity like NRCG, ICG, habit, country and variety.

Number of Mature Pods	2.13	15.00	6.73	21.591**	0.55
One Seeded Pods (%)	11.67	55.20	29.45	153.122**	1.75
Two Seeded Pods (%)	33.00	88.33	67.84	279.994**	1.76
Three Seeded Pods (%)	0.00	44.97	2.70	155.592**	0.50
Pod Length (mm)	19.67	35.50	25.56	19.599**	0.36
Pod Width (mm)	10.67	14.90	12.11	2.828**	0.16
Seed Length (mm)	9.83	18.23	13.03	8.642**	0.20
Seed Width (mm)	6.27	9.40	7.66	1.192**	0.14
100-Pod Weight (g)	60.17	145.70	88.54	893.743**	3.11
Shelling Percentage (%)	51.60	74.17	65.82	64.569**	1.09
Sound Mature Kernels (%)	63.23	93.00	83.33	85.360**	1.66
100-Seed Weight (g)	30.20	60.53	41.30	151.092**	1.11
Pod yield/m^2 (g)	4.77	173.90	58.99	4889.802**	5.26
Pod yield/Plant (g)	1.33	27.60	10.15	72.422**	1.02

Table 2. Distinguishing features of some released varieties

Name of Variety	Distinguishing characteristics
Chitra and CSMG 84-1 (HYR)	Seed colour variegated (Salmon + white)
Kaushal (G 201) (HYB)	Flower on main stem, thick shell
Tirupati 3 (HYB)	Red testa colour
ALR 1 (VUL)	Dark red testa colour
BAU 13 (HYB)	Bold pods with red testa colour and thick shell
DRG 12 (HYB)	Pods like spanish culture
M 145 (HYB)	Red testa colour
RS 138 (HYB)	Red testa colour
RSB 87 (HYB)	Red testa colour
TMV 10 (HYB)	Variegated testa colour
OG 52-1 (VUL)	Red testa colour
Gangapuri (FST)	Red two to three seeded, smooth pods
ICGV 86590 (VUL)	Two to three seeded, Medium BCR
MH 2 and MH 4 (FST)	Dwarf mutant type plant
DH 3-30 (VUL)	Very small pods with light reticulation, thick shell
Girnar 1 (VUL)	Two to three seeded pods with medium beak

Table 1. Variation in quantitative traits among 116 released varieties

Traits	Min	Max	Mean	MSS	CD (5%)
Days to Maturity	114.00	141.00	126.30	348.735**	0.30
Number of Immature Pods	1.00	6.33	2.99	2.782**	0.22
ICG (FDRS) 4 (VUL)	Elongated rachis, high reticulation, thick shell				
JL 24 (VUL)	Smooth pods greener large leaflets				
TG 26 (VUL)	Two to three seeded, smooth pods				
TKG 19 A (VUL)	Medium bold pods, thick shell, dark green leaves				
ALR 2 (VUL)	Dark green waxy type leaves, late maturity				
Somnath (HYB)	Flower on main axis, less leaves				
GG 2 (VUL)	Thicker and green leaves				

Table 3. Variability for various traits in released varieties

Traits	Min	Max	Mean	MSS	CD (5%)	CV (%)
DFF	17.67	26.67	21.17	11.66**	1.48	5.21
LLL	4.27	6.47	5.24	0.60**	0.56	7.92
LLW	1.87	2.77	2.25	0.14**	0.29	9.45
LWR	2.03	2.77	2.33	0.06**	0.21	6.65
NMP	3.43	17.13	9.48	18.19**	3.80	29.92
DTM	106.67	127.67	115.75	170.74**	2.77	1.79
OSP	4.83	41.93	14.26	135.78**	8.22	43.03
TSP	33.73	94.27	81.17	425.60**	9.45	8.69
THP	0.00	59.37	4.55	351.98**	7.96	130.52
PDL	18.67	34.83	25.09	37.43**	2.57	7.64
PDW	9.33	16.83	11.55	4.03**	0.92	5.94
SDL	9.50	17.17	12.45	8.14**	1.28	7.68
SDW	5.67	8.50	6.88	0.89**	0.80	8.65
HPW	50.93	130.40	80.68	821.01**	14.46	13.38
SHE	55.27	72.10	64.07	52.00**	5.87	6.85
SMK	74.27	96.77	90.11	48.79**	5.25	4.35
HSW	22.13	57.87	34.74	158.81**	7.76	16.67
PPMT	33.33	219.47	105.58	4522.12**	34.73	24.56
PYP	3.33	50.60	11.33	70.58*	9.74	64.18
DRYWT	7.17	46.08	21.33	177.90**	8.62	30.17

[DFF: days to 50% flowering; LLL: leaflet length; LLW: leaflet width; LWR: length-width ratio; NMP: no. of mature pods; DTM: days to maturity; OSP: one seeded pods; TSP: two seeded pods; THP: three seeded pods; PDL: pod length; PDW: pod width; SDL: seed length; SDW: seed width; HPW: 100-pod weight; SHE: shelling outturn; SMK: sound mature kernels; HSW: 100-seed weight; PPMT: pod yield/ m^2; PYP: pod yield/plant; DRYWT: dry weight]

Table 4. Variation in germplasm accessions for 11 agronomic traits at two locations

Trait	Junagadh				Jalgaon			
	Min	Max	Mean	CV (%)	Min	Max	Mean	CV (%)
Days to 50 % flowering	21.0	29.0	22.9	6.1	27.0	38.0	30.1	5.1
Days to maturity	106.0	139.0	121.0	8.9	112.0	131.0	117.0	3.2
Pod yield/plant (g)	1.0	21.8	7.5	57.0	2.8	13.0	6.0	34.7
Pod yield/m^2 (g)	32.0	185.0	83.0	40.0	47.0	217.0	100.0	34.7
Pod length (mm)	17.0	44.5	26.8	17.7	17.0	47.0	28.5	19.3
Pod width (mm)	8.0	17.0	11.9	11.6	7.0	19.0	12.1	14.4
Seed length (mm)	8.0	19.0	12.7	16.7	7.0	20.0	13.8	20.6
Seed width (mm)	5.0	8.5	6.9	9.7	5.0	11.0	6.6	15.8
Shelling outturn (%)	52.1	82.4	63.3	8.7	55.3	72.0	64.5	4.9
SMK (%)	50.0	98.4	87.8	9.1	76.0	95.0	87.6	3.7
100-seed weight (g)	15.0	58.4	32.8	26.7	16.8	60.0	29.9	19.6

Table 5. Range of variability in large seeded collection

Traits	Min	Max	Mean	MS	CD (5%)	CV (%)
Days to maturity	118.00	132.00	127.06	65.63**	3.30	1.15
Shelling percentage (%)	51.07	71.57	63.48	55.00**	4.44	5.17
Sound mature kernel (%)	64.47	90.93	81.78	61.64*	NS	6.97
Pod yield/m^2	34.10	144.10	85.20	2309.87**	29.78	25.83
Pod yield/plant	1.90	13.13	7.74	19.06**	3.05	29.16
100-seed weight (g)	24.00	55.93	39.04	168.32**	6.91	13.08

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

(RADHAKRISHNAN T., LUKE RATHNAKUMAR, CHUNILAL, S.K. BERA, T.V. PRASAD, HARIPRASANNA AND VINODKUMAR)

Hybridization:

Four interspecific F1 and one F2 hybrids (table 1) were back crossed with cultivar GG 2 to evelop BC1F1 populations during rainy season under field condition. The probable cross pods would be own for isolation of true hybrids and use in further back crossing for developing BC2F1 progeny. Simi-larly, six different wild species have been used as pollen parent for hybridization with *Arachis hypogaea* (cv. J 11) during rainy season under field condition. The probable cross pods from six direct crosses have been sown in the field during summer season. Maximum success (6.1%) have been achieved in J11/ *A. pusilla* followed by J11/ *A. kretschmeri* (3.9%) and J11/ *A. monticola* (1.1%). The F1 Hybrids are being maintained in the field for pod setting, characterization and use in back crossing. Besides, three other crosses viz Puckered/ crinkle, OG 52-1/ CS 19 and ICGV 86590/ CS 19 have been made for use in vitro anther culture and introgression of stem rot resistance.

Table 1 Hybridization undertaken during rainy season in the field

Cross combination	No. of pollination	No. of pod	No. of kernels	No. of Hybrids
Back cross (BC_1)				**(BC_1F_1)**
GG2 // (J11 / *A.duranansis*) F2	845	310		Will be
GG2 // (J11 / *A. kretschmeri*) F1	840	375		sown during
GG2 // (J11 / *corentina*) F1	790	375		ensuing
GG2 // (J11 / *A. kemf-marcadoi*) F1	816	315		rainy season
GG2 // (J11 / *A. stenosperma*) F1	796	285		
Direct Cross				**F_1**
J11 // *A. diogoi* (NRCG11781)	634	300	450	6 (0.9%)
J11 // *A. batizocoi* (NRCG 12030)	598	353	510	22 (3.7%)
J11 // *A. monticola* (NRCG 11800)	699	280	430	8 (1.1%)
J11 // *A. pusilla* (ICG 8131)	672	360	370	41 (6.1%)
J11 // *A. kretschmeri* (NRCG 12029)	712	340	520	28 (3.9%)
J11 // *A. rigoni* (NRCG 12032)	737	150	570	0
Other cross				
OG 52-1 // NRCG CS 19	257	155	290	59 (23%)
ICGV 86590 // NRCG CS 19	473	250	404	57 (12%)
Pucard // Crincle	691	200	300	27 (3.9%)

Advancement of segregating lines

Eighty-six progeny lines comprising BC1F1, F2, F3 and F4 generations from eleven cross have been sown during rainy season for further selection(table 2). Seventy one bulk and forty one single plant progenies have been selected on the basis of desirable agronomic traits.

Table 2 Advancement of segregating materials

	Pedgree	Generation	Lines sown	Lines selected	
				Bulk	Single plant
1	J 11 // *A. duranansis*	F4	29	23	32
2	6X of *A.hypogaea/ A. cardinasii*	F4	1	-	1
3	VRI 4/ *A.correntina*	F4	3	-	3
4	J11/ *A.oteroi*	F2	1	-	1
5	J11/ *A.appresippilla*	F4	1	-	1
6	J11/ *A.diogoi*	F3	1	-	1
7	J11/ *A.helodes*	F2	1	-	1
8	J11/ *A.duranansis*	F3	1	-	1
9	J 11/ *A. kretschmeri*	F2	13	13	-
10	J 11/ *A. kretschmeri// GG 2*	BC1F1	5	5	-
11	J11/ *A.duranansis*// GG 2	BC1F1	30	30	-
	Total		**86**	**71**	**41**

Screening of wild *Arachis* species against stem rot.

The screening of twenty-five seed bearing wild *Arachis* accessions against *Sclerotium rolfsii* was repeated during rainy season. Twenty-five accessions of wild *Arachis* species were sown in earthen pots. Each accession had been sown in three replications. Five seeds were sown in each replication totaling fifteen seeds for each accession. Artificial inoculation was done on soil surface on 45 days after germination. Final plant count and pod infection were recorded at harvest and expressed in seedling mortality % and pod infection % (table 3). Accession Nos. NRCG12035, NRCG12047, NRCG11785, NRCG11795 and NRCG11786 recorded less than 30% seedling mortality and pod infection. However, the pooled observations over two seasons (2004 &2005) confirmed less than 30% seedling mortality and pod infection percent in accessions Nos. NRCG12035, NRCG12047, NRCG11789, NRCG11805 and NRCG11786. These wild *Arachis* accessions may be resistant/tolerant against *S. rolfsii* and would be further confirmed by seedling mortality testing under laboratory condition and as well as molecular polymorphism.

Table 3 Screening of wild *Arachis* species against *S. rolfsii*

Acc. No.	Species	Kh-05		Mean over-04 & 05	
		Mort (%)	pod inf.(%)	Mort.(%)	Pod inf.(%)
12035	*A. appressipila*	**28.6**(7)	14.1(85)	14.3	7.98
11789	*A. monticola*	50.0(14)	16.7(102)	25.0	9.40
12047	*A. pusilla*	**26.7**(15)	17.7(186)	13.3	9.59
11785	*A. appressipila*	**22.2**(9)	17.6(68)	50.4	13.82
12031	*A. batizogaea*	55.6(9)	0.0(11)	45.6	3.65
12029	*A. kretschmeri*	62.5(8)	37.5(8)	71.3	23.30
11800	*A. monticola*	75.0(16)	11.4(35)	40.4	7.61
12032	*A. rigoni*	35.3(17)	11.9(101)	39.1	7.39
12042	*A. paraguariensis*	92.9(14)	NB	87.3	4.75
11793	*A. paraguariensis*	40.0(10)	40.7(27)	46.7	21.62
11792	*A. duranensis*	100.0(6)	NB	100.0	0.00
11810	*A. batizocoi*	100.0(1)	NB	100.0	0.00
11811	*A. stenophylla*	50.0(2)	NB	70.5	5.00
12045	*A. duranensis*	45.5(11)	14.1(64)	69.8	7.03
12057	*A. helodes*	100.0(1)	NB	87.5	11.10
12043	*A. duranensis*	64.7(17)	12.0(108)	75.7	7.02
11794	*A. vilosa*	66.7(6)	23.3(30)	68.3	11.67
11806	*A. duranensis*	50.0(16)	15.8(38)	60.3	10.29
11802	*A. duranensis*	100.0(15)	21.6(37)	77.8	17.06
12038	*A. duranensis*	62.5(16)	15.6(32)	77.9	11.26
11805	*A. duranensis*	43.8(16)	5.8(86)	**26.0**	4.66
11795	*A. rigonii*	**0.0**(3)	26.2(42)	46.2	16.25
12030	*A. batizocoi*	100.0(1)	0.0(4)	70.0	0.00
11801	*A. duranensis*	100.0(4)	0.0(4)	89.3	7.70
11786	*A. appressipila*	**11.1**(9)	11.5(200)	**28.6**	6.35
Mean		59.31	12.55	59.3	8.9
SE		6.1	2.2	5.2	1.2

Figure in parenthesis indicates the number of plants and seeds available

Induction of variability through chemical mutagenesis:

Seeds of cv.GG 2 was treated with three chemical mutagens (Ethyle methane sulphonate, Colchicine and Chloramphenicol). Hundred seeds for each treatment had been treated with different doses (0.3%,0.4%,0.5%,0.6% and 0.7%) of three chemical mutagens. Treated seeds were sown in the field and advanced upto M4 generation in bulk. There was no germination in the treatment of EMS 0.7%. M4 bulk progeny of 14 (table 4) treatments along with control had been sown during rainy season. Single plant were harvested on the basis of desirable agronomic traits. Treatment with EMS and Chloramphenicol showed maximum variability for pod yield/pl. The variability estimates for different treatment revealed significant increase of pod yield/plant over control in EMS(0.3%), EMS(0.5%),

CHL(0.6%) and CHL(0.7%). The selected single plant progeny would be advanced further for higher pod yield.

Table 4 Variability estimates for pod yield/plant of cv. GG 2 in M4 generation

Treatment	No. of sel.	Mean pod yield/pl.	Range	SE
EMS(0.3%)	16	13.31	2.0-23.0	1.7
EMS(0.4%)	11	9.36	1.0-22.0	1.9
EMS(0.5%)	4	14.0	5.0-28.0	5.0
EMS(0.6%)	14	7.43	1.0-14.0	0.91
COL(0.4%)	2	4.0	4.0-4.0	1.0
COL(0.7%)	2	8.0	5.0-11.0	3.0
CHL(0.3%)	21	7.24	1.0-25.0	1.31
CHL(0.4%)	11	7.73	1.0-19.0	1.83
CHL(0.5%)	2	3.5	3.0-4.0	0.5
CHL(0.6%)	15	15.33	8.4-24.0	1.27
CHL(0.7%)	12	10.83	4.0-23.0	1.7
Control	10	8.5	5.6-15.0	1.65

One hundred and ten selected lines along with GG 2 were re-evaluated for yield and its related traits during rabi/ summer season. Biological yield/pl. responded maximum towards positive side from 36.0g in cv. GG 2 to 62.8g in population mean with a range of 118.7g to 25.2g. However, this increase in B among selected population was due to increase in plant biomass rather pod yield/pl. which, in turn may help to increase fodder yield in groundnut rather increase in pod yield/pl.. Harvest Index and shelling percent also decreased due to increase of fodder biomass with out increasing economic yield. The wide range in all characters indicated that transgressive segregations exists in the population for individual and or multiple traits and variability may be exploited.

Table 5 Variability estimates for six characters in M5 generation

	Pl.wt./pl(g)	Pod wt/pl(g)	BY(g)	kernel wt./pl(g)	HI%	Shelling%
Range	92.0-13.6	36-7.6	118.7-25.2	25.48-5.0	38.2-6.6	81.1-46.0
Mean	41.8	21.0	62.8	13.6	22.3	64.8
SE	1.4	0.5	1.7	0.4	0.6	0.7
Check	18.0	18.0	36.0	12.8	35.6	71.1

Introgression of stem rot resistance to cultivated groundnut:

NRCGCS 19, a stem rot resistant line was crossed in reciprocal with GG 20, a susceptible cultivar to introgress stem rot resistance from NRCGCS 19. Crossing was done during rainy season under field condition. Total of 394 F1 single plants were harvested. The progeny lines would be screened under artificially inoculated field condition. Molecular analysis would be conducted in selected progeny lines for identification of marker

Evaluation of selected advanced lines for yield and related traits

Twenty nine selected advanced lines along with check had been sown in RBD with three replications during rainy season. Observations were recorded from 10 plant samples for different agronomic traits at harvest (table 6). Eleven genotypes registered significantly higher pod yield /plant over check. CS135 showed highest pod yield per plant followed by CS229, CS148, DRPV18 and CS158. Among these genotypes, CS148 recorded high shelling % and HKM. Similarly, genotypes CS158, DRPV17 and DRPV 18 also recorded higher shelling % along with pod yield than check.

Table 6 Evaluation of selected advanced lines

Genotypes	PW/pl (g)	KW/pl (g)	Shelling %	HI(%)	HKM
CS 36	12.2	8.6	70.3	21.0	29.1
CS 135	**17.5**	11.2	63.9	27.6	33.1
CS 148	**13.9**	10.2	**73.5**	21.7	**48.7**
CS 158	**13.8**	9.4	**68.1**	25.9	31.0
CS 163	13.4	8.9	66.3	17.8	38.2
CS 170	13.4	8.3	62.2	21.5	43.9
CS 200	12.6	7.1	56.3	13.4	26.3
CS 221	12.3	7.8	63.8	16.6	41.9
CS 229	**15.1**	9.8	64.7	21.1	34.7
DRPV 17	13.1	8.8	**67.7**	28.0	**50.1**
DRPV 18	**13.9**	9.7	**69.3**	25.8	31.8
GG 20	14.4	9.7	67.5	19.5	43.9
Mean	11.4	7.4	64.8	19.8	34.0
SE	0.5	0.3	0.9	0.8	1.2

Initial evaluation of advanced breeding lines:

One hundred and twenty advanced breeding lines along with five checks have been evaluated in the field during rainy season. The experiment was conducted in augmented design with five blocks. Twenty four breeding lines and five checks were sown in each block. Each genotype was sown in two lines of three meters bed. Observation on yield and its related traits were recorded at harvest (table 7). Seventeen genotypes recorded higher pod yield per plant than elite check GG 20. CS 281 recorded highest pod yield per plant as well as highest shelling % and HKM. Besides, CS 239, 241 242, 252 and 263 also recorded significantly higher pod yield per plant along with at per shelling % and HKM. However, none of the genotypes could able to register higher HI% than elite check TAG 24. Genotypes CS264, CS266 and CS268 though recorded moderately higher pod yield per plant than check but their HKM was considerably higher and may be considered as large seeded genotypes.

Table 7 Evaluation of Advanced breeding lines

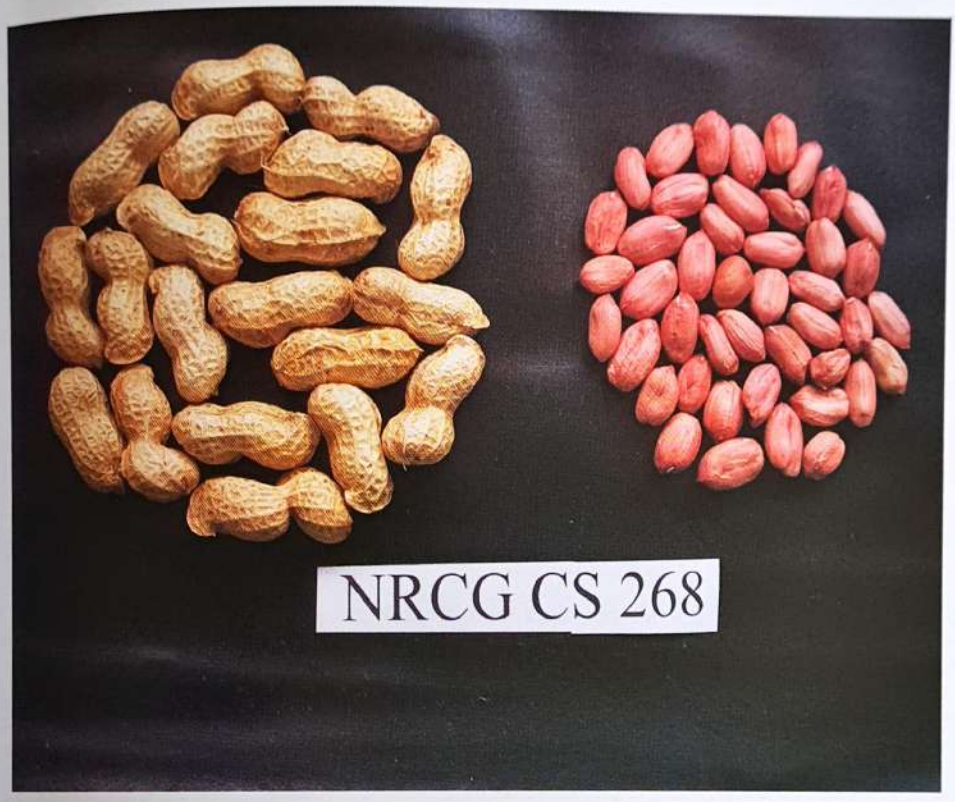
Genotype	Pod yield/p(g.)	Shelling (%)	HKM (g.)	HI (%)
CS 239	15.1	48.1	31.4	16.2
CS 241	16.2	53.9	41.2	16.5
CS 242	16	58.3	34.5	20.7
CS 245	13.8	58.0	31.5	18.5
CS 246	11.7	62.0	40.5	20.6
CS 249	13	37.9	33.7	10.0
CS 252	14	36.5	40.6	11.5
CS 253	12.9	64.3	42.2	21.9
CS 263	14.1	61.5	36.5	21.0
CS 264	12	62.3	**50.7**	24.4
CS 266	12.6	59.1	**48.5**	22.0
CS 268	12.6	61.8	**61.2**	19.9
CS 270	12.7	50.0	35.1	16.5
CS 274	13.8	62.1	34.5	19.4
CS 280	13.7	56.3	36.5	17.4
CS 281	**16.7**	**70.0**	**65.5**	20.5
CS 296	14	62.7	27.3	21.2
TKG 19 A	14.4	52.4	**49.0**	23.45
GG 20	**11.1**	61.6	40.7	22.02
GG 2	7.7	**61.7**	31.2	27.10
JL 24	8.0	57.2	34.5	22.72
TAG 24	8.6	53.4	34.1	**28.09**
Mean	12.9	56.9	40.0	20.1
SE	0.5	1.7	2.1	0.9

The same set of 120 advanced cultures was repeated during Rabi/Summer season along with five checks. NRCGCSs237, 240, 241, 242, 251, 259, 268, 281, 287, 289, 291, 296, 297, 312, 322 and 347 recorded higher pod yield per plant and genotypes NRCGCS 240, 248, 265, 268, 270, 281, 287, 302, 306, 315, 332, 336, 342, 345, 346 and 350 recorded higher shelling percent than best check.. Higher sound matured kernel(SMK) % was recorded than check in forty nine genotypes. Seven advanced lines viz, NRCGCSs 255, 268, 269, 281, 283, 285 and 313 recorded higher HKM than check value. However, NRCGCSs 268 and 281 recorded higher pod yield/pl, higher shelling%, higher SMK% and Higher HKM% than check while, NRCGCS 287 recorded higher pod yield/pl., higher shelling % and higher sound matured kernel % (SMK).

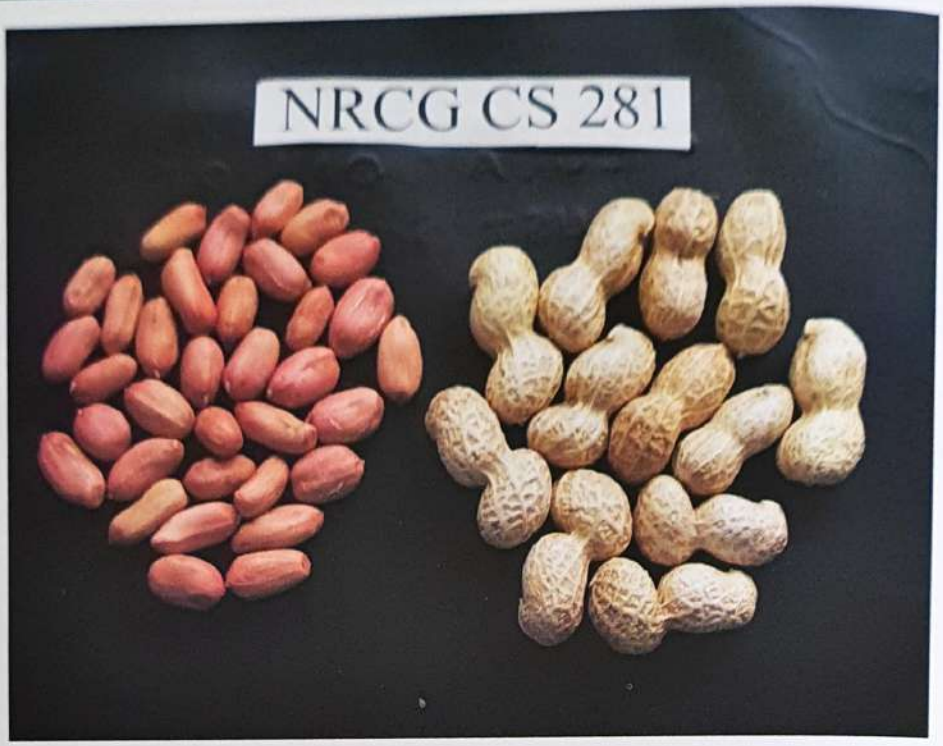
Novel Germplasm developed

A) Large seeded Spanish Bunch Groundnut

NRCGCS 268, an early maturing large seeded germplasm developed at the Center. The hundred kernel mass (HKM) is 89g, which at par with the check variety TKG 19A and matures in 100-105 days. NRCG CS268 is a Spanish bunch groundnut developed through Deep Red testa mutant as female and Purple variegated testa mutant as male parent. It produced an average pod yield of 3.0 to 3.5 tons/ha with 72% shelling out turn and 30.57% harvest Index. Pods are predominantly two seeded with moderate reticulation, constriction and beak. Kernels are cylindrical and rose in colour. It shows moderate reaction (4-7) to Rust, ELS and LLS diseases under 1-9 scale.



NRCGCS 281, an early maturing large seeded germplasm developed at the Center. The hundred kernel mass (HKM) is 101g, which is 15% higher than the check variety TKG 19A and matures in 100-1005 days. NRCG CS281 is a Spanish bunch groundnut developed through Deep Red testa mutant as female and Purple variegated testa mutant as male parent. It produced an average pod yield of 3.0 to 3.5 tons/ha with 66.8% shelling out turn and 21.44% harvest Index. Pods are predominantly two seeded with moderate beak, reticulation and high constriction. Kernels are long cylindrical and rose in colour with oil contain of 50%. It shows moderate reaction (4-7) to Rust, ELS and LLS diseases under 1-9 scale.



B) Multiple disease resistant Groundnut

Two hundred and forty five advanced lines were screened for foliar and stem rot diseases with the help of plant pathology section in disease nursery under field condition during 2003, 2004 and 2005 rainy seasons. Data recorded on ELS, LLS, Rust and Stem rot over three years showed that seven cultures (NRCGCSs 72, 77, 86, 124, 132, 159 and 160) constantly recorded multiple disease resistance against ELS, LLS, RUST and Stem rot in 0-9 scale over susceptible checks at Junagdh location.

Table 8 Promising germplasm for multiple disease resistance

NRCGCS No.	ELS (Mean of 03,04,05)	LLS (Mean of 03,04,05)	Rust (Mean of 03,04,05)	Stem rot (Mean of 03,04,05)
72	4.21	3.71	2.25	18.83
77	2.83	2.78	1.83	18.99
86	3.22	3.39	2.00	15.63
124	5.44	3.96	2.44	12.22
132	3.56	1.94	1.89	16.67
159	4.42	3.38	1.63	17.88
160	4.08	3.58	1.96	12.59
GG 20	**7.19**	**6.92**	**5.80**	**25.63**
GG 2	**6.79**	**6.13**	**5.42**	**36.25**

Anther culture:

The calli of GG 2, J 11, TAG 24 and TMV 2 differentiated in a medium containing Half the strength MS with the vitamins of B5 +0.5mgBAP+1.5mg NAA+30g sucrose+6g agar after three weeks of culture while, calli of hybrids and wild species did not differentiated even after six months of regular sub culturing in the same medium. Thus, indicates calli of wild species and derivatives of wild species may be required different hormonal combinations for regeneration. Fifty regenerating calli from each of the cultivars GG 2, TAG 24, J 11 and TMV 2 were sub cultured for shoot induction media (Table 9). The calli of GG 2 produced 100% shoots induction after three weeks of culture followed by TAG 24 (20%), J 11 (14%) and TMV 2 (6%), respectively. Number of shoots/callus recorded after four weeks of culture was maximum in GG 2 (1.28) followed by J 11 (0.28) and TAG 24 (0.22) (Table 10). Shoot tips of about one inch in length was separated and was sub cultured in shoot elongation medium containing basal MS with 3mg BAP, 30g. sucrose and 6g. agar per liter and maintained about sixty days for shoot elongation. 3-4 inch in length (about) shoots of cultivar GG 2 and J 11 had been sub cultured in root induction medium containing basal MS with 1mg. NAA, 30g. sucrose and 6g. agar per liter. Profuse rooting was observed after seven to ten days of culture. No elongated shoots could be generated from cultivars TAG 24 and TMV 2 due to poor response to the medium. Twenty six plants of GG 2 and two plants of J 11 have been transferred to earthen pots for hardening.

Table-9 Regeneration in anther calli of cultivated genotypes

Genotype	Number of regenerated callus plated	Calli regenerated (%)
GG 2	50	100
TAG 24	50	20
J 11	50	14
TMV 2	50	6
Mean	50	35
SE		16.97

Table 10 Regeneration of shots from anther calli of four cultivated genotypes

Genotype	Number of callus plated	Number of shot developed	Regeneration/ callus	No. of Plants developed
GG 2	50	64	1.28	26
TAG 24	50	11	0.22	0
J 11	50	14	0.28	2
TMV 2	50	6	0.12	0
Mean	50	23.75	0.47	7.0
SE		10.50	0.21	

Fig. 1 Regenerated plants from anther callus of GG 2

SSR Studies on Cultivated groundnut

The SSR profiles of 127 (fifty-three spreading and sixty four erect) cultivars were worked out using the 12 SSR primers. (Table 11 & 12) Some of the primers were found to be polymorphic and the data generated was inadequate for the characterisation/fingerprinting of these cultivars

Table 11 SSR polymorphism in spreading (HYB and HYR) cultivars

S No	SSR Primer	Alleles	Size range	Poly. Allele	% Poly.	SPI
1	IDT1/2	4	75-162	3	75	1.11
2	IDT3/4	4	137-238	3	75	0.12
3	IDT5/6	4	61-215	2	50	1.11
4	IDT7/8	4	149-290	1	25	0.04
5	IDT9/10	4	177-264	2	50	0.08
6	IDT11/12	5	101-224	4	80	1.30
7	IDT13/14	4	97-234	2	50	0.08
8	IDT15/16	5	134-323	1	20	0.04
9	PM 65	4	110-278	4	100	0.29
10	PM 137	4	143-285	3	75	0.15
11	PM 183	3	64-103	2	66	0.08
12	PM 188	5	124-246	4	80	0.26

Table 12 SSR polymorphism in erect (VULand FST) cultivars

S No	SSR Primer	Alleles	Size range	Poly. Allele	% Poly.	SPI
1.	IDT1/2	3	91-269	3	100	0.42
2.	IDT3/4	4	78-196	3	75	0.48
3.	IDT5/6	2	163-193	2	100	0.26
4.	IDT7/8	2	39-140	2	100	0.18
5.	IDT9/10	6	108-264	6	100	0.48
6.	IDT11/12	7	40-224	3	42	0.15
7.	IDT13/14	4	97-205	3	75	0.09
8.	IDT15/16	5	137-323	2	40	0.78
9.	PM 65	3	102-278	3	100	0.33
10.	PM 137	5	1131-285	3	60	0.27
11.	PM 145	3	58-168	1	33	0.18
12.	PM 183	4	77-248	3	75	0.33
13.	PM 188	3	118-175	3	100	0.27

SSR Studies on Wild species of groundnut

Thirting-four wild species (Tabel 3) were analysed for SSR polymorphism using 18 SSR primers. Some of the primers were polymorphic and could produce several alleles. The study is kept temporarily in abeyance and will be resumed shortly. The analysis of data will be done when data with more primers are generated.

Table 13 List of wild species studied

Sr.No.	Species name	Section	Type	Chromosome number
1	*A. hypogaea Var. hypogaea*	*Arachis*	Cultivated	2n=4x=40
2	*A. hypogaea Var. hirsuta*	*Arachis*	Cultivated	2n=4x=40
3	*A. hypogaea Var. fastigiata*	*Arachis*	Cultivated	2n=4x=40
4	*A. hypogaea Var. peruviana*	*Arachis*	Cultivated	2n=4x=40
5	*A. hypogaea Var. aequatoriana*	*Arachis*	Cultivated	2n=4x=40
6	*A. hypogaea Var. vulgaris*	*Arachis*	Cultivated	2n=4x=40
7	*A. benensis*	*Arachis*	Wild	2n=2x=20
8	*A. kuhlmannii*	*Arachis*	Wild	2n=2x=20
9	*A. stenosperma*	*Arachis*	Wild	2n=2x=20
10	*A. batizocoi*	*Arachis*	Wild	2n=2x=20
11	*A. batizogaea*	*Arachis*	Wild	2n=2x=20
12	*A. cardenasii*	*Arachis*	Wild	2n=2x=20

13	*A. correntina*	*Arachis*	Wild	2n=2x=20
14	*A. cruziana*	*Arachis*	Wild	2n=2x=20
15	*A. diogoi*	*Arachis*	Wild	2n=2x=20
16	*A. duranensis*	*Arachis*	Wild	2n=2x=20
17	*A. helodes*	*Arachis*	Wild	2n=2x=20
18	*A .kempff-mercadoi*	*Arachis*	Wild	2n=2x=20
19	*A. magna*	*Arachis*	Wild	2n=2x=20
20	*A. monticola*	*Arachis*	Wild	2n=4x=40
21	*A. villosa*	*Arachis*	Wild	2n=2x=20
22	*A. cryptopotamica*	*Arachis*	Wild	2n=2x=20
23	*A. hermannii*	*Erectoides*	Wild	2n=2x=20
24	*A. oteroi*	*Erectoides*	Wild	2n=2x=20
25	*A. paraguariensis*	*Erectoides*	Wild	2n=2x=20
26	*A. stenophylla*	*Erectoides*	Wild	2n=2x=20
27	*A. dardani*	*Heteranthae*	Wild	2n=2x=20
28	*A. pusilla*	*Heteranthae*	Wild	2n=2x=20
29	*A. appressipila*	*Procumbentes*	Wild	2n=2x=20
30	*A. kretschmeri*	*Procumbentes*	Wild	2n=2x=20
31	*A. rigonii*	*Procumbentes*	Wild	2n=2x=20
32	*A. glabrata*	*Rhizomatosae*	Wild	2n=2x=20
33	*A. pintoi*	*Caulorrhizae*	Wild	2n=2x=20
34	*A. triseminata*	*Triseminatae*	Wild	2n=2x=20

3SSR Analysis of disease resistant germplasm

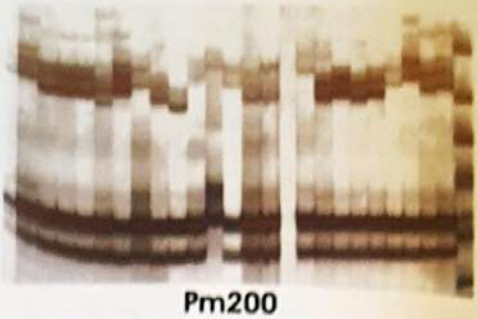
The following genotypes from the cultivated groundnut, which were earlier reported as disease resistant along with five susceptible cultivars were selected for the detection of DNA polymorphism and subsequent correlation with the agronomically desirable characters to find our the markers for those if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

Table 14 List of genotypes used in the study

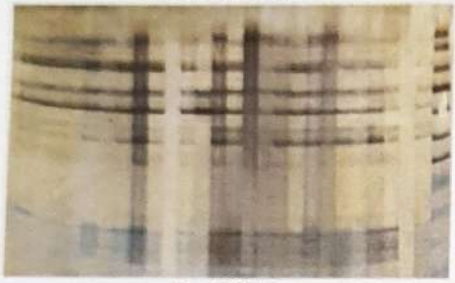
Sr.No.	NRCG No.	ORIGIN	HBT	RESISTANCE
1.	11586	PER	VUL	RUST
2.	4859	PER	FST	RUST
3.	11879	PER	FST	RUST
4.	1177	PER	FST	RUST+ LLS
5.	5186	ISR	HYB	RUST
6.	13149	PER	FST	RUST
7.	4734	USA	HYB	RUST
8.	4853	PER	FST	RUST
9.	4857	PER	HYR	RUST
10.	12205	UN	HYR	RUST
11.	288	USA	HYR	RUST
12.	8013	UNK	FST	RUST
13.	250	IND	HYR	RUST
14.	4849	PER	FST	LLS
15.	11580	PER	FST	LLS
16.	11581	PER	FST	LLS
17.	4998	UGA	FST	LLS
18.	6517	ISR	FST	LLS
19.	7598	PER	FST	RUST+ LLS+ALT
20.	6524	PER	FST	RUST+ LLS+ALT
21.	GG 2	IND	FST	Susceptible
22.	JL24	IND	FST	Susceptible
23.	GG 20	IND	HYB	Susceptible
24.	CS 19	IND	HYB	Susceptible
25.	GG11	IND	HYR	Susceptible

An additional 10 SSR primers were used to characterise these genotypes. Some of the primers were capable of detecting polymorphism and had exclusive bands. The informative primers are shown in the picture. More data is being generated for conclusive analysis.

IDT 11.12



Pm200



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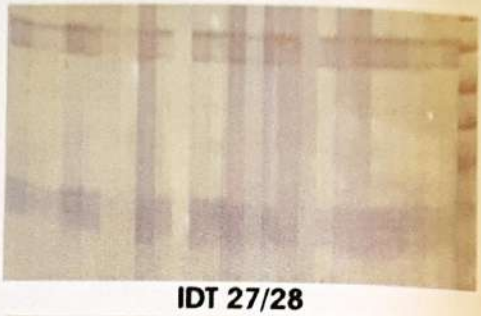
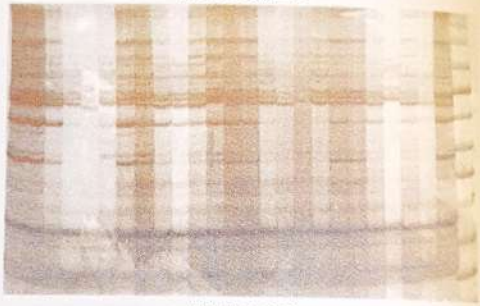


IDT 27/28

IDT 13/14



PM 137

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

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

Subproject 1: Assessment of quality in germplasm collection, breeding material and produce of other experiments

(J.B.Misra)

Oil content and O/L ratio of kernel samples of groundnut cultivars

The oil content of 32 cultivars was in the range of 45.7% (Chandra) and 54.2% (TMV 10). The kernels of cultivars M145, UF 70-103, ICGS 37 and TMV 10 contained more than 52.0% oil while the cultivars AK 12-24, DRG 12, DRG 17, LGN 2, M 522, RSB 87, ALR 3, GG 13, M 335, GAUG 10 and MH 2 were among those which contained less than 45.0% oil.

Sixty-three groundnut cultivars (21 Spanish, 19 Virginia bunch, 21 Virginia runners and 2 Valencia) sown during *kharif* 2005, were analyzed for fatty acid composition and oil content. The stability index, calculated as the ratio of oleic acid to linoleic acid (O/L ratio) ranged between 0.8 (GG 6) and 3.1 (GG 11). Among the different habit groups, the O/L ratio varied from 0.8-2.3 in Spanish bunch, 0.9-2.8 in Virginia bunch, 1.0-3.1 in Virginia runners and there was no variation among Valencia habit group cultivars.

Irrespective of the habit groups, the kernels of 14 cultivars viz., ICGS 37, Kadiri 4, BAU 13, ICGS 76, GG 20, Chitra, GG 11, GG13, Karad 4-11, M 335, S 230, UF-70-103, TMV 3, and M 13 had O/L ratio value greater than 2.0, whereas kernels of 18 cultivars viz., CO 1, GG 3, GG 6, Jawan, Kisan, RG 141, Spanish Improved, Tirupati 4, TMV 12, DRG 17, Kadiri 3, LGN 2, M 522, R 9251, ALR 3 and Punjab 1, Gangapuri and MH 2 had O/L ratio of less than 1.2.

Development of protocols for comparing groundnut cultivars for their blanching quality

Two experiments were conducted. In experiment I, the kernels of three groundnut cultivars GG 20, GG 2 and BAU 13 were soaked in plain water at room temperature for 2 or 5 minutes and then placed in an oven at 100°C for five different durations *viz*., 5, 10, 15, 20 or 30 minutes. The testa of these kernels, was then removed by pressing the kernels between the index finger and thumb. For each cultivar, the number of kernels from which testa was completely removed and observations on coloration of the roasted kernels, were recorded. The results are shown in Table 1 and Figure 1.

In experiment II, the kernels of another four cultivars *viz*., ICGV 86031, M 13, TAG 24 and ICGS 76 were soaked in plain water for 2 or 5 minutes and then heated at 100°C for only for four durations viz., 5, 10, 15, and 20 minutes. Then the testa from kernels was removed and the observations were recorded in the same way as described above. The results are shown in Table 1.

Based on results, the following protocol was developed for comparing groundnut genotypes for their blanching attribute: soaking of 20 kernels in plain water for two minutes followed by heating kernels in an oven at 100°C for 15 minutes. After cooling, holding each kernel between the thumb and index finger and then pressing to remove the testa. The observations on the number of kernels showing complete removal of testa, partial removal of testa and discoloration of the blanched kernels, if any, to be noted for comparing the genotypes.

presence of Hg and Cu at 5 mM completely inhibited the activity of alkaline protease activity. The activity of amylase obtained from Bacillus amyloliquefaciens by slurry fermentation, decreased with the increasing concentration of Ca and Mg from 2.5 mM to 20 mM.

One unit (IU) of protease activity was defined as the amount of enzyme that produced an absorbance at 280 nm equal to 1 mole of tyrosine in one minute under the assay conditions.

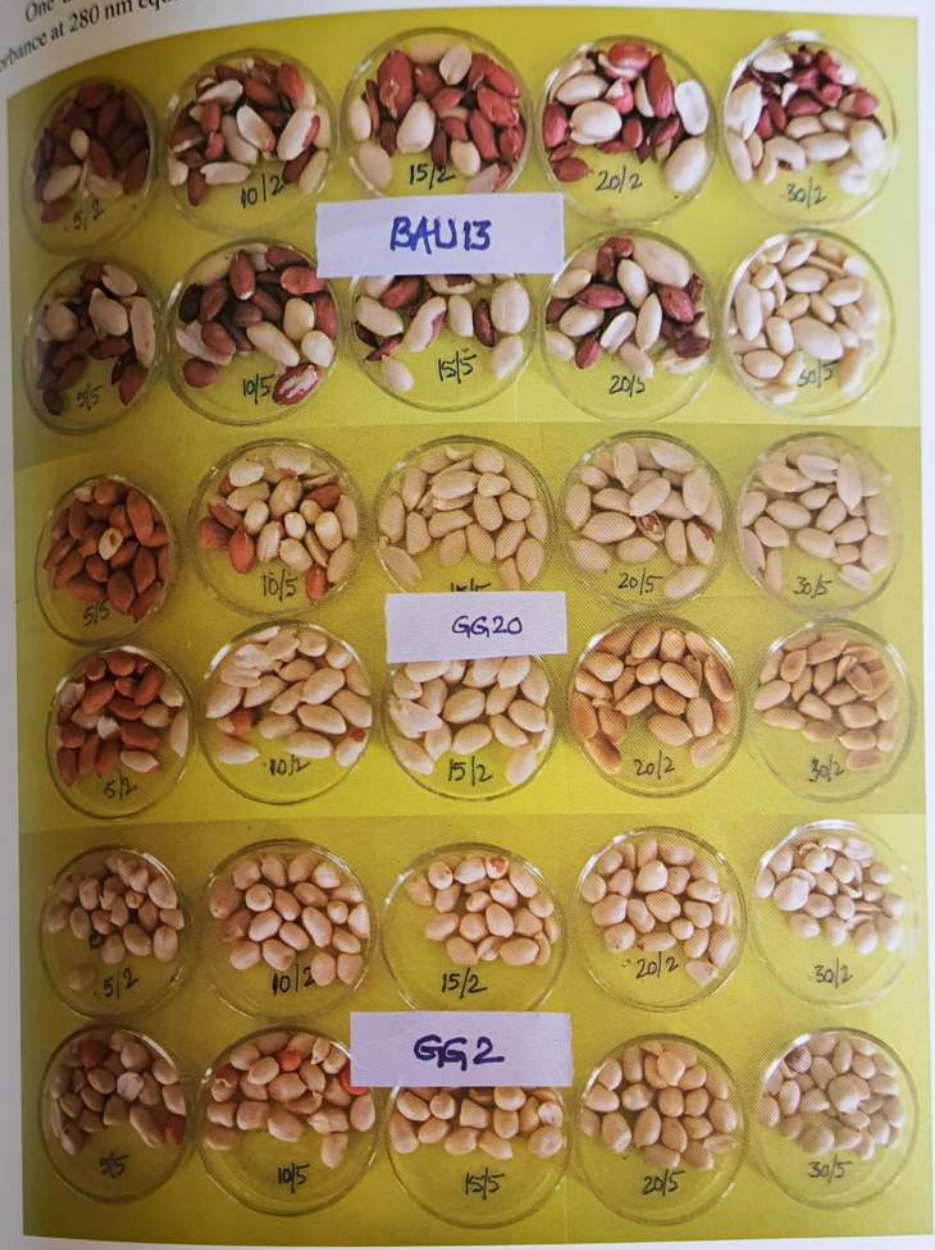


Figure 1. Effect of durations of soaking and heating on ease of blanching of three groundnut genotypes

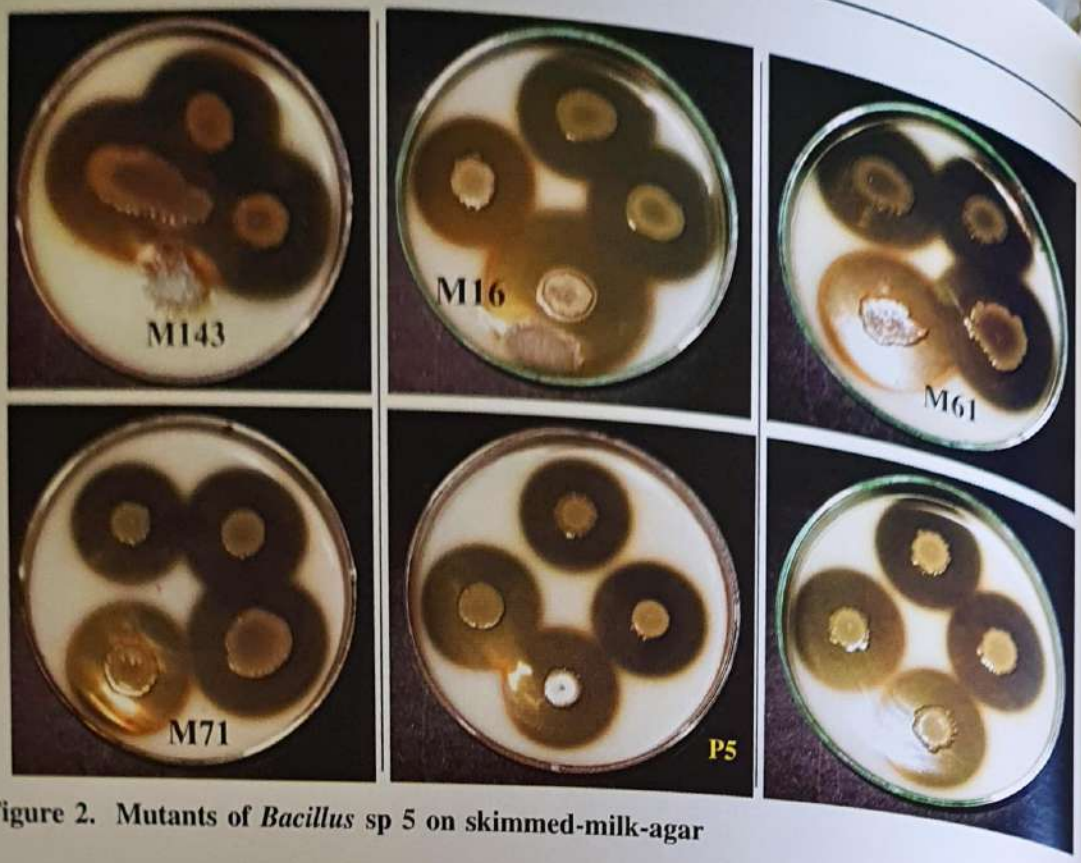


Figure 2. Mutants of *Bacillus* sp 5 on skimmed-milk-agar

Table 1. Effect of duration of soaking and heating on ease of blanching of groundnut genotypes

Cultivar	Soaking (min.)	Extent of blanching (out of 20)				
		Duration of heating (min.)				
		5	10	15	20	30
Experiment-I						
GG 20	2	4	17+3	20	20 (Br)	20 (Br)
	5	2	10+5	20	20	20
GG 2	2	19+1	20	20	20	20
	5	18	18	20	20	20
BAU 13	2	4+5	5+2	11+1	12+1	20
	5	3+1	5+3	5+7	6+6	8+8
Experiment-II						
ICGV 86031	2	3+8	18	20	15	-
	5	5+9	18	15	16	-
M 13	2	16	16	20	20	-
	5	15	16	20	20	-
TAG 24	2	11+5	19	20	20	-
	5	16	18	20	20	-
ICGS 76	2	5+2	7+3	10+3	20	-
	5	5+1	10+2	20	20	-

Table 2. Influence of temperature and pH of assay medium on the reaction velocity of protease from *Bacillus* sp. P5

Temp. °C	Activity (units)		
	pH 5.0	pH 7.0	pH 9.0
30	11	104	130
35	68	129	289
40	131	331	659
45	204	391	680
50	157	623	765
55	102	498	408
60	16	295	76
65	-	-	-

PROJECT 11 : BREEDING FOR LARGE-SEEDED AND CONFECTIONERY TYPE GROUNDNUT

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

The activities carried out under this project included effecting fresh crosses, generation advancement and selection in segregating populations, evaluation of advanced breeding lines developed at the NRCG and confectionery type groundnut cultures acquired from ICRISAT for yield superiority and quality attributes, and some basic studies on seed size and related aspects. A brief report of activities undertaken is as follows:

Hybridization

During *kharif* 2005, 18 crosses were attempted in a line x tester mating design involving nine genotypes as lines and two as testers having high yield potential. The lines involved advance breeding lines as well as largeseeded accessions from germplasm. Apart from these, six crosses were effected for generation mean analysis (six generation model) for seed size. A total of 5321 buds were pollinated and 1814 probable hybrid pods were harvested with 34.1% success.

Selection and generation advancement

Thirty crosses attempted in a diallel mating design during previous *kharif* season were raised in a randomized block design with two replications. True hybrids were identified and pods were harvested separately for further advancement. A total of 563 single plants were identified. Leaf samples were collected from large x small type crosses and parents for molecular analysis. Pods were harvested separately for further advancement. Post harvest data were collected from identified hybrid plants for statistical analysis. The F_2 generations of three crosses were sown and segregating lines were identified and harvested. Fourteen crosses in the F_3 were sown and progenies were harvested in bulk. Phenotypic selections were operated for large pod size and yield in F_4 to F_6 generations and 93 selections were made for advancing to next respective generation. The selections made in different segregating generations are given in Table 1. Segregating materials in F_4 to F_7 generations (from 13 crosses) were supplied to 12 AICRP-G centers after obtaining the signed MTA from the concerned breeder for location specific selection and varietal development.

Table 1. Selections made during the year

Gen.	Purpose	No.of crosses	Crosses/ Seln. sown	No. of bulks/ Seln. made
F_2	Seed size increase/early maturity	3	3	3
F_3	Genetics of seed size/oil content	14	14	14
F_4	Large seeded & early maturity	4	7	10
F_5	Large seeded ness	12	30	31
F_6	Large seeded ness	20	47	49

Multiplication and maintenance

Five Spanish type new advanced breeding lines were multiplied and 40 lines (4 Spanish, 36 Virginia) were maintained. Among these only 44 lines were selected for the next season sowing. Fifty-nine new advanced breeding lines (Virginia) were developed from the segregating generations based on pod size or yield superiority during the season. These will be multiplied, maintained and evaluated in replicated trials subsequently.

Evaluation trials

A preliminary and an advanced yield evaluation trial were conducted under this project. The advanced breeding lines developed with different breeding objectives as well as those obtained from ICRISAT were evaluated under these trials. In all the trials observations on pod yield and related traits were recorded and analyzed statistically. The results of these trials are given trial-wise as under:

Preliminary yield trial of advanced breeding lines

Twenty-two Virginia type advanced breeding lines along with three checks (GG 20, M 13 and TKG 19A), were evaluated for yield superiority in three replications in a RBD. The entries also involved 17 confectionery cultures obtained from ICRISAT. At 45 DAS sampling was carried out for SCMR. Five-plant sampling at harvest was carried out and the relevant observations were recorded. The pod yield ranged from 1687.7 to 3675 kg/ha with PBS 29079A recording significantly higher pod yield than TKG 19A, the best check. Nine advanced breeding lines had numerically higher yield than the best check. The kernel yield ranged from 1084.3 to 1930.7 kg/ha with seven lines recording higher kernel yield than M 13, the best check for the trait. The 100-seed mass (HSM) ranged between 33.2 and 66.6 g. The best check, M 13 recorded only 44.5 g seed size and 15 genotypes had higher HSM than the check. Seventeen cultures, which recorded pod yield or seed size superior to or at par with the check varieties were promoted to advanced trial to be taken up in the ensuing *kharif* season. Performance of some of the selected entries is given in Table 2.

Large-seeded yield evaluation trial

Fifteen genotypes along with three checks (GG 20, M 13 and TKG 19A) were evaluated in a RBD. Apart from yield related traits data were also recorded for SCMR, flowering initiation, 50% flowering and days to maturity. Significant variation was found for all the traits studied. The pod yield ranged from 1429.1 to 3308.4 kg/ha and kernel yield from 797.1 to 2167.2 kg/ha. Two genotypes (PBS 29078 and PBS 29077) recorded significantly higher pod yield over the best check, GG 20. Four other genotypes (PBS 29067, PBS 29047, PBS 29080 and PBS 29073) recorded numerical superiority over the best check. For kernel yield none of the genotypes could surpass the best check statistically, but six genotypes (PBS 29078, PBS 29077, PBS 29067, PBS 29047, PBS 29080 and PBS 29073) had numerically higher kernel yield over GG 20. The HSM ranged from 32.2 to 59.4 g and four genotypes (PBS 29077, PBS 29078, PBS 29067 and PBS 29080) recorded HSM above 50 g while the best check GG 20 had only 46.3 g. The genotype PBS 29077 had significantly higher seed size over M 13, the National check, and PBS 29077 and PBS 29078 had significantly higher seed size over TKG 19A. The proportion of SMK varied between 28.9 and 51.9% and high variation was recorded for this trait due to difference in maturity. The mean performance of some selected genotypes is given in Table 3.

The mean duration for flower initiation ranged between 21.7 to 26.3 days. The days to maturity (DTM) showed nine-day difference between the earliest and late genotype. GG 20 matured in 120 days and all other genotypes matured between 123 and 128 days. None of the test entries had significantly

higher shelling outturn than the best check, GG 20. Four genotypes (PBS 29067, PBS 29080, PBS 29077 and PBS 29078) had numerical superiority for harvest index over TKG 19A, the best check for the trait.

Analysis of variance for seven genotypes evaluated for two years showed that the variation due to year was significant for most of the traits except HSM, SMK, shelling outturn and harvest index, while G x E interaction was significant only for number of pods per plant, pod and kernel yield and harvest index indicating the differential response of genotypes over years. The combined analysis showed that none of the entries had significant superiority for both pod and kernel yield over GG 20. However, PBS 29077, PBS 29078, PBS 29080 and PBS 29034 were at par with GG 20 and TKG 19A with more than 2000 kg/ha pod yield. PBS 29077 recorded significantly higher HSM (58.2 g) compared to all the checks. For SMK and harvest index none of the entries could perform better than GG 20. The SCMR, the trait associated with high water use efficiency, was highest for PBS 23031, which was only fifth in pod yield. PBS 29077 that had highest pod yield among the test entries had SCMR value close to that of PBS 23031 and higher than that of GG 20. Owing to the high mean performance, genotypes PBS 29077, PBS 29078 and PBS 29080 will be proposed for evaluation under AICRP-G trials after seed increase.

Quality evaluation

The produce of the genotypes evaluated under yield evaluation trials during *kharif* 2004 was subjected to quality analysis. In the advanced trial the HSM ranged from 25.4 to 57 g (PBS 29077). The genotypes PBS 29077, 29058, 29078 and 29080 had HSM above 50 g while the best check (TKG 19A) had only 47 g. The SMK ranged from as low as 14% to 52% with an overall mean of 34% only, and none of the genotypes recorded significantly higher values than the checks. Majority of the genotypes had elongated-oval to oval seed shape with tapering to intermediate shape of the end (Table 4). Seed size uniformity was highly varying with PBS 29077, 29071, 29078 and 29058 having high uniformity while PBS 29075, 29070, 29080, 19007, 29072 and ICGV 99101 had moderate uniformity. Genotypes PBS 30062, 29010, 21063 and 23031 had highly varying seed size. Except four (PBS 19011, 21063, 29075, 29034) all other entries had pink or light brown testa colour which is acceptable. The high yielding entry ICGV 99101 had dark pink testa colour with elongated seed shape. Among the 42 genotypes evaluated in the preliminary trial the HSM ranged from 23.7 to 60 g and SMK from 5.4 to 81.3% (Table 5). Majority of the genotypes had elongated to oval seed shape with intermediate end and light pink or light brown testa colour. Some of the PBS lines and ICRISAT cultures had highly shriveled kernels, which is not an acceptable quality trait. The oil content was analyzed in collaboration with Biochemistry section. The oil content in the genotypes (advanced trial) ranged from 45.8% (PBS 19011) to 52.2% (PBS 30061) with a mean of 50%. Four genotypes (PBS 19011, 21063, 19007 and ICGV 99101) had lower oil content than the check M 13 that had the lowest oil content among the checks.

Screening for seed coat tolerance of *A. flavus* infection

Selected advanced breeding lines from the yield evaluation trial were subjected to lab screening for seed coat tolerance of *A. flavus* (isolate *AF III*) infection in collaboration with the Plant Pathology section. The percentage seed colonization ranged from zero to as high as 56.7% (PBS 29034). The check varieties M 13 and TKG 19A, and breeding lines ICGV 00428 and PBS 29077 showed below 10% seed colonization.

Evaluation of Spanish type germplasm lines

During rabi/summer 2005, 29 germplasm lines of Spanish habit group were evaluated for yield and seed size superiority over TKG 19A. The pod yield per plant ranged from 2.66 to 7.04 g/plant. Three germplasm lines (NRCG 10655, 11183 and 10910) recorded numerical superiority over TKG 19A for pod

and kernel yields. The HSM ranged between 21.3 g and 42.9 g while HSM of mature kernels lied between 31.4 g and 60.2 g. No genotype had seed size higher than TKG 19A but NRCG 11909 was at par with the check. The proportion of SMK ranged from 38.5 to 82.4%. Twelve germplasm lines (NRCG 10911, 10569, 6213, 10665, 12383, 10978, 12482, 11603, 10655, 10580, 12213 and 11909) had significantly higher SMK than the check (Table 6).

Experiment on flowering duration vs. pod yield and yield components

An experiment on flowering duration vs. pod yield and yield components was taken up for two seasons to study the effect of flowering duration on yield or components, especially seed mass and recovery of mature kernels. Four varieties (TPG 41, TKG 19A, TG 37A and GG 2) were used for the study. The proposed treatments were deflowering after 7 days after flower initiation (DAF), 14, 21, 28 and 35 DAF up to 42 DAF and a control with three replications. However, due to delayed flower initiation and raise in temperature during both the seasons there was considerable reduction in flowering after three weeks and hence, only three treatments were imposed. The harvesting was taken up at 110 DAS and post-harvest data were recorded.

There was non-significant difference for pod and kernel yields among the four varieties. Similarly the pod and kernel yields did not show significant difference among the treatments. But the treatments differed significantly for HSM and SMK indicating that the duration of flowering affects the seed size and maturity. The seed size and recovery of SMK showed a linear decrease with increase in duration of flowering. The variety x treatment interaction was found to be significant for shelling outturn and HSM. The regression of duration of flowering upon HSM and SMK was near to unity (r=0.92, P=0.04 for HSM, r=0.97, P=0.01 for SMK) and significant. Thus, the shorter the flowering duration more will be the recovery of mature kernels and seed size. Hence, selection for large seeded and confectionery genotypes should also take into consideration the duration of flowering in the genotype. The results have to be confirmed with further detailed experiments.

Genetic control of yield and quality traits

The data collected from crosses generated in a 6 x 6 diallel mating design raised during *kharif* 2005 were analyzed for understanding genetic control of pod yield and related traits as well as to identify good combiners among the parents and best cross combinations. The ANOVA for the experiment indicated existence of significant variation for all traits among the genotypes except for kernel yield. The variation due to genotypes was further divided into Parents, F_1s and P vs. F_1. Parents differed significantly for shelling outturn, 100-pod mass (HPM), HSM and SMK. The crosses differed significantly for all the traits except for number of kernels per plant and pod yield per plant. The crosses significantly differed from parents for majority of the traits except HPM, HSM and SMK indicating presence of heterosis for pod yield.

ANOVA for combining ability indicated that variance due to GCA was significant for all the traits except pod yield per plant, while variance due to SCA was significant for all traits except count, the number of kernels per ounce. Significant GCA and SCA variance indicate the importance of both additive and non-additive gene action. The variance due to reciprocal effect was significant for number of pods, shelling outturn, HPM, HSM, count and SMK, thereby indicating presence of reciprocal differences and maternal influence in the expression of these traits. The estimates of gca and sca calculated showed predominance of non-additive gene action in the control of number of pods and kernels per plant, pod yield per plant and shelling outturn. For the traits HPM, HSM, count and SMK both additive and non-additive

gene action were important but there was predominance of additive gene action for HPM and SMK. Thus, the information generated on genetic control and influence of maternal parent in the expression of pod and seed size would help in devising appropriate breeding strategies aimed at development of largeseeded groundnut genotypes.

Table 2. Mean performance of selected genotypes in preliminary trial

Sl. No.	Genotype	PY (kg/ha)	KY (kg/ha)	HSM (g)	SMK (%)	SP (%)	HI (%)
1	PBS 29079 A	3675.0	1930.7	57.2	35.79	52.60	33.14
2	ICGV 97049	3059.0	1639.3	33.2	27.35	53.46	35.31
3	PBS 29068	2900.3	1798.3	45.7	28.56	62.64	43.12
4	ICGV 89214	2579.0	1649.7	52.3	32.60	63.93	40.55
5	PBS 29069	2572.3	1157.7	51.0	43.06	44.38	32.57
6	ICGV 97040	2533.7	1631.0	49.8	35.43	64.34	40.10
7	PBS 29079 B	2516.0	1440.3	56.4	34.00	55.90	34.02
23	GG 20	2163.0	1401.3	38.6	39.30	64.59	42.61
24	M 13	2292.0	1527.7	44.5	40.51	66.66	57.12
25	TKG 19 A	2299.3	1309.7	36.5	31.97	56.79	40.92
	CD	875.5	NS	15.09	NS	7.06	12.44

Table 3. Mean performance of selected genotypes in advanced trial

Sl. No.	Genotype	DTM	PY (kg/ha)	KY (kg/ha)	HSM (g)	SMK (%)	SP (%)	HI (%)
1	PBS 29078	123	3308.4	2167.2	58.5	44.62	65.58	45.40
2	PBS 29077	126	3295.3	2190.2	59.4	46.60	66.45	45.75
3	PBS 29067	125	3134.2	1953.0	54.8	50.79	61.95	46.81
4	PBS 29047	125	3031.6	1900.0	45.1	36.22	61.61	42.84
5	PBS 29080	125	2870.0	1784.6	50.2	44.31	62.23	46.21
16	GG 20	120	2373.3	1630.6	46.3	51.93	68.67	40.68
17	M 13	126	2082.5	1279.9	45.0	31.90	61.33	29.75
18	TKG 19 A	127	2225.4	1408.1	41.6	37.82	62.67	42.89
	Grand mean	125	2348.6	1463.3	43.9	40.42	61.44	37.65
	CD (0.05)	1.5	849.4	583.8	13.7	12.72	6.62	10.28

Table 4. Quality parameters of selected genotypes from advanced trial (*kharif* 2004)

Sl. No.	Genotype	SHK	SHEnd	SSU	HSM (g)	SMK (%)	Oil (%)
1	PBS 29077	8	3	8	56.95	38.60	50.83
2	PBS 29058	8	5	8	52.46	29.98	52.00
3	PBS 29078	9	5	8	51.93	33.98	49.67
4	PBS 29080	8	3	6	51.87	36.31	50.83
5	PBS 29071	9	5	8	49.50	37.32	51.33
6	PBS 29070	6	3	6	48.38	41.29	51.50

7	PBS 29072	9	5	6	47.90	30.26	51.67
8	ICGV 00428	9	4	6	47.20	20.75	48.67
9	ICGV 99101	9	3	6	46.73	39.88	46.33
10	PBS 23031	9	3	2	43.55	28.20	50.67
24	GG 20	9	3	6	40.96	33.44	51.67
25	M 13	9	5	9	39.41	14.00	48.50
26	TKG 19 A	9	5	8	47.06	40.71	50.17

[SHK-Shape of kernel: Score 10...1 (Elongated to round); SHend-Shape of end: Score 5..0 (Tapering to blunt); SSU-Seed size uniformity: 10…1 (highly uniform to highly varying)]

Table 5. Quality parameters of selected genotypes from preliminary trial (*kharif* 2004)

Sl. No.	Genotype	SHK	SHEnd	SSU	HSM (g)	SMK (%)
1	PBS 29082	8	3	4	59.96	59.21
2	PBS 29052	7	3	8	56.42	55.02
3	PBS 29068	6	3	6	53.38	48.95
4	ICGV 97040	6	3	6	52.26	41.54
5	ICGV 90325	6	3	6	52.02	51.11
6	ICGV 97051	9	5	6	51.51	46.03
7	PBS 29073	8	3	6	50.42	34.41
8	ICGV 90196	8	4	5	49.66	32.06
9	ICGV 90308	8	3	4	47.64	40.00
10	ICGV 91099	7	3	6	47.53	29.31
40	TKG 19 A	8	3	6	51.61	37.11
41	GG 20	8	3	6	43.84	65.79
42	M 13	8	3	4	38.35	5.38

[SHK-Shape of kernel: Score 10...1 (Elongated to round); SHend-Shape of end: Score 5..0 (Tapering to blunt); SSU-Seed size uniformity: 10…1 (highly uniform to highly varying)]

Table 6. Performance of selected Spanish germplasm lines

Sr. No.	Genotype	NPP	PYP (g)	KYP (g)	HSM (g)	SMK (%)	SP (%)
1	NRCG 10655	9.93	7.04	4.95	28.63	64.26	70.21
2	NRCG 11183	8.61	6.86	4.45	32.23	62.56	64.47
3	NRCG 10910	8.66	6.66	4.27	28.75	52.53	63.93
4	NRCG 6213	6.75	6.11	3.83	34.39	72.04	62.42
5	NRCG 12731	10.51	5.93	4.09	25.46	55.39	69.06
6	NRCG 10580	10.37	5.91	4.17	25.80	64.18	70.74
7	NRCG 11909	5.03	5.63	3.39	40.03	62.72	60.22
30	TKG 19 A	7.67	6.57	3.91	42.89	46.38	59.42

gene action were important but there was predominance of additive gene action for HPM and SMK. Thus, the information generated on genetic control and influence of maternal parent in the expression of pod and seed size would help in devising appropriate breeding strategies aimed at development of largeseeded groundnut genotypes.

Table 2. Mean performance of selected genotypes in preliminary trial

Sl. No.	Genotype	PY (kg/ha)	KY (kg/ha)	HSM (g)	SMK (%)	SP (%)	HI (%)
1	PBS 29079 A	3675.0	1930.7	57.2	35.79	52.60	33.14
2	ICGV 97049	3059.0	1639.3	33.2	27.35	53.46	35.31
3	PBS 29068	2900.3	1798.3	45.7	28.56	62.64	43.12
4	ICGV 89214	2579.0	1649.7	52.3	32.60	63.93	40.55
5	PBS 29069	2572.3	1157.7	51.0	43.06	44.38	32.57
6	ICGV 97040	2533.7	1631.0	49.8	35.43	64.34	40.10
7	PBS 29079 B	2516.0	1440.3	56.4	34.00	55.90	34.02
23	GG 20	2163.0	1401.3	38.6	39.30	64.59	42.61
24	M 13	2292.0	1527.7	44.5	40.51	66.66	57.12
25	TKG 19 A	2299.3	1309.7	36.5	31.97	56.79	40.92
	CD	875.5	NS	15.09	NS	7.06	12.44

Table 3. Mean performance of selected genotypes in advanced trial

Sl. No.	Genotype	DTM	PY (kg/ha)	KY (kg/ha)	HSM (g)	SMK (%)	SP (%)	HI (%)
1	PBS 29078	123	3308.4	2167.2	58.5	44.62	65.58	45.40
2	PBS 29077	126	3295.3	2190.2	59.4	46.60	66.45	45.75
3	PBS 29067	125	3134.2	1953.0	54.8	50.79	61.95	46.81
4	PBS 29047	125	3031.6	1900.0	45.1	36.22	61.61	42.84
5	PBS 29080	125	2870.0	1784.6	50.2	44.31	62.23	46.21
16	GG 20	120	2373.3	1630.6	46.3	51.93	68.67	40.68
17	M 13	126	2082.5	1279.9	45.0	31.90	61.33	29.75
18	TKG 19 A	127	2225.4	1408.1	41.6	37.82	62.67	42.89
	Grand mean	125	2348.6	1463.3	43.9	40.42	61.44	37.65
	CD (0.05)	1.5	849.4	583.8	13.7	12.72	6.62	10.28

Table 4. Quality parameters of selected genotypes from advanced trial (*kharif* 2004)

Sl. No.	Genotype	SHK	SHEnd	SSU	HSM (g)	SMK (%)	Oil (%)
1	PBS 29077	8	3	8	56.95	38.60	50.83
2	PBS 29058	8	5	8	52.46	29.98	52.00
3	PBS 29078	9	5	8	51.93	33.98	49.67
4	PBS 29080	8	3	6	51.87	36.31	50.83
5	PBS 29071	9	5	8	49.50	37.32	51.33
6	PBS 29070	6	3	6	48.38	41.29	51.50

7	PBS 29072	9	5	6	47.90	30.26	51.67
8	ICGV 00428	9	4	6	47.20	20.75	48.67
9	ICGV 99101	9	3	6	46.73	39.88	46.33
10	PBS 23031	9	3	2	43.55	28.20	50.67
24	GG 20	9	3	6	40.96	33.44	51.67
25	M 13	9	5	9	39.41	14.00	48.50
26	TKG 19 A	9	5	8	47.06	40.71	50.17

[SHK-Shape of kernel: Score 10...1 (Elongated to round); SHend-Shape of end: Score 5..0 (Tapering to blunt); SSU-Seed size uniformity: 10…1 (highly uniform to highly varying)]

Table 5. Quality parameters of selected genotypes from preliminary trial (*kharif* 2004)

Sl. No.	Genotype	SHK	SHEnd	SSU	HSM (g)	SMK (%)
1	PBS 29082	8	3	4	59.96	59.21
2	PBS 29052	7	3	8	56.42	55.02
3	PBS 29068	6	3	6	53.38	48.95
4	ICGV 97040	6	3	6	52.26	41.54
5	ICGV 90325	6	3	6	52.02	51.11
6	ICGV 97051	9	5	6	51.51	46.03
7	PBS 29073	8	3	6	50.42	34.41
8	ICGV 90196	8	4	5	49.66	32.06
9	ICGV 90308	8	3	4	47.64	40.00
10	ICGV 91099	7	3	6	47.53	29.31
40	TKG 19 A	8	3	6	51.61	37.11
41	GG 20	8	3	6	43.84	65.79
42	M 13	8	3	4	38.35	5.38

[SHK-Shape of kernel: Score 10...1 (Elongated to round); SHend-Shape of end: Score 5..0 (Tapering to blunt); SSU-Seed size uniformity: 10…1 (highly uniform to highly varying)]

Table 6. Performance of selected Spanish germplasm lines

Sr. No.	Genotype	NPP	PYP (g)	KYP (g)	HSM (g)	SMK (%)	SP (%)
1	NRCG 10655	9.93	7.04	4.95	28.63	64.26	70.21
2	NRCG 11183	8.61	6.86	4.45	32.23	62.56	64.47
3	NRCG 10910	8.66	6.66	4.27	28.75	52.53	63.93
4	NRCG 6213	6.75	6.11	3.83	34.39	72.04	62.42
5	NRCG 12731	10.51	5.93	4.09	25.46	55.39	69.06
6	NRCG 10580	10.37	5.91	4.17	25.80	64.18	70.74
7	NRCG 11909	5.03	5.63	3.39	40.03	62.72	60.22
30	TKG 19 A	7.67	6.57	3.91	42.89	46.38	59.42

EXTERNALLY FUNDED PROJECTS

PREVENTION AND MANAGEMENT OF MYCOTOXIN CONTAMINATION IN COMMERCIALLY IMPORTANT AGRICULTURAL COMMODITIES

(Vinod Kumar and T. Radhakrishnan)

FUNDING AGENCY: ICAR (AP CESS FUND)

Objective 1: **Screening of genotypes for resistance against *A. flavus***

Screening of genotypes against A. flavus under laboratory conditions

A total of 127 genotypes along with 27 released varieties were screened for dry seed resistance against A. flavus under laboratory conditions during summer 2005 (table1). Fifteen genotypes viz. NRCG-CS 126, NRCG-CS 14, NRCG-CS 38, NRCG-CS 272, NRCG-CS 65, NRCG-CS 77, ICGV 00428, TKG 19A, NRCG-CS 326, NRCG-CS 346, NRCG-CS 344, NRCG-CS 345, NRCG-CS 350, NRCG-CS 320, NRCG-CS 352 showed promise against in-vitro seed colonization.

Table 1: Promising genotypes against *in-vitro* seed colonization by *Aspergillus flavus* under artificially inoculated laboratory conditions

Sr. no.	Cultivars/ Genotypes	% Seed infection	% Seed colonization
1.	NRCG-CS 126	20.00	13.00
2.	NRCG-CS 14	13.00	3.00
3.	NRCG-CS 38	7.00	3.00
4.	NRCG-CS 272	10.00	7.00
5.	NRCG-CS 65	7.00	3.00
6.	NRCG-CS 77	10.00	7.00
7.	ICGV 00428	10.00	0.00
8.	TKG 19A	16.67	3.33
9.	NRCG-CS 326	6.70	3.30
10.	NRCG-CS 346	13.30	6.70
11.	NRCG-CS 344	6.70	3.30
12.	NRCG-CS 345	10.00	3.30
13.	NRCG-CS 350	23.30	13.30
14.	NRCG-CS 320	10.00	3.30
15.	NRCG-CS 352	6.70	6.70
	NRCG-CS 47	100.00	100.00
	J 11*	17.00	27.00
	GG 10 **	73.00	60.00

* Resistant check **Susceptible check

Screening of genotypes against A. flavus under field conditions (sick plot)

A total of fifty advanced breeding lines of NRCG and cultivars, showing promising resistance against seed infection against A. flavus under laboratory conditions, including susceptible (GG 20) and resistant check (J11) were evaluated in augmented block design under artificially inoculated sick plot conditions for tolerance/ resistance against A. flavus infection during Kharif 2005. The soil was inoculated thrice with the most virulent isolate of A. flavus isolate AF 111, at sowing, flowering and at 90 days of crop. Observations were recorded on incidence of aflaroot and pod samples wee taken. They were analyzed for seed infection by A. flavus and aflatoxin contamination levels. The infection level varied between 0-4.5 percent. The samples were categorized in four lots viz. bulk, large sized, medium, and small sized pods. The aflatoxin contamination ranged from 0.00 to 270.54 µg/kg (table 2). Though there were significant differences among the varieties, the level of contamination was quiet low (since the crop could not be imposed end of season drought due to rain) however three advanced breeding lines viz. NRCG-CS nos' - 333, 350, 354, and two released varieties, B95 and BAU 13 showed promise against aflatoxin contamination during Kharif 2005 showing tolerance to A. flavus infection and subsequent aflatoxin contamination.

Table 2: Aflatoxin B_1 content in different genotypes screened during *Kharif* 2005 at NRCG, Junagadh

Sr. No.	Genotypes	Aflatoxin B_1 (µg/ kg)			
		B	L	M	S
1	CS 125	11.79 (3.43)	31.99 (5.66)	3.81 (1.95)	8.07 (2.84)
2	CS 126	1.21 (1.10)	2.15 (1.47)	5.28 (2.30)	5.18 (2.28)
3	CS 14	1.87 (1.36)	0.22 (0.47)	0.83 (0.91)	1.19 (1.09)
4	CS 15	2.55 (1.59)	2.53 (1.59)	1.96 (1.40)	11.01 (3.31)
5	CS 215	39.07 (6.25)	18.78 (4.33)	18.33 (4.28)	41.73 (6.46)
6	CS 272	25.46 (5.04)	56.29 (7.50)	47.00 (6.86)	15.01 (3.87)
7	CS 273	0.00 (0.00)	2.14 (1.46)	60.46 (7.78)	1.89 (1.37)
8	CS 306	6.59 (2.56)	1.99 (1.41)	2.35 (1.53)	21.55 (4.64)
9	CS 32	0.58 (0.76)	1.02 (1.01)	1.15 (1.07)	0.91 (0.95)
10	CS 327	13.85 (3.72)	24.51 (4.95)	8.79 (2.97)	28.21 (5.31)
11	CS 332	1.21 (1.10)	0.86 (0.93)	0.77 (0.88)	1.62 (1.27)
12	CS 333	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.11 (0.33)
13	CS 334	2.08 (1.44)	3.14 (1.77)	1.00 (1.00)	0.02 (0.14)
14	CS 338	2.60 (1.61)	1.34 (1.56)	0.66 (0.81)	1.94 (1.39)
15	CS 343	1.31 (1.14)	1.22 (1.10)	0.00 (0.00)	6.02 (2.45)
16	CS 349	3.15 (1.77)	3.52 (1.88)	3.81 (1.95)	3.72 (1.93)
17	CS 35	133.37 (11.55)	1.11 (1.05)	2.12 (1.46)	75.77 (8.71)
18	Cs 350	0.00 (0.00)	0.25 (0.50)	0.00 (0.00)	0.00 (0.00)
19	CS 354	0.00 (0.00)	3.59 (1.89)	6.77 (2.60)	0.00 (0.00)

20	CS 36	2.81 (1.68)	3.42 (1.85)	9.11 (3.02)	11.75 (3.43)
21	CS 38	2.66 (1.63)	1.24 (1.12)	2.53 (1.60)	3.56 (1.87)
22	CS 39	2.73 (1.65)	7.17 (2.68)	3.98 (2.00)	1.34 (1.16)
23	CS 41	3.97 (1.99)	2.55 (1.59)	2.69 (1.64)	5.88 (2.43)
24	CS 42	1.29 (1.14)	1.78 (1.33)	2.66 (1.63)	1.07 (1.03)
25	CS 47	1.57 (1.25)	4.69 (2.17)	4.41 (2.10)	3.26 (1.81)
26	CS 61	0.61 (0.78)	1.51 (1.23)	1.64 (1.28)	1.51 (1.23)
27	CS 65	2.14 (1.46)	2.91 (1.70)	2.93 (1.71)	1.32 (1.15)
28	CS 67	2.04 (1.43)	1.45 (1.20)	0.67 (0.82)	9.69 (3.11)
29	CS 69	0.92 (0.96)	0.81 (0.90)	0.33 (0.57)	2.20 (1.48)
30	CS 76	0.95 (0.98)	2.39 (1.55)	0.84 (0.91)	1.28 (1.13)
31	CS 77	5.97 (2.44)	3.85 (1.96)	4.86 (2.21)	8.00 (2.82)
32	ALR 2	1.57 (1.25)	1.12 (1.06)	0.73 (0.85)	1.12 (1.06)
33	B 95	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
34	BAU 13	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
35	DRG 17	6.11 (2.47)	68.76 (8.29)	51.38 (7.71)	6.58 (2.58)
36	GG 7	61.42 (7.83)	30.47 (5.52)	33.98 (5.82)	39.91 (6.32)
37	ICGS 1	9.75 (3.12)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
38	JL 24	0.99 (0.99)	1.89 (1.36)	0.85 (0.92)	1.08 (1.04)
39	K 134	21.39 (4.63)	64.92 (8.06)	29.94 (5.47)	11.87 (3.45)
40	M 13	1.82 (1.35)	0.00 (0.00)	9.95 (3.15)	6.27 (2.50)
41	M 335	3.05 (1.75)	0.00 (0.00)	0.63 (0.79)	3.30 (1.81)
42	OG 52-1	3.96 (1.99)	8.25 (2.87)	6.74 (2.60)	0.69 (0.83)
43	RHRG 12	2.98 (1.73)	0.11 (0.33)	0.30 (0.55)	1.58 (1.25)
44	Somnath	10.27 (3.20)	2.31 (1.52)	4.06 (2.01)	6.62 (2.57)
45	TAG 24	6.49 (2.54)	3.62 (1.90)	1.94 (1.39)	6.04 (2.45)
46	TAG 26	0.80 (0.89)	0.43 (0.65)	0.61 (0.78)	1.72 (1.31)
47	VRI 3	0.40 (0.63)	1.17 (1.08)	0.36 (0.60)	0.95 (0.97)
48	GG 2	270.54 (16.44)	61.01 (7.81)	68.76 (8.29)	60.85 (7.80)
49	GG 20	117.70 (9.20)	68.76 (8.29)	4.58 (2.14)	133.37 (11.55)
50	J 11	10.12 (3.18)	5.32 (2.30)	8.57 (2.92)	17.13 (4.13)
	S. Em. ±	**0.78**			
	C. D. at 5%	**2.18**			
	C.V. %	**70.15**			

** Data in parentheses are transformed values.

B : Kernels from bulk pods L : Kernels from large sized pods

M : Kernels from medium sized pods S : Kernels from small sized pods

Objective 2: Evaluation of Trichoderma sp. for bio-control efficacy against *A. flavus* under laboratory conditions

Antagonistic activity of seventeen isolates of *Trichoderma* belonging to eight species was studied under in-vitro conditions (bangle method) against *Aspergillus flavus* (table 3). Out of these isolates, two isolates viz. T 71 and T 29 showed more than 50 % inhibition of growth. The maximum inhibition (51.11%) of growth of *A. flavus* was exhibited by the isolates T 71 (T. viride) and T 29 (T. coningii), followed by T 219 (42.22%) and T 226 (42.22%) belonging to T. viride. The growth and sporulation studies of different isolates of Trichoderma revealed that out of seventeen isolates, four viz. T 28, T 93, T 219 and T 362 were very good sporulating while the isolates T 00, T 04, T 29, T 115 and T 126 showed good sporulation. The colony diameter after 3 days of inoculation was maximum (4.93 cm) in isolates T 00 and T 29 followed by T 219 (4.87 cm) and T 257 (4.80 cm). Based on these results it can be concluded that the isolates, T 71 and T 29 have antagonistic potential against A. flavus and can be used as bio-control agents in preventing aflatoxin contamination in groundnut.

Table 3: Inhibition of growth of *Aspergillus flavus* by different isolates of *Trichoderma* spp.

Isolate No.	*Trichoderma* sp.	Growth of *A. flavus* after 48 hr (in cm) (y)	Inhibition of *A. flavus* over control (%)	Over Growth of *Trichoderma* sp.	Growth and sporulation of *Trichoderma* isolates		
					Colony diameter	Sporulation**	Pigmentation after 3 days (cm)
T 00	*Trichoderma* sp.	2.20	26.67	N	4.93	+++	Y
T 04	*T. viride*	2.00	33.33	Y	4.30	+++	Y
T 22	*T. viride*	2.26	24.44	Y	3.93	+	Y
T 28	*Trichoderma* sp.	2.20	26.67	N	4.03	++++	N
T 29	*T. koningii*	1.46	51.11	Y	4.93	+++	N
T 71	*T. viride*	1.46	51.11	N	4.13	+	N
T 93	*T. hamatum*	2.26	24.44	Y	4.00	++++	Y
T 115	*T. viride*	1.94	35.56	Y	4.03	+++	Y
T 126	*T. harzianum*	2.66	11.11	N	4.23	+++	Y
T 170	*T. harzianum*	1.94	35.56	Y	4.30	+	Y
T 219	*T. viride*	1.74	42.22	N	4.87	++++	Y
T 226	*T. viride*	1.74	42.22	Y	4.10	++	N
T 257	*T. harzianum*	1.94	35.56	N	4.80	++++	Y
T 292	*T. hamatum*	2.46	17.78	N	4.13	++	N

T 354	*T. hamatum*	2.20	26.67	Y	4.03	++	N
T 362	*T. oiluliferum*	1.94	35.56	N	4.20	++++	Y
T 390	*T. harzianum*	2.00	33.33	N	4.33	++	N
Control							
(*A. flavus*)			3.00				

** Qualitative Scale for categorization of sporulation

\+ = Poor/ scanty

++ = Moderate

+++ = Good

++++ = Very Good

Overgrowth: Y= Overgrown, N= Not overgrown

Pigmentation: Y= Pigment production, N= No pigment production

Objective 3: Isolation of bio-control agents

Isolation of the bio-control agent viz. Trichoderma spp. was carried out on Trichoderma Selective Medium (Elad et al.,1981) from all the samples. A total of 42 isolates of Trichoderma spp. could be purified and maintained as single spore culture from these samples. These will be identified up to species level and is being evaluated for their antagonistic potential so as to see the feasibility of inclusion in the pre-harvest integrated aflatoxin management package.

Objective 4: Survey for incidence of aflatoxin contamination and sampling

A questionnaire and methodology for sampling to collect ancillary data were developed to conduct surveys for aflatoxin contamination. Two rounds of surveys were undertaken in the major rabi/ summer groundnut growing areas of Gujarat during March to May 2005. A total of 324 soil samples (185 from fallow land and 139 from cropped land) were collected. The samples were analysed for soil population of A. flavus by serial dilution method on Rose Bengal agar medium. The soil population of A. flavus in samples from cropped and fallow land varied from 0 - 67 x 103 spores/g soil and 0-25 x 103 spores/g soil, respectively. A total of 186 new isolates of A. flavus isolated, purified and are being maintained as single spore cultures on agar slants. Seven additional isolates of Trichoderma sp. were isolated and purified from these samples.

A total of 74 pod samples from rabi/ summer produce were analysed for level of aflatoxin contamination. The aflatoxin B1 level ranged from 0.1 to 300 mg/ kg seed (ppb) in the samples (Table 4). Majority of the samples (61 out of 74) from all the rabi summer growing districts of Gujarat showed AFB1 level below 5 ppb. About thousand farmers were contacted during summer 2005. The awareness among farmers was found lacking since aflatoxin contamination was not visible and hence went unnoticed. But a few progressive farmers (about 1%) were aware about this problem and were enthusiastic to know more about aflatoxin contamination and its management. The pamphlets of NRCG on Management of stem rot disease and aflatoxins in groundnut were distributed among farmers and they were made aware about the aflatoxin problem and its management.

Table 4: Aflatoxin content in samples from groundnut growing areas of Gujarat (Summer 2005)

District	Major *Talukas* covered under survey	Level of aflatoxin AFB1 (in µg/kg)						Total no of samples	Remarks
		0-10	11-20	21-30	31-40	41-50	> 50		
Junagadh	Mangrol, Kodinar, Una, Visavadar, Talala, Veraval, Sutrapada, Manavadar, Keshod Vanthali	26	1	-	-	-	5	32	Maximum levels of aflatoxin ranged between 90-270 µg/kg
Amreli	Amreli, Savarkundla, Rajula	6	-	-	-	-	-	6	-
Anand	Umreth, AICRP-G Centre	2	-	-	-	-	5	7	Maximum levels of aflatoxin -300µg/kg
Bhavnagar	Mahua, Talaja, Bhavnagar	9	-	-	-	-	-	9	-
Bhuj	Bhuj, Mandvi, Mundra Anjar	8	-	-	-	-	1	9	Maximum levels of aflatoxin -200µg/kg
S. K Nagar	Talod, Prantij	10	-	-	-	-	1	11	Maximum levels of aflatoxin -300µg/kg
	Total		**61**	**1**	**-**	**-**	**-**	**12**	**74**

Two rounds of survey of Kharif groundnut growing areas of Gujarat *viz.* Junagadh, Amreli, Porbander, Bhavnagar, Bhuj, Rajkot, Jamnagar and Surendranagar for aflatoxin contamination were undertaken during 2005. About 20-25 samples were taken from each district in each round of survey. A total of 306 soil samples (150 in the first round during August i.e. one month after sowing of the crop and 156 in second rounds in October 2005 i.e. before harvest of the crop) and 160 pod samples were collected from farmers' fields. The care was taken so as to collect the samples from those farmers field from which samples were collected in the first round so that the soil population of *A. flavus* at both the rounds could be correlated. The soil samples were analysed for population of *A. flavus* by serial dilution method on Rose Bengal Agar medium. The soil population of *A. flavus* in samples taken one month after sowing and just before harvest varied between 0.33 – 56.33 x 103 spores/g soil and x 103 spores/g soil, respectively (Table 5). From these samples 156 *Aspergillus spp.* were isolated and purified. The soil population of *A. flavus* was higher in the samples of Kharif from the same fields than the rabi/summer. The population increased towards the maturity of the crop as evident by higher soil population in samples of 2nd round that was taken one to two weeks before harvest of the crop. The maximum population recorded was about 70 x 103 spores per/ gm soil. The district which recorded low soil population (below 10 x 103 spores/gm soil) is Junagadh, Bhavnagar, and Bhuj.

Natural infection of *A. flavus* in Kharif 2005 samples from farmer's field and of on-station trials of NRCG were studied. The infection level varied between 0-4.5 percent. About 90% of the samples

showed zero infection level.

About 200 farmers were contacted during Kharif 2005. The awareness among farmers was found lacking since aflatoxin contamination was not visible and hence went unnoticed. But a few progressive farmers (about 1%) were aware about this problem and were enthusiastic to know more about aflatoxin contamination and its management. The pamphlets of NRCG on Management of stem rot disease and aflatoxins in groundnut were distributed among farmers and they were made aware about the aflatoxin problem and its management.

Table 5: Soil population of *A. flavus* in cropped land during *Kharif* 2005

District	Taluka	No. of samples	Population of *A. flavus* (x 10^3)	
			Before sowing	At harvest
Junagadh	Madihatiyana	3 (2 + 1)	18.67 – 21.67	5.30
	Vanthali	27 (12 + 15)	5.66 – 56.33	14.80 – 21.80
	Keshod	8 (2 + 6)	15.67 – 22.67	5.30 – 26.00
	Kodinar	3 (1 + 2)	9.67	17.50 – 22.30
	Una	4 (2 + 2)	22.33 – 68.33	19.50 – 20.30
	Kutiyana	3	-	15.00 – 22.00
	Ranavav	1	-	14.80
	Porbandar	3 (1 + 2)	8.33	14.30 – 23.00
	Bhalej	2	-	15.50 – 20.00
	Junagadh	2	-	17.80
	Total	**56 (20 + 36)**		
Bahvanagar	Mahuva	16 (10 + 6)	0.67 – 47.67	12.80 – 20.50
	Alang	3	-	9.00 – 14.00
	Talaja	20 (10 + 10)	0.67 – 35.00	10.30 – 21.50
	Bhavanagar	1	-	10.50
	Total	**40 (20 + 20)**		
Bhuj	Bhuj	5 (2 + 3)	1.00 – 3.33	14.5 – 20.00
	Mandvi	13 (6 + 7)	0.33 – 7.33	2.50 – 20.00
	Nakhatrana	7 (3 + 4)	3.00 – 24.33	3.00 – 18.50
	Mundra	8 (5 + 3)	2.00 – 14.33	5.80 – 11.50
	Anjar	7 (4 + 3)	2.33 - 6.00	4.8 – 14.8
	Total	**40 (20 + 20)**		
Amreli	Amreli	5 (4 + 1)	1.67 – 4.67	22.8
	Bagesara	9 (6 + 3)	1.33 – 5.00	23.33 – 31.50

	Dhari	9 (5 + 4)	1.00 – 5.00	23.50 – 30.30
	Lathi	3	-	27.00 – 30.00
	Khambha	2	3.00 – 6.37	-
	Rajula	6 (3 + 3)	0.33 – 2.00	24.00 – 32.30
	Savarkundla	7 (5 + 2)	1.33 – 8.33	26.30 – 30.33
	Vadiya	3	-	25.80 – 27.30
	Total	**44 (25 + 19)**		
Surendranagar	Surendranagar	12 (4 + 8)	4.00 – 25.00	9.30 – 38.50
	Muli	4 (2 + 2)	11.00 – 45.00	12.50 – 14.00
	Saayala	4 (2 + 2)	3.33 – 9.67	11.00 – 23.50
	Chuda	3	10.00 – 29.33	-
	Limdi	7 (2 + 5)	5.00 – 20.00	9.80 – 35.50
	Lakhatar	8 (5 + 3)	9.67 – 27.00	14.00 – 26.80
	Vadhavan	2	11.67 – 14.67	-
	Total	**40 (20 + 20)**		
Rajkot	Dhoraji	7 (5 + 2)	1.00 – 7.33	18.80 – 24.80
	Gondal	11 (5 + 6)	2.00 – 6.33	21.00 – 27.00
	Jetpur	6 (4 + 2)	1.00 – 7.67	23.50 – 31.50
	Lodhika	10 (4 + 6)	5.33 – 14.00	27.50 – 34.80
	Rajkot	4 (3 + 1)	6.33 – 8.33	32.33
	Upleta	8 (4 + 4)	1.67 – 4.33	25.00 – 33.8
	Total	**46 (25 + 21)**		
Jamnagar	Bhanvad	4 (2 + 2)	2.33 – 3.00	11.30 – 12.80
	Jam Jodhpur	8 (5 + 3)	1.67 – 21.67	14.00 – 23.50
	Jamnagar	5 (2 + 3)	6.00 – 6.67	23.00 – 31.00
	Kalavad	12 (6 + 6)	1.00 – 13.00	14.00 – 31.00
	Khambhalia	7 (3 + 4)	5.00 – 8.33	11.80 – 18.30
	Lalpur	3 (2 + 1)	2.67 – 3.33	15.3
	Dhrol	1	-	23.5
	Total	**40 (20 + 20)**		
	Grand Total	**306 (150 + 156)**		

The distribution pattern of the mycotoxigenic fungi in the soils of different districts was studied. Among the different species of *Aspergillus, A. flavus* was dominant in Junagadh (39.29%) and Amreli

(37.78%) districts where as the other species like *A. terreus* was dominant in Bhuj, Bhavnagar and Anand (Table 6) during summer 2005. During Kharif 2005, in most of the districts *A. flavus* dominated over the other species (Table 7). Over the seasons it is evident from the table 8 that during Kharif *A. flavus* population increases and becomes the dominant species leading to aflatoxin contamination of groundnuts.

Table 6: Distribution pattern of mycotoxigenic fungi in the soil of different districts of Gujarat during summer 2005

District	Percent distribution				
	A. flavus	*A. ochraceus*	*A. terreus*	*A. nidulans*	*Penicillium spp.*
Junagadh	39.29	5.95	23.81	10.71	20.24
Amreli	37.78	11.11	17.78	2.22	31.11
Bhuj	22.86	2.86	48.57	8.57	17.14
Bhavnagar	13.79	13.79	24.14	6.90	41.38
Anand	18.18	9.09	54.55	9.09	9.09

Table 7: Distribution pattern of mycotoxigenic fungi in the soil of different districts of Gujarat during *Kharif* 2005

District	Percent distribution				
	A. flavus	*A. ochraceus*	*A. terreus*	*A. nidulans*	*Penicillium spp.*
Junagadh	51.35	2.70	10.81	21.62	13.51
Amreli	48.28	6.90	13.79	17.24	13.79
Rajkot	20.83	0.00	16.67	25.00	37.50
Jamnagar	21.05	0.00	21.05	36.84	21.05
Surendranagar	56.41	0.00	2.56	23.08	17.95
Porbandar	52.94	0.00	5.88	11.76	29.41
Bhuj	41.38	0.00	0.00	44.83	13.79
Bhavnagar	68.97	0.00	10.34	6.90	17.24

Table 8: Distribution pattern of mycotoxigenic fungi in the soil of different districts of Gujarat over the seasons

District	Percent distribution									
	A. flavus		*A. ochraceus*		*A. terreus*		*A. nidulans*		*Penicillium spp.*	
	Sum 05	**Kh 05**	**Sum 05**	**Kh 05**	**Sum 05**	**Kh 05**	**Sum 05**	**Kh 05**	**Sum 05**	**Kh 05**
Junagadh	39.29	51.35	5.95	2.70	23.81	10.81	10.71	21.62	20.24	13.51
Amreli	37.78	48.28	11.11	6.90	17.78	13.79	2.22	17.24	31.11	13.79
Bhuj	22.86	41.38	2.86	0.00	48.57	0.00	8.57	44.83	17.14	13.79
Bhavnagar	13.79	68.97	13.79	0.00	24.14	10.34	6.90	6.90	41.38	17.24

Objective 5: Morphological and molecular characterization of isolates of *Aspergillus sp.*

Morphological characterization

A total of 284 new isolates of *Aspergillus spp. (A. flavus and A. ochraceus)* isolated, purified and are being maintained as single spore cultures on agar slants. The morphological and growth characteristics of all the isolates were studied on solid medium (PDA medium). The growth habit, colour of colony and the diameter after four days were recorded for all the isolates. The isolates varied for their sclerotial size, growth rate and sporulation. After proper identification of species they were accessioned (as per the details given in information sheet in table 9) in the **Repository of Isolates of *Aspergillus*** at NRCG. Lyophilization of all the isolates accessioned is being done.The isolates could be categorized in the six groups based on their colony and growth characteristics (Table 10). Aflatoxigenicity of isolates of Aspergillus spp. (mostly *A. flavus*) using ammonia vapour method was carried out. About 100 isolates appeared to be non-aflatoxigenic which was further being confirmed using indirect competitive ELISA.

Table 9: Information sheet for accession of isolates

List of cultures of *Aspergillus* at NRCG Accession

AMRELI (Code 02)

Sl. No	NRCG Accession No.	Old Ref. No.	Sample No. / Survey Sheet No.	Type of sample (Seed/ Soil/ haulm)	Village	Taluka	District	*Aspergillus* spp.	Date of Collection
1	NRCG 02 001	Amreli 1 (S1)	74 / I	Soil	Manekwadad	Bagasra	Amreli	*A. terreus*	08.04.05
2	NRCG 02 002	Amreli 2A (S1)	75 / I	Soil	Manekwadad	Bagasra	Amreli	*A. flavus*	08.04.05
3	NRCG 02 003	Amreli 2B (S1)	75 / I	Soil	Manekwadad	Bagasra	Amreli	*A. nidulens*	08.04.05
4	NRCG 02 004	Amreli 3 (S1)	76 / I	Soil	Manekwadad	Bagasra	Amreli	*A. flavus*	08.04.05

Table 10: Characteristics of different groups of isolates of *Aspergillus* spp.

Group	Reference Isolate	Colony characters		Growth characterstics		*Aspergillus* spp.
		Front	Reverse	Growth habit	Sporulation	
A	NRCG 01 018	Parrot green	Light greenish yellow	Surface mycelium scanty, fast growing	Profuse	*A. flavus*
B	NRCG 03 004	White fluffy with yellow sporulation	Light lemon yellow	Fast growth with cottony white fluffy mycelium	Moderate sporulation	*A. flavus*
C	NRCG 01 027	White turning to green in circular rings	Dark brownish yellow	Fast growing forming dark greenish rings of surface mycelium	Dark greenish sporulation.	*A. nidulans*
D	NRCG 01 015	Dark creamy white with	Creamy yellow	Moderate growth with aerial	Profuse sporulation on	*A. ochraceus*

		yellowish brown sporulation		mycelium and conidiophores	aerial erect conidiophores	
E	NRCG 03 003	Ochraceus center with white margin	Lemon yellow	Moderate mycelium	Sporulation moderate in center	*A. terreus*
F	NRCG 02 012	Fluorescent yellow green	Light lemon yellow	Slow growing colony with fluorescent yellow sporulation	Moderate sporulation	*Penicillium sp. (?)*
G	NRCG 02026	Dark olive green	Light greenish yellow	Surface mycelium scanty fast growing	profuse	*A. flavus*

Molecular characterization of Aspergillus spp.

The isolates of Aspergillus spp collected during summer 2005 from six districts of Gujarat were sub-cultured and genomic DNA was isolated, purified and estimated. Standardization of protocol for isolation of genomic DNA of Aspergillus flavus was done. The DNA was tested for their suitability for PCR by RAPD with random primers and was found to be amplifying.

Objective 6: Evaluation of techniques for prevention of pre-harvest contamination

During Kharif 2005, the following three field experiments were undertaken at NRCG to study prevention of pre-harvest contamination methods

1. Evaluation of a package of management practices for prevention of pre-harvest aflatoxin contamination.
2. Effect of application of gypsum and micronutrients on aflatoxin contamination under field conditions.
3. Long-term experiment on groundnut-garlic rotation to see the effect on aflatoxin contamination.

Artificial inoculation with severe strain of A. flavus at NRCG was done thrice in the experiment no. 1 and 2 and soil was made sick. The soil samples from 0-5 cm and 10-15 cm depth from three places were taken for nutrient status analysis before sowing to estimate the exchangeable Ca, S, Zn, and Fe in pod zone and root zone in experiment no. 2. The samples from these experiments were analyzed for seed infection by A. flavus and aflatoxin contamination levels. The aflatoxin contamination levels in these experiments are given in tables 11 to 13. The improved integrated management package reduced the contamination significantly over farmers' practice. The treatments in the experiment no. 2 and 3 showed non-significant differences.

Table 11: Effect of Integrated management practice vis-à-vis Farmers' practice on pre-harvest aflatoxin contamination

Variety	Aflatoxin B_1 content (µg/ kg)*							
	B		L		M		S	
	FP	IP**	FP	IP	FP	IP	FP	IP
GG-2	371.76	1.20	221.59	1.32	266.99	1.02	403.66	1.11
	(19.28)	(0.88)	(14.88)	(0.83)	(16.34)	(0.82)	(20.09)	(0.86)
J-11	208.50	0.55	177.15	1.23	195.79	1.66	140.62	44.36
	(8.51)	(0.43)	(8.04)	(0.93)	(8.52)	(0.94)	(7.06)	(4.09)
GG-20	562.33	0.16	536.54	0.46	555.11	0.48	563.99	0.52
	(23.17)	(0.26)	(23.15)	(0.46)	(23.53)	(0.40)	(23.74)	(0.57)
GAUG-10	478.25	1.48	472.05	2.08	463.05	2.16	462.68	1.59
	(21.85)	(0.99)	(21.69)	(1.18)	(21.50)	(1.18)	(21.49)	(0.96)
S. Em.	4.16	0.28	3.72	0.34	3.87	0.33	3.71	1.72
C. D. at 5%	14.82	N.S	12.86	N.S.	13.38	N.S	12.85	N.S
C.V.%	47.37	75.90	43.93	69.87	44.91	69.03	43.17	184.05
S. Em. (FP x IP)	3.06		3.49		3.30		4.16	
C. D. at 5% (FP xIP)	N.S.		N.S.		N.S.		N.S.	
C.V.% (FP x IP)	46.38		55.36		51.15		59.93	

*Data in parentheses are Arc sine transformed values

B : Kernels from bulk pods

L : Kernels from large sized pods

M : Kernels from medium sized pods

S : Kernels from small sized pods

Experimental design: RBD

Treatments: FP: Farmers' method **IP**: Integrated management practice

No. of genotypes : 4 (**SB**- GG 2, J 11; VB- GG 20, GAUG 10)

No. of replication: 3

Plot size : 5 x 4.5 m^2

Spacing: Spanish Bunch (**SB**) - 45x 10 cm, Virginia bunch (**VB**): 75 x 10 cm

****Integrated management practices included:**

a. Seed treatment with Bavistin @ 2 g/kg

b. Soil application of *Trichoderma harzianum* isolate 170 formulated in castor cake as carrier (500Kg castor cake+ 2.5 Kg *Trichoderma* multiplied in sorghum medium/ hectare)

c. Application of recommended dosages of fertilizers (12.5: 25: 0)

d. Application of gypsum @ 500Kg/ha @at first flowering/pegging

e. Soil application of castor cake @ 500 Kg/ha

f. Application of micronutrients Zn, Fe (Zn as $ZnSO_4$ @20 Kg/ha and Fe as $FeSO_4$ as 0.5 % foliar spray, two spray- 1st Spray at 35-40 DAS, 2nd at 50-55 DAS)

g. Control of pests and diseases (Monocrotophos & Bavistin need based spray)

h. Supplementary irrigation during dry spell

i. Harvest at right maturity

The results showed that there was up to 94.72% prevention of aflatoxin contamination in improved practices over farmers' practice

Table 12: Effect of gypsum and micronutrients on aflatoxin contamination

Treatments	Aflatoxin B1 content (µg/ kg)			
	B	L	M	S
T1	0.60 (0.57)	1.28 (1.13)	0.88 (0.54)	1.48 (1.16)
T2	2.15 (1.39)	1.07 (0.96)	1.84 (1.20)	1.91 (1.26)
T3	2.01 (1.33)	0.93 (0.90)	2.23 (1.46)	1.86 (1.29)
T4	4.10 (1.87)	2.23 (1.46)	0.94 (0.79)	3.93 (1.91)
T5	0.12 (0.20)	1.86 (1.10)	1.30 (1.02)	0.46 (0.39)
T6	96.91 (10.80)	2.37 (1.12)	1.19 (1.08)	0.54 (0.60)
T7	2.73 (1.60)	1.67 (1.25)	8.14 (2.37)	2.00 (1.39)
T8	1.81 (1.32)	1.39 (1.12)	1.94 (1.13)	2.20 (1.33)
S.Em ±	3.35	0.39	0.57	0.36
C.D. at 5%	N.S.	N.S.	N.S.	N.S.
C.V. %	242.92	60.20	81.95	53.75

**Data in parentheses are Arc sine transformed value

B : Kernels from bulk pods L : Kernels from large sized pods

M : Kernels from medium sized pods S : Kernels from small sized pods

Treatments:

T1: Soil application of gypsum @ 500 Kg/ha at pegging

T2: Soil application of Zn as $ZnSO_4$ @ 20 Kg/ ha

T3: Foliar application of Fe as $FeSO_4$ (0.5%), two sprays at 35-40 DAS and 50 DAS

T4: T1+ T2 ; T5: T1 + T3; T6: T2+ T3; T7: T1+ T2+ T3; T8: Control

Variety: GG 2 Replication: 3 Plot Size: 5 x 5.4 m^2

Table 13: Long-term experiment on crop rotation to see the effect on aflatoxin contamination during *Kharif* 2005

Verities	Treatments	Aflatoxin B1 content (µg/ kg)			
		B	L	M	S
GG-2	1	259.59 (12.41)	131.88 (8.64)	174.75 (9.81)	224.42 (11.12)
	2	102.92 (7.50)	49.00 (5.51)	41.00 (5.49)	50.28 (5.61)
	3	139.63 (8.06)	216.05 (8.99)	209.40 (9.03)	200.42 (9.01)
	4	0.41 (0.37)	1.34 (1.06)	1.17 (1.07)	1.08 (0.84)
	S. Em. +	3.50	4.35	4.42	4.59
	C.D. at 5%	N.S.	N.S.	N.S.	N.S.
	C.V. %	85.57	124.68	120.61	119.62
J-11	1	1.09 (0.60)	0.46 (0.39)	0.31 (0.32)	0.58 (0.44)
	2	1.15 (0.85)	2.64 (1.22)	4.97 (1.74)	5.37 (1.62)
	3	1.21 (0.87)	2.06 (1.15)	1.49 (0.96)	4.06 (1.61)
	4	1.27 (0.89)	1.58 (1.01)	0.74 (0.66)	1.02 (0.78)
	S. Em. +	0.29	0.33	0.42	0.41
	C.D. at 5%	N.S.	N.S.	N.S.	N.S.
	C.V. %	63.12	61.10	79.72	63.72
S. Em. + (GG2 x J11)		1.52	1.14	1.14	1.36
C.D. at 5% (GG2 x J11)		N.S.	N.S.	N.S.	N.S.
C.V. % (GG2 x J11)		91.22	77.09	77.09	83.15

Data in parentheses are Arc sine transformed values

B: Kernels from bulk pods L: Kernels from large sized pods

M: Kernels from medium sized pods S: Kernels from small sized pods

Treatments:

Treatments: Main Plot: 2 varieties (GG 2, and J 11)

Subplot: **1.** Garlic (var.: local), **2.** Onion (Var.: Nasik red),

3. Groundnut (Var: GG2), **4.** Control (fallow in Rabi/summer)

Replication: 3; Plot size: 6.3 x 8 m^2; Experimental Design: Split Plot design

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- Singh, A.L. and Vidya chaudhari, 2006. Macronutrient requirements of groundnut I. Effects on the growth, dry matter production, chlorophyll, nodulation, transpiration, flowering, podding and pod yield. Indian J. Plant Physiology (in press)
- Nautiyal, P. C., Mariko Shono and Yoshinobu Egawa, 2005. Enhanved thermotolerance of the Vegetative parts of MT-sHSP transgenic tomato lines, Scientia Horticulturae 105:393-409.

Meetings/ Trainings Attended

Dr.M.P.Ghewande

- Annual Kharif Groundnut workshop held at TNAU, Coimbatore from – 11-13 April 2005 Annual rabi/ summer Groundnut workshop at ICRISAT.
- Participated in Farmers Training as resource person sponsored by NABARD at NRCG, during December 22-24, 2005.
- Participated in State level Officers Training on Groundnut Production Technology organized by Dept. of Agril. Under ISOPOM during 17-19 January-2006 at Narendrapur, Kolkata.
- Participated in Training Programme on quality seed production in groundnut at NRCG during 3-5 March, 2006.

Dr.T.V.Prasad

- Training on "Chemoreception and behavioural responses in insect: Electroantennography and olfactometry" organized by Project Directorate of Biological Control, Bangalore from 18th to 23rd July, 2005.
- Participated in Farmers Training as resource person sponsored by NABARD at NRCG, during December 22-24, 2005.

Dr.Vinod Kumar

- Attended Annual Review meeting of ICAR Net work project "Prevention and management of Mycotoxin contamination in commercially important Agricultural commodities" held at NCIPM, New Delhi, 15th December 2005.
- Training on "Chemoreception and behavioural responses in insect: Electroantennography and olfactometry" organized by Project Directorate of Biological Control, Bangalore from 18th to 23rd July, 2005.
- Participated in Farmers Training as resource person sponsored by NABARD at NRCG, during December 22-24, 2005.

STAFF LIST OF NRCG AS ON 31ST MARCH, 2006

DR.M.S.BASU	DIRECTOR
DR. M.P. GHEWANDE	Principal Scieutin
DR. I.K. GIRDHAR	PRI. SCI.
DR.J.B.MISRA	PRI.SCI.
DR.P.C.NAUTIYAL	PRI.SCI.
DR.DEVI DAYAL	Senior Scieutin
DR.A.L.SINGH	SR.SCIE.
DR.T.RADHAKRISHNAN	SR.SCIE.
DR. K. RAJGOPAL	SR. SCIE.
DR.A.L.RATHNA KUMAR	SR.SCIE.
DR.RINKU DEY	SR.SCIE.
DR.K.K.PAL	SR.SCIE.
DR.S.K.BERA	SR.SCIE.
DR.CHUNI LAL	SR.SCIE.
SH.G.D.SATISHKUMAR	Scientist
SH.G. GOVID RAJ	SCIE..
DR.HARIPRASANNA K	SCIE.
DR.T.V.PRASAD	SCIE.
SH.V.V.SUMANTH KUMAR	SCIE.
DR.VINOD KUMAR	SCIE.
DR.R.S.TOMAR	Farm Superendentent T-6
SH.M.M.DAS	Techical Officer, T-6
MS.S.M.CHAUHAN	T..O., T-6
SH.V.K.SOJITRA	T..O., T-6
SH.V.G.KORADIA	T..O., T-6
SH.D.M.BHATT	T..O., T-6
SH.H.B.LALWANI	T..O., T-6
SMT. VEENA GIRDHAR	T..O., T-6
DR.D.L.PARMAR	T..O., T-6
SH.C.P.SINGH	T..O., T-6
SH.N.R.GHETIA	T..O., T-6

	T..O., T-6
SH.P.V.ZALA	T..O., T-6
SH.H.M.HINGRAJEA	T..O., T-6
SH.RANVIR SINGH	T..O., T-6
SH.H.K.GOR	T..O., T-6
DR.J.R.DOBARIA	T..O., T-6
DR.S.D.SAVALIA	T.O. T-5
SH.P.R.NAIK	T.O. T-5
SH.P.K.BHALODIA	T.O. T-5
MRS.V.S.CHAUDHARY	T.O. T-5
SH.B.M.CHIKANI	T.O. T-5
SH.VIRENDRA SINGH	T.O. T-5
SH.M.V.GEDIA	T.O. T-5
SH.D.R.BHATT	Technical Assistant T-4
SH.A.D.MAKWANA	T.A.T-4
SH.R.D.PADAVI	T.A.T-4
SH.H.V.PATEL	T.A.T-4
SH.V.K.JAIN	T.A.T-4
SH.SURAJ PAL	T.A.T-4
SH.G.J.SOLANKI	T.A.T-4
SH.PRABHU DAYAL	T.A.T-3
SH.SUGAD SINGH	T.A.T-3
SH.C.B.PATEL	TRACTOR DRIVER T – 3
SH.J.G.KALARIA	Artist-cum-Photographar. T- 3
SH.A.M.VAKHARIA	DRIVER T – 3
SH.K.H.KORADIA	ELECTRICIAN T-3
SH.P.B.GARCHAR	T.A.T-2
SH.PITABAS DAS	DRIVER T –2
SH.G.G.BHALANI	DRIVER T – 2
SH.N.M.SAFI	TRACTOR DRIVER T – 2
SH.B.M.SOLANKI	ADMN.OFFICER
SH.S.K.GHOSH	Finance & Accomts Officer
SH.ARVIND	Assistant Admin Officer
SH.DILIP KAR	

MS.ROSAMMA JOSEPH	Stenographer
SH.Y.S.KARIA	Junior.STENO.
SH.L.V.TILWANI	JR.STENO.
SH.J.B.BHATT	Assistant
SH.R.T.THAKAR	ASSTT.
MS.K.A.VASANI	ASSTT.
MS.S.VENUGOPALAN	Savier.Clerk
MS.M.N.VAGHASIA	SR.CLERK
SH.R.D.NAGWADIA	Junior or Clerk
SH.C.G.MAKWANA	JR.CLERK
SH.H.S.MISTRY	JR.CLERK
SH.KHER M.B.	Secaning Supervisor
SH.N.M.PANDYA	SSG 4
SH.D.M.SACHANIA	SSG 4
SH.C.N.JETHWA	SSG 3
SH.B.K.BARIA	SSG 3
SH.R.B.CHAWDA	SSG 3
SH.M.B.SHEIKH	SSG 2
SH.J.G.AGRAWAT	SSG 2
SH.R.V.PUROHIT	SSG 2
SH.V.N.KODIATAR	SSG 2
SH.K.T.KAPADIA	SSG 2
SH.G.S.MORI	SSG 1
SH.P.M.SOLANKI	SSG 1
SH.R.P.SONDARWA	SSG 1
SH.A.D.MAKWANA	SSG 1
SH.V.M.CHAWDA	SSG 1
MS.D.S.SARVAIYA	SSG 1
SH.N.G.VADHER	SSG 1
SH.B.J.DABHI	SSG 1
SH.P.N.SOLANKI	SSG 1

STAFF STRENGTH

Total staff in NRCG, and the Number of SC/ST and OBC employees as on 31.3.2005-06.

Category of staff	Sanctioned	Filled	SC	ST	OBC
Scientific	39	20	02	-	03
Technical	39	41	06	05	04
Admn.	13	13	02	-	02
Supporting	19	19	05	03	08
Total	110	103	15	08	17

DEPARTMENTAL PROMOTION COMMITTEE

DPC meeting was held on 20.6.2005 to consider the probation clearance of the following scientists

Sl. No.	Name of Scientist	Discipline	Date of Clearance of Probation	Date of Confirmation
01.	Dr. Hariprasanna K., Scientist	Pl. Breeding	17.4.2005	17.4.2005
02.	Dr. Vinod Kumar, Scientist	Pl. Pathology	17.4.2005	17.4.2005
03.	Dr. T.V. Prasad, Scientist	Entomology	17.4.2005	17.4.2005
04.	Shri V.V. Sumanth Kumar, Scientist	Computer Application	17.4.2005	17.4.2005

- Research Advisory Committee Meeting was held during 27-29/10/2005.

FINANCE & ACCOUNTS

EXPENDITURE STATEMENT FOR THE YEAR 2005-06

Rs. in Lakhs

Sr. No.	Budget Head	Non Plan			Plan		
		BE	RE	Expenditure	BE	RE	Expenditure
1	Estt. Charges	209.00	185.50	180.54	0.00	0.00	0.00
2	Wages	17.00	16.00	16.42	0.00	0.00	0.00
3	O.T.A.	0.00	0.00	0.00	0.00	0.00	0.00
4	T.A.	3.60	4.50	4.50	13.00	10.00	10.00
5	HRD	0.00	0.00		2.00	0.00	0.00
6	Other Charges including Equipment	22.50	26.00	23.77	90.00	140.12	140.12
7	Works	6.00	6.00	0.48	91.50	55.38	55.37
	Total	258.10	238.00	225.71	196.50	205.50	205.49

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