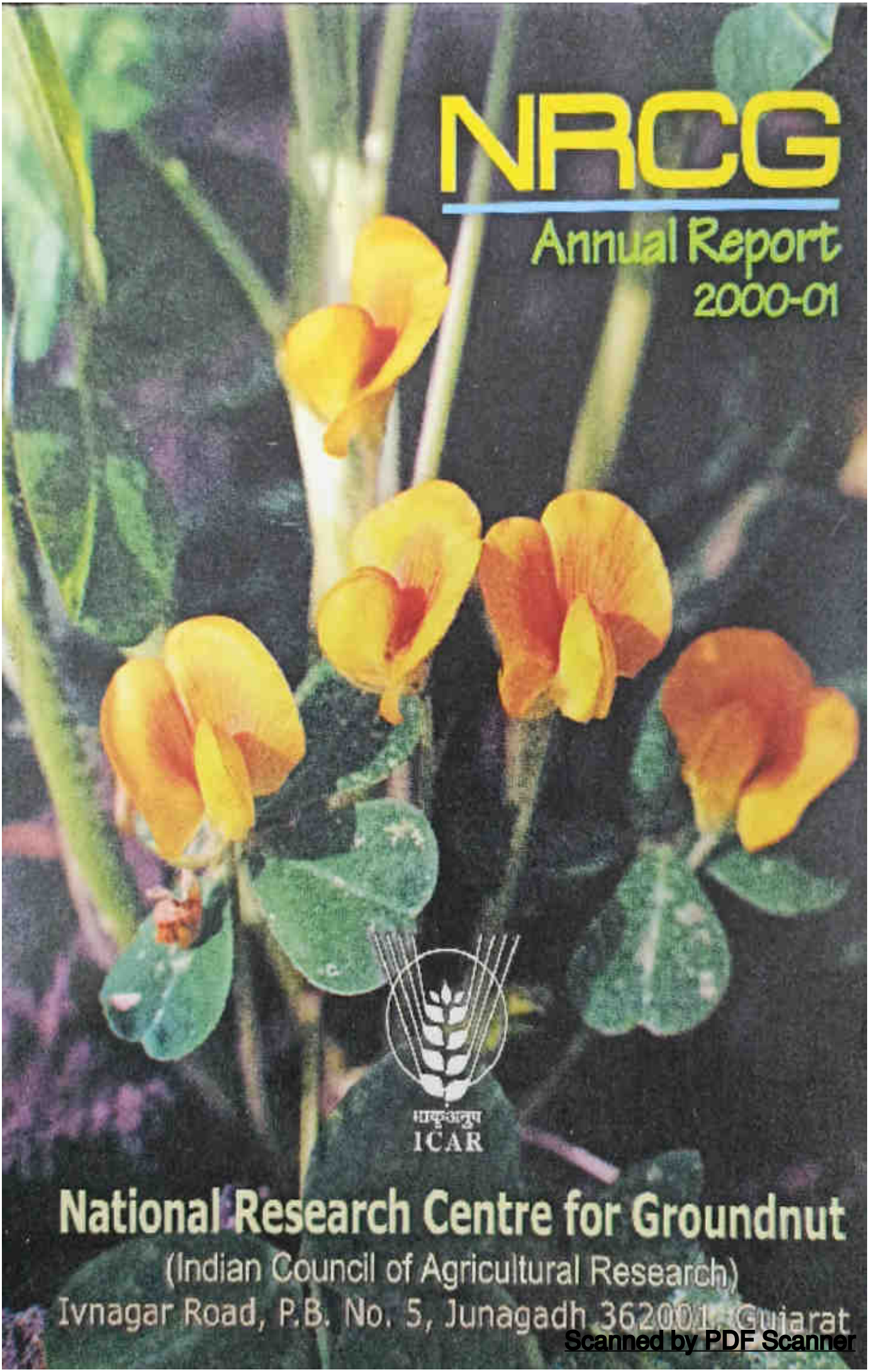

ANNUAL REPORT

2000-2001

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

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Compiled and Edited by :
Dr. Radhakrishnan T
Dr. K. Chandaran

Summary in Hindi by :
C. P. Singh

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Dr. M S Basu
Director, NRCG,
Junagadh-362 001

PREFACE

It gives me an immense pleasure in bringing out the annual report of the National Research Centre for Groundnut for the year 2000-2001.

During this year, emphasis was laid on problems of national interest to meet the challenges of groundnut production systems under different farming situations. Extensive efforts have been made to augment, characterize and distribute the germplasm of groundnut to the researchers across the country. Many advanced breeding lines have been developed for incorporating resistance against major biotic- and abiotic-stresses. Genetics of different morphological traits have been studied. In a holistic approach, the interaction of cultivars of intercrops on the cropping system was studied in detail. An exhaustive study was conducted in four districts of Gujarat, four in Andhra Pradesh and two in Karnataka to map low- and high-risk aflatoxin contamination regions for production of aflatoxin-free groundnuts. The nutrient dynamics under different groundnut based cropping system has been studied. By using the infrastructure and manpower at the Outreach Centre at Bhubaneswar, efforts were made for bringing groundnut under non traditional areas and rice fallows. Steps were also taken to delve into the biotechnological aspects by developing protocols for genetic transformation and molecular characterization.

Thus a pace of research that was set in the past was further accelerated and the NRCG continued to march in a resolute manner towards the set goals.

We shall be grateful to receive suggestions, if any, which would help us to improve the quality our work and also the content of future reports

(M S Basu)

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सारांश:

खरीफ, 2000 की अवधि में परिवर्त्य सड़न (collar rot) की आनुवंशिकी के अध्ययन हेतु 20 संकर बनाये गए। भविष्य में उपयोग के लिए गिरनार-1 के 146 स्थिर परिवर्तियों, 220 अग्रिम प्रजननिक कल्चरों, 26 अन्तर्जातीय व्युत्पन्नों, 153 जननद्रव्यों तथा 30 विमोचित किस्मों को मिलाकर कुल 575 जीन प्ररुपों का बहुगुणन किया गया। पीढ़ियों को आगे बढ़ाने के क्रम में 24, 17, 4, 17 एवं 9 संकरों को क्रमशः F2, F3, F4, F5 तथा F6 पीढ़ियों में अग्रसारित किया गया। विभिन्न वांछनीय गुणों के लिए F4 में 21, F5 में 56 तथा F6 में 6 संकरों का चयन किया गया। स्पैनिश किस्मों के परीक्षण में राष्ट्रीय चेक JL 24 की तुलना में पी बी एस संख्या के चार कल्चरों PBS 11065, 12018, 28008 तथा 24008 को उत्कृष्ट पाया गया। वर्जीनिया किस्मों के परीक्षण में राष्ट्रीय चेक Kadiri 3 की तुलना में तीन कल्चरों PBS 24030, 24006 तथा 24022 को उत्कृष्ट पाया गया। चेक की चारों प्रजातियों की अपेक्षा PBS 24008 कल्चर में सेलिंग प्रतिशत अधिक होने के अलावा दानों का भार भी अधिक पाया गया। JL 24 X ICGV 87280, R33-1 X ICGV 87280, R33-1 X ICG 3001 तथा R33-1 X ICE899 क्रासों के F1 से प्राप्त बीजों को कॉलर रॉट संक्रमण के प्रति प्रतिरोधी पाया गया। अग्रिम प्रजननिक लाइनों की 5 तथा 24 लाइनों को क्रमशः पछेती पर्णछब्बा (LSS) के प्रति प्रतिरोधक तथा मध्यम प्रतिरोधक पाया गया। पांच प्रजननिक लाइनों को आल्टरनेरिया के प्रति मध्यम प्रतिरोधक पाया गया। फलियों में जाली (reticulation) के अध्ययन में सभी तीनों संकरों के F2 में पृथकीकृत नमूनों में बिना जाली : मध्यम जाली के अनुपात 13:3 को बिल्कुल सही पाया गया जो कि जीन प्रतिक्रिया की इन्हिबिटरी प्रकार को दर्शाता है, एक अन्तर्राष्ट्रीय पर्ण रोग प्रतिरोधी किस्मों के परीक्षण में चेक गिरनार-1 की तुलना में जीन प्ररुपों ICGV 96225 तथा 96248 को अगेती व पछेती पर्णछब्बा रोगों के प्रति, 4 के विरुद्ध 1 के स्कोर की दर से प्रतिरोधक पाया गया।

विभिन्न आनुवांशकीय गुणों के अध्ययन के लिए कुल 40 क्रास बनाये गये। पीढ़ी अग्रसारित करने के क्रम में F_2, F_3, F_4, F_5 तथा F_6 पीढ़ियों में क्रमशः 25, 29, 35, 37 तथा 2 क्रास आगे बढ़ाये गये। विभिन्न इच्छित गुणों के लिए F_4 में 25, F_5 में 117 तथा F_6 में 27 चयन किए गए। एस. एल. ए. के लिए ICGV 86031, TAG 24 तथा TMV 2 (NLM) जनकों की पहिचान अच्छे सामान्य संयोजकों के रुप में की गयी। विशिष्ट पर्ण क्षेत्र (SLA) को बुआई के 45-85 दिनों के बाद मापने की अपेक्षा बुआई के 65 दिनों बाद मापना बेहतर पाया गया। दो वर्षों के मूल्यांकन के आधार पर, 15 माह तक भन्डारण के बाद जनक GG_2(<5% अंकुरण) की तुलना में जीन प्ररुपों FSD 7, 11, 25, 29, 46, 68 तथा 71 की पहचान अच्छी वैविक शक्ति (>75% अंकुरण) के साथ की गयी। बारानी मौसम में उगाये गये मूंगफली (*Arachis hypogtea* L.) के 12 जीन प्ररुपों के अंकुरण के 45 दिन बाद नमूना लेने पर पत्तियों में बाह्य त्वचा पर मोम की मात्रा (EWL) में आनुवांशकीय भिन्नता सार्थक रुप से अवलोकित की गयी। छै: जीन प्ररुपों में अंकुरण के 75 तथा 95 दिनों बाद भी पत्तियों पर मोम की मात्रा (EWL) के निर्धारण से संकेत मिला है कि पत्तियों पर मोम की मात्रा (EWL), फसल की आयु बढ़ने के साथ बढ़ती जाती है। एक दूसरे प्रयोग जिसे ग्रीष्म काल (फरवरी-मई) में लगाया गया, में जब अंकुरण के 42-75 दिन बाद की अवधि में नियमित सिचाई को रोककर फसल को नमी की कमी के दबाव में रखा गया तो 6 जीन प्ररुपों में जल संतुप्तता की कमी (WSD) की मात्रा में बढ़ोत्तरी तथा पत्तियों में मोम की मात्रा (EWL) में सार्थक आनुवांशिक भिन्नता पाई गयी।

लौह अल्पता जनित हरिमहीनता की आनुवंशिकी के अध्ययन के लिए विपरीत संकरीकृत संकरों सहित 12 संकर बनाये गये। क्लोरोफिल 'a' तथा क्लोरोफिल की कुल मात्रा के लिए F_1 के 12 x ICGV 86031 तथा ICGV 86031 x 12 के मध्यमानों में विपरीत भिन्नता सार्थक पायी गयी। क्लोरोफिल की मात्रा के लिए ICGV 86031 तथा PBS 21063 जनकों को उत्तम संयोजक पाया गया। जीन प्ररुपों PBS 21031, 12012, 24004, 12124 तथा 12126 को लौह अल्पता जनित हरिमहीनता के लिए सहिष्णु के रुप में श्रेणीकृत किया गया। नमी के दबाव की परिस्थिति के अन्तर्गत मिश्रित

एकलीय परीक्षण में किस्मों व मिश्रित किस्मों (GG 2+JL 24+SB X1), (ALR 1+GG 2+SB X1) तथा (ALR 2+SB X1+TG 26) में से TG 26 (1384 किग्रा०/है०) तथा GG 2 (1120 किग्रा०/है०) में अधिक उपज दर्ज की गयी ।

जल उपयोग क्षमता (WUE) पर बहु-स्थानीय परीक्षण में प्रथम दस प्रविष्टियों यथा: JUN 17, TIR 44, JUN 15, JUN 13, JAL 11, TIR 16, ICR 40, JUN 24, JAL 30 तथा JAL 33 ने औसतन 1546 से 1499 किग्रा०/है० तक उच्च फली उत्पादन दर्शाया । जीन प्ररूपों PBS 24004, PBS 29017 तथा PBS 30008 को चिन्हांकित किया गया ।

पांच जीन प्ररूपों यथा: TKG 19 A, TG 45, TG 48, K 4 तथा VR 13 ने दोनों रोगाणुओं एसपर्जिलस नाइजर तथा स्क्लेरोशियम रोल्फसी के प्रति शुष्क बीजों में प्रतिरोधकता दर्शायी । खेत की परिस्थितियों में 81 जीन प्ररूपों में से 13 जीन प्ररूपों जैसे; M 197, RS 138, TMV 12, ALR 2, Dh 3-30, TKG 19A, Karad 4-11, TG 17, TMV 17, ICGV 86594 (विमोचित प्रजातियां); PBS 29030, PBS 20507 (एन. आर. सी. जी. की अग्रिम प्रजननिक लाईनें) तथा जनन्द्रव्य ICG 7887 को तना सड़न के संक्रमण से मुक्त पाया गया ।

मूंगफली के साथ 3:1 के अनुपात में बाजरा के अन्तरशस्यन+बुआई के 55 दिन बाद 5% की दर से राई की खली के जलीय सत्व के छिड़काव ने अगेती पर्णधब्बा की सघनता को 87% एवं पछेती पर्णधब्बा की सघनता को 81% तक सार्थकरूप से कम किया । राई की खली का जलीय सत्व पछेती पर्णधब्बा एवं रस्ट की फफूंदी के बीजाणुओं के अंकुरण को रोकता है।

भण्डारकर्ताओं की सक्रिय भागीदारी के साथ एफ्लाटॉक्सिन के कम व अधिक संक्रमण वाले क्षेत्रों को मापने का एक नवीनतम कदम उठाया गया । एसपर्जिलस फ्लैवस द्वारा बीजों में संक्रमण व उपनिवेशन तथा फफूंदी द्वारा मिट्टी में संक्रमण का मूल्यांकन करने के लिए दस जिलों (जूनागढ़, राजकोट, अमरेली एवं पोरबन्दर-गुजरात के; करनूल, कुडप्पा, अनन्तपुर एवं चित्तूर-आन्ध्र प्रदेश के तथा तुमकुर एवं कोलार-कर्नाटक के) से बीजों के 1041 तथा मिट्टी के 767 नमूने एकत्रित किए गये । विभिन्न जिलों की मृदा में फफूंदी की संख्या के स्तर में भिन्नता (0-730 x 10^3 प्रोपैग्यूल्स/ग्रा० मृदा) पायी गयी ।

खरीफ 2000 की अवधि की कटाई/खुदाई के समय गुजरात, आन्ध्रप्रदेश व कर्नाटक से बीजों के नमूने एकत्र किए गये । एसपर्जिलस फ्लैवस की संख्या में मूल्यांकन के लिए मृदा के नमूने भी एकत्र किए गये । एक प्राथमिक अवलोकन में पाया गया कि जहाँ ट्राइकोडर्मा की संख्या अपेक्षा कृत कम थी वहां एसपर्जिलस फ्लैवस की संख्या अधिक पायी गई और यह एक-दूसरे के विरुद्ध सक्रिय भी है ।

बीजों की जैवशक्ति व गुणवत्ता को बनाये रखने के लिए मूंगफली की फलियों को सुखाने की तकनीक (एन.आर.सी.जी. विधि) का खेतों पर किसानों के समक्ष प्रदर्शन किया गया । फलियों के पकाने व सुखाने की अवधि में सुखाने में अपनाये जाने वाले विभिन्न तरीकों के अनुसार बीजों में देर से भ्रूणोत्पादकतायुक्त प्रचुर प्रोटीनें गतिशील अवस्था में पायी गयी जैसा कि सूखे बीजों के प्रोटीन बैंडिंग पैटर्न में प्रतिबिम्बित हुआ । इसलिए उच्च जैवशक्तियुक्त लाइनों और उच्च जैवशक्ति के लिए मार्कर की पहिचान के लिए PAGE तकनीक का उपयोग किया जा सकता है ।

सुसुप्तावस्था युक्त स्पैनिश जीन प्ररूपों के बीच संकरण बीजावरण पर निर्भर करता है जैसे कि ICGS 11 एवं ICG 44 तथा सुसुप्तावस्था युक्त स्पैनिश प्रकारों जैसे कि GG2, TAG24 तथा गिरनार 1 ताजी सुसुप्तावस्था समाहित कर सकती हैं। खुदाई से पूर्व ताजी सुसुप्तावस्था के गुणों के कारण SB XI प्रजाति का उपयोग किया जा सकता है ।

एक प्रक्षेत्र परीक्षण में पौधों की वृद्धि को बढ़ाने वाले राइजोबैक्टीरियल आइसोलेटों के साथ बीजों के जीवाणुकरण से मूंगफली की फलियों की उपज में सार्थक वृद्धि (13-23%) की । मूंगफली के बीजोपचार में उपयोग के लिए कार्बन व नत्रजन के स्रोत के रूप में PGR 4 संवर्धक को उत्तम पाया गया । राइजोबियल आइसोलेटों NRCG 4 से NRCG 13 के साथ बीजों का बीजाणुकीकरण के परिणाम स्वरूप फलियों व जैवभार के उत्पादन तथा ग्रन्थियों की संख्या में सार्थक वृद्धि हुई ।

मूंगफली के बड़े दानों वाली प्रजातियों में उत्तम गुणवत्ता युक्त विकसित बीजों के लिए छोटे दानों वाली प्रजातियों की अपेक्षा कैल्शियम की अधिक मात्रा की आवश्यकता होती है । बालू में किए गये प्रयोगों में बड़े दानों वाली मूंगफलियों में पोटाश की 100ppm तथा कैल्शियम की 200ppm की खुराक उत्तम पायी गयी है ।

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

फास्फोरस दक्ष : NRCG Acc. 7085-1, 6919, 1308, 3498, GG 5 एवं SG 84

कैल्शियम दक्ष : NRCG Acc. 7085-1, 6155 तथा ICGHNG 88448

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

मूंगफली पर आधारित पांच प्रमुख शस्य प्रणालियों (मूंगफली की एकल फसल, मूंगफली के साथ अरहर व बाजरा का अन्तरशस्यन तथा मूंगफली-गेहूँ व मूंगफली-गेहूँ-मूंग की क्रमवार खेती) के अन्तर्गत पोषक तत्वों की गतिशीलता एवं टिकाऊपन पर तीन वर्षों के अध्ययन के परिणामों से संकेत मिले हैं कि मूंगफली+अरहर के अन्तरशस्यन से जीवांशीय कार्बन की मात्रा में(0.04%) बढ़ोत्तरी होती है, उपलब्ध नत्रजन की उत्तता बरकरार रहती है तथा मात्र मूंगफली की खेती में जीवांशीय कार्बन 0.33%, नत्रजन 56 ppm तथा नत्रजन स्थिरीकरण सूक्ष्म जीव 5.1×10^4 की तुलना में मृदा में स्वतंत्र नत्रजन का स्थिरीकरण करने वाले सूक्ष्मजीवों की गतिविधियां (50.5×10^4 कालोनी प्रति वर्ग फीट) बढ़ जाती हैं । मूंगफली की मुख्य फसल के राइजोस्फीयर के ph(7.41) की अपेक्षा अरहर व बाजरा के साथ मूंगफली के अन्तरशस्यन ने कुछ हल्का सा अधिक ph(7.64 - 7.071) बरकरार रखा । मूंगफली+बाजरा के अन्तरशस्यन में, बाजरा के लिए नत्रजन की संस्तुति खुराक को चार भागों (1/3 आधारीय रूप में तथा बाकी बची हुई मात्रा को 3 भागों में ऊपर से) में डालने से बाजरा ने मृदा में NO_3 को कम मात्रा (12-13.6 ppm) को बरकरार रखा तथा नत्रजन को दो भागों में देने की अपेक्षा इस प्रणाली में मूंगफली तुल्य उपज अधिक दी ।

चार वर्षों की कुल प्रगति के आधार पर उत्तर-पूर्वी क्षेत्रों में मूंगफली की हाँत में विमोचित प्रजातियों का औसत फली उत्पादन राष्ट्रीय औसत से अधिक रहा । उत्तर-पूर्वी क्षेत्रों के लिए ICGS 76, ICGV 86590 तथा TKG 19A किस्में सर्वाधिक उपयुक्त पाई गयीं इसलिए इन्हे संस्तुति किया जाता है ।

कम ph की परिस्थिति के अन्तर्गत मूंगफली के 100 जीन प्ररुपों की छंटनी की गयी और तीन वर्षों के अध्ययन के आधार पर एल्युमिनियम विषाक्तता तथा अम्लीय मृदा के प्रति सहिष्णु व संवेदनशील जीन प्ररुप निम्न प्रकार पाये गये ।

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

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

उत्तर-पूर्वी राज्यों में ब्रैडीराइजोबियम और पी एस एम के साथ फास्फेटिक उर्वरक एवं चूना की उत्कृष्ट प्रतिक्रिया पायी गयी जिसने इनके उपयोग को आवश्यक बना दिया है । चूना 2 टन/है०+50 किग्रा०/है० फास्फोरस+ब्रैडीराइजोबियम एवं चूना+फास्फोरस+पी एस एम के प्रयोग से कन्ट्रोल की अपेक्षा क्रमशः 40-51% तथा 49-50% तक फली उत्पादन बढ़

सकता है । यद्यपि चूना+फास्फोरस (50 किग्रा०/है०)+बैडीराइजोबियम+पी एस एम के प्रयोग ने कन्ट्रोल की अपेक्षा सर्वाधिक 67% फली उत्पादन दिया ।

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

लगातार दो वर्ष तक मूंगफली के 31 जीन प्ररूपों की उनकी एल्यूमिनियम विषाक्तता की सहिष्णुता के लिए बालू संवर्धन में छंटनी की गई और NRCG 7599, 1038, 3489 तथा 6919 जीन प्ररूपों को सहिष्णु और GG 4, GG 5 तथा GG 20 को संवेदनशील पाया गया ।

इक्रीसैट (ICRISAT) से कृष्ट मूंगफली के 394 तथा जंगली प्रजातियों के 42 जननद्रव्यों का संग्रहण किया गया । लक्षण निश्चयन के लिए मूंगफली की 6 विभेदित प्रजातियों को उनके उत्पत्ति केन्द्रों से प्राप्त किया गया ।

लक्षण निश्चयन एवं मूल्यांकन के विभिन्न परीक्षणों में स्पैनिश जननद्रव्यों NRCGs 10273, 10334, 10443, 11429 को उपज के लिए होनहार के रूप में चिन्हित किया गया, NRCGs 11900, 11903 तथा 11952 को वांछनीय कम्पेकटनेस गुणों के लिए और NRCGs 10950, 11001, 11597, 11003, 11004, 11005, 11014, 11060, 11062, 11069, 11072, 11073, 11580, 11585, 11590, 11596, 11609 एवं 11616 को अगेती व पछेती पर्णधब्बा एवं रस्ट रोगों प्रति प्रतिरोधक/सहिष्णु के रूप में चिन्हित किया गया । बीजों में प्रोटीन के लिए SDS PAGE द्वारा 70 विभेदित किस्मों का विश्लेषण किया गया तथा उच्च अणुभारीय (126 एवं 113 kd) और निम्न अणुभारीय (30 एवं 7 kd के बीच) प्रोटीनों के लिए पॉलीमारफिज्म का अवलोकन किया गया । पात्रीय संरक्षण अध्ययन में भ्रूणरहित बीजपत्रों से बहुप्ररोह उत्पन्न हुए, 2% मैन्निटोल प्रतिपूरक के साथ बहुगुणन माध्यम को बहुप्ररोहों के ओज को कम किए बिना उपसंवर्धन अवधि को बढ़ाते हुए पाया गया ।

भुवनेश्वर केन्द्र पर खरीफ मौसम में एक मूल्यांकन परीक्षण में वर्जीनिया रनर के 13 जनन द्रव्यों (ICGs 697, 2696, 4430, 4515, 4957, 4211, 4495, 6794, 2288, 4442, 5290, 6098 तथा 6784) तथा वर्जीनिया बन्च के 6 जनन द्रव्यों (ICGs 863, 916, 920, 921, 1019 तथा 2659) की पहचान फली उत्पादन के लिए होनहार के रूप में की गयी । वर्षा व वर्षा उपरान्त के मौसम में भुवनेश्वर पर वर्जीनिया बन्च के 126 जननद्रव्यों के मूल्यांकन में 11 जननद्रव्यों यथा ICGs 500, 4520, 4805, 5656, 11998, 1643, 2630, 2689, 6434 तथा 6740 को होनहार रूप में पाया गया । वर्जीनिया बन्च के 126 जननद्रव्यों का मूल्यांकन जो कि धान की फसल की अवशिष्ट नमी में किया गया, में बेल की तुलना में पाँच जननद्रव्यों जैसे - ICGs 4515, 6098, 6739, 6794 तथा 11998 ने उत्कृष्टता का संकेत दिया ।

मर्क्यूरिक नाइट्रेट उत्पन्न करने के एक प्रयोग में आई. ए. ए., आई. बी. ए. तथा जी. ए. के पर्णीय छिड़काव से परागकणों में क्रमशः 28%, 50% तथा 18% तक बंध्यता पाई गयी । गिरनार 1 के M_2 पीढ़ी के पौधों को रासायनिक म्यूटेजनों DES तथा EMS से उपचारित करके नर बंध्यता की आनुवंशिकी का अध्ययन किया गया और तिरोहित प्रकृति के जीन सुनिश्चित किए गये । खरीफ मौसम में कृत्रिम संकरण के दरम्यान स्वनिषेचित फलियों को कम करने के लिए पुष्प कलिकाओं को तोड़ने हेतु प्रातः 7 बजे से पूर्व के समय को आदर्श समय के रूप में चिन्हित किया गया । पात्र के द्वारा F1 में बहुगुणन हेतु 1ppm NAA, 1 ppm GA_3 तथा 20 ग्राम/ली. सुक्रोज से प्रतिपूरित एकमात्र MS मीडियम को मानकीकृत किया गया ।

उत्कृष्ट जननद्रव्यों का एक संग्रह प्रकाशित किया गया तथा 70 विभेदित किस्मों व 700 जननद्रव्यों का एक सूची-पत्र प्रकाशनाधीन है ।

एरैचिस की 19 प्रजातियों की 51 प्रविष्टियों की गुणवत्ता हेतु 32 तथा मात्रात्मकता के लिए 16 गुणों का लक्षण निश्चयन किया गया । एरैचिस ग्लैब्राटा प्रविष्टियों में उच्च अन्तर्जातीय भिन्नता पायी गयी । एरैचिस ग्लैब्राटा की बारे के लिए उपयुक्त प्रविष्टियों में, 11828, 12036, 11840, 11846 में निम्नतर अन्तर सन्धि; 11818, 11832, 11833 में बड़ी पत्तियां तथा 12033 में पुष्प हीनता पायी गयी । एरैचिस मोन्टीकोला की 3 प्रविष्टियों की पत्तियों के आकार, रोमिलपन एवं फलियों के आकार में भिन्नता पाई गयी ।

क्रास J 11 X *A. duransis*, J 11 X *A. kretschmeri* एवं J 11 X *A. cardenasii* से 57 अन्तर्जातीय संकरों को पृथक किया गया ।

50 एक्सप्लान्टों के साथ 25 सह-संवर्धकों जो कि Crylac जीन रखते हों, को जीन निर्माण स्थानांतरण के लिए बनाया और उनमें से पहचान किए गये ट्रांसजेनिक पौधों में से 60 को GUS assay के लिए पॉजिटिव पाया गया ।

मूंगफली के लिए AFLP प्रोटोकोल का मानकीकरण व ईष्टतमीकरण किया गया । PCR उत्पादों की खोज के लिए चाँदी की स्टेनिंग को मानकीकृत किया गया । चौसठ प्राइमरों की छंटनी के प्राथमिक अवलोकनों से स्पष्ट हुआ कि प्राइमरों के 10 संयोजनों से भी अधिक संयोजन पॉलीमार्फिज्म खोजने में समक्ष हैं ।

चौरासी जीन प्ररुपों में से ICGV 86590, ICGS 1, ICGS 21, HNG (HPS)2, GG 12 तथा CSMG 884 को तेल की उच्च मात्रा (≥51%) के लिए पहचाना गया जब कि S 206, TG 87, TMV 2, Tirupati 4, ISGS 76, M 522, BG 2 तथा Gangapuri को तेल की कम मात्रा के लिए पहचाना गया । मूंगफली के बीजों के नमूनों में ऐचिलियोमीटर द्वारा प्राप्त तेल की मात्रा और उन्हीं नमूनों का साक्सलेट विधि द्वारा प्राप्त तेल की मात्रा के साथ सह-सम्बन्ध पाया गया । बीजों में ओथियोनीन की मात्रा के लिए विश्लेषण किए गये 18 जीन प्ररुपों में से GG 2, ICGS 44 (1.55), JL 24 (1.12), TMV 7 (1.08), GG 20 (1.44) तथा J 11 (1.61) में उनकी प्रोटीनों में मेथियोनीन की मात्रा 1% से अधिक पायी गयी ।

बीज भार की अनुवांशिकता पर अध्ययन से संकेत मिले हैं कि दूसरे संयोजनों की अपेक्षा उच्च बीज भार X उच्च बीज भार तथा/अथवा उच्च बीज भार X मध्यम बीज भार, उच्च बीज भार के लिए बेहतर ट्रान्सग्रेसिव सेग्रीगेन्ट पैदा करेंगे । कल्चर PBS 29055 ने बड़े दाने व उच्च उत्पादकता के रुप में उन्नति के लिए उच्च क्षमता प्रदर्शित की । बड़े आकार की फलियों का गुण प्रभावी पाया गया तथा दोहरे जीनों के दो सेटों को P_1/p_1; P_2/p_2 तथा Q_1/q_1; Q_2/q_2 चिन्हों के साथ प्रस्तावित किया गया । मूंगफली के छिलकों को सड़ाने में उनकी दक्षता के लिए परीक्षण किए गये, 4 सेल्यूलोलाइटिक सूक्ष्मजीवों में से Phanerochaete chrysosporium को सर्वाधिक दक्ष पाया गया ।

SUMMARY

- Twenty crosses were made to study the genetics of collar rot resistance during *Kharif* 2000. A total of 575 genotypes 7comprising of 146 stable mutants of Girnar 1, 220 advanced breeding cultures, 26 inter-specific derivatives, 153 germplasm, and 2 released cultivars were multiplied for future use.
- In generation advancement, 24, 17, 4, 17, and 9 crosses were advanced to F2, F3, F4, F5 and F6 generations respectively. Twenty-one in F4, 56 in F5 and 6 in F6 generations were made for different desirable traits.
- In Spanish trial, Four cultures PBS 11065, 12018, 28008 and 24008 were superior over the national check JL 24. In Virginia three cultures, PBS 24030, 24006 and 24022 were superior over the national check Kadiri 3. The culture PBS 24008 has higher seed mass than all the four check varieties besides its high shelling percent and resistance.
- The F2 seeds of the crosses JL 24 x ICGV 87280, R33-1 x ICGV 87280, R33-1 x ICG 3001 and R33-1 x ICG 899 was found to be highly resistant to collar rot infection. Five advanced breeding lines were found to be resistance and 24 moderately resistance to LLS.
- Five advanced breeding lines were found to be moderately resistance to *Alternaria*. In pod reticulation study, the F2 segregation pattern of all the three crosses fit well with ratio 13:3 for no reticulation : moderate reticulation indicating inhibitory type of gene interaction.
- The genotype ICGVs 96275 and 96248 were found to be resistant to ELS and LLS as it had a score of 1 as against 4 in check. Girnar 1 foliar disease resistance for international varietal trial.
- A total of 40 crosses were made for studying the genetics various traits. In generation advancement, 25, 29, 35, 37, and 2 crosses were advanced to F2, F3, F4, F5 and F6 generations respectively.
- Twenty-five selections in F4, 117 in F5 and 27 in F6 generations were made from microns for different desirable traits. The parents ICGV 86031, TAG 24, and TMV 2 NLM were identified as good general combiners for SLA. It was found that the SLA measured at 65 days after sowing was more desirable than SLA measured at 45 and 85 DAS.
- Based on the two years evaluation, the genotypes, FSD 7, FSD 11, FSD 25, FSD 29, FSD 46, FSD 68, and FSD 71 with good seed viability (>75% germination) were identified even after 15 months of storage as compared to the parent GG 2 (<5% germination).
- Significant genotypic differences were observed in the epicuticular wax load (EWL) of leaves of 12 groundnut genotypes grown in rainfed season when sampled 45 day

after emergence (DAE). In six genotypes, EWL was also determined at 75 and 95 DAE, which indicated that EWL increased with ageing of the crop. In another experiment, conducted in summer (February-May) season, significant genotypic differences were observed in the quantum of increase in water saturation deficit (WSD) and the EWL of leaves of six genotypes when crop was subjected to moisture deficit stress by withholding regular irrigation during the period of 42 to 75 DAE.

- Twelve crosses including reciprocal were made to study the genetics of iron deficiency chlorosis. Significant reciprocal differences were observed in the means of F1s' I2 x ICGV 86031 and ICGV 86031 x I2 for chroprphyll 'a' and total chlorophyll content. Parents ICGV 86031 and PBS 21063 found to be good combiner for chloroplyll content. Genotypes PBS 21031, 12012, 24004, 12124, and 12126 were categorized as tolerant to iron-deficiency chlorosis.
- In varietal blending trial under moisture-stress condition TG 26 (1384 kg / ha) and GG 2 (1120 kg/ha) among the cultivars and the blends (GG 2 + JL 24 + SB XI), (ALR 2 + GG 2 + SB XI) and (ALR 2 + SB XI+ TG 26) recorded higher yield. In Multi location trial on WUE the top ten entries viz., JUN 17, TIR 44, JUN 15, JUN 13, JAL 11, TIR 16, ICR 40, JUN 24, JAL 30 and JAL 33 showed higher pod yield ranged from 1546 to 1499 kg/ha. The genotypes PBS 24004, PBS 29017 and PBS 30008 were registered as germplasm.
- Five genotypes viz., TKG 19 A, TG 45, TG 48, K 4, and VRI 3 showed dry seed resistance to both pathogens (*Aspergillus niger* and *Sclerotium rolfsii*).
- Out of 81 genotypes, 13 genotypes viz., M 197, RS 138, TMV 12, ALR 2, Dh 3-30, TKG 19 A, Karad 4-11, TG 17, TMV 7, ICGV 86594, (Released varieties), PBS 29030, PBS 20507 (advanced breeding lines) and ICG 7887 (germplasm line) were found free from stem rot infection under field condition.
- Groundnut intercropped with bajara (3:1) + foliar spray of aqueous extract of mustard cake @ 5% at 55 DAS significantly reduced the intensity of ELS by 87 % and LLS by 81%. Aqueous extract of mustard cake inhibited germination of spores of late leafspot and rust fungi effectively.
- An initiative has been taken to map low- and high-risk aflatoxin contamination areas with the active participation of stakeholders. Seed (1041) and soil (767) samples from ten districts (Junagadh, Rajkot, Amreli, and Probandar in Gujarat; Kurnool, Cuddapah, Ananthpur and Chittoor in Andhra Pradesh; and Tumkur and Kolar in Karnataka) have been collected for assessing seed infection and colonization by *A. flavus* and soil infestation by the fungus. The soil population levels varied from 0-730x10^3 propagules/g of soil among districts. Seed samples at harvest during *Kharif* 2000 were also collected from Gujarat, A.P. and Karnataka and Soil samples were collected for assessing *A. flavus* population in soil.
- A preliminary observation was that wherever the Aspergillus flavus populations were high, corresponding *Trichoderma* populations were relatively low and *vice-versa* was also true.

- The technology for drying of groundnut pods (NRCG pod drying method) to maintain viability and seed quality was demonstrated to the farmers (on farm). During curing and drying of pods the late embryogenesis abundant proteins were found to be in a dynamic state as reflected in the protein banding pattern of the seed dried following various drying methods. Therefore, the PAGE technology can be utilized to identify high viability lines and markers for high viability.

- Crosses between the spanish genotype with dormancy dependant on seed coat for example, ICGS 11 and 44, and non-dormant spanish types for example, GG 2, TAG 24 and Girnar 1, may incorporate fresh seed-dormancy. Cultivar SB XI could be used for its characteristic for fresh-seed dormancy before harvesting.

- Seed bacterisation with plant growth promoting rhizobacterial isolates significantly enhanced pod yield of groundnut (13-23%) in a field trial. PGPR 4 culture was found to be the best in utilizing seed exudates of groundnut as the sole source of C and N. Seed bacterization with rhizobial isolates, NRCG 4 to NRCG 13, resulted in significantly higher pod yield, biomass production and nodule number.

- Large seeded groundnut cultivars had higher requirement of Ca than the small seeded one for full development of seed of the best quality. In sand culture experiment the best dose was 100 ppm K and 200 ppm Ca for large-seeded groundnut.

- Several groundnut genotypes were screened and the nutrient efficient genotypes identified were P-efficient NRCG 7085-1, 6919, 1308, 3498 GG 5, and SG 84 Ca-efficient NRCG 7085-1, 6155, and ICGHNG 88448.

- Various, organic sources were evaluated and FYM, caster/neem cakes, together with biofertilizers were found most promising for groundnut.

- The results after three years of study on nutrient dynamics and sustainability under five major groundnut based cropping systems (groundnut sole crop, Intercropping of pigeon pea and pearl millet with groundnut and sequential cropping of groundnut-wheat and groundnut-wheat -green gram) indicated that intercropping of groundnut+pigeon pea improved organic carbon content (0.40%), maintained higher available nitrogen (60 ppm) and enhanced the activities of free nitrogen fixing microbes in the soil (50.5×10^5 colony forming unit, cfu) as compared to sole groundnut (0.3 0.38%, nitrogen 56 ppm and N fixing microbe cfu of 5.1×10^4 . The intercropping of pigeon pea and pearl millet with groundnut maintained slightly higher pH (7.64-7.71) in the rhizosphere than sole groundnut (7.41).

- In groundnut+pearl millet intercropping, application of recommended dose nitrogen for pearl millet in four splits (1/3rd as basal and remaining as top dressing in 3 split application) to pearl millet maintained less NO_3 content in soil (12-13.6 ppm) and gave higher groundnut equivalent yield of the system than in two split application of nitrogen.

- High Temperature Tolerance in groundnut genotypes were studied using leaf membrane the stability. ICGS 44 was found to be stable to high temperature fluctuations. it was also found that low SLA lines were able to acclimatize to high temperature and water deficit.
- The study also revealed that the contrasting seasons influence the SLA, however, their ranking across the seasons remained unchanged.
- The mean pod yield of recently released groundnut cultivars, in NEH region, was more than the national average and based on the overall performance for four years ICGS 76, ICGV 86590 and TKG 19A were found to be most suitable for NEH Region and hence being recommended.
- One hundred groundnut genotypes were screened under low pH condition and based on the studies conducted for three years the Al toxicity and acid soils tolerant and sensitive genotypes were as follows. Tolerant: ICG 813, 1001, 1021, 1048, 1056, 1064, 1355, 3606, 10964,11183. Sensitive: ICG 2120, 4407, 6727, 6855, 7288, 7600, 7787, 7821, 10580, 11748.
- An excellent response of *Bradyrhizobium* and PSM was found with phosphatic fertilizer and lime in NEH region making their application essential. Application of lime (2t/ha) +50 kg/ha P + Bradyrhizobium and lime+P+PSM could increase 40-51% and 49-50 % pod yield over control, respectively. However application of lime + P(50 kg/ ha)+*Bradyrhizobium* +PSM showed maximum pod yield of 67% more over control. Lime and FYM reduced the direct and indirect effects of Al-toxicity in groundnut and increased the yield.
- Thirty one groundnut genotypes were screened under sand culture for their tolerance of Al-toxicity for consecutive two years and the genotypes NRCG 7599 and 1038, 3498 and, 6919 were found tolerant and GG 4 and GG 5 and GG 20 sensitive
- Three hundred and ninety-four accessions of cultivated groundnut and forty-two accessions of wild Arachis species have been procured from ICRISAT. Further six released groundnut cultivars were acquired from the originating Centres for detailed characterization.
- In different characterization and evaluation trials, the accessions NRCGs 10273, 10334, 10443, 11429 were identified promising for yield, NRCGs 11900, 11903 and 11952 for desirable confectionary traits and NRCGs 10950, 11001,11597, 11003,11004, 11005, 11014, 11060, 11062, 11069, 11072, 11073, 11580, 11585,11596, 11590, 11609, 11616 resistant/tolerant for ELS, LLS and Rust diseases.
- Seventy released cultivars were also analysed for seed protein by SDS PAGE and polymorphism was observed for high molecular weight proteins (126 and 113 kd) and low molecular weight proteins (between 30 and 7 kg).
- In *In vitro* conservation studies with multiple shoots induced from de-embryonated cotyledons, the multiplication medium supplemented with 2% Mannitol found to increase the duration of sub culturing without loosing vigour of the shoots.

- At Bhubaneshwar center, in an evaluation trial during rabi season, thirteen virginia runner accessions (ICGs 697, 2698, 4430, 4515, 4957, 4211, 4495, 6794, 2238, 4442, 5290, 6098 and 6784) and six virginia bunch accessions (ICGs 863, 916, 920, 921, 1019 and 2659) were identified promising for pod yield. Out of one hundred and twenty six virginia bunch accessions evaluated during rainy and post-rainy seasons at Bhubaneswar, eleven accessions, viz. ICGs 500, 4520, 4805, 5656, 11998, 1642, 2630, 2659, 6434 and 6740 appeared promising. Evaluation of 126 virginia bunch accessions under residual moisture conditions in rice fallows indicated superior performance of five accessions, viz. ICGs 4515, 6098, 6739, 6794 and 11998 compared to local check.

- In an experiment to induce functional male sterility with foliar spray of Indole acetic acid, indole butyric acid and gibberellic acid, 28%, 50% and 18% pollen sterility were obtained respectively. The genetics of male sterility have been studied in the M2 generation of plants of Girnar 1 treated with chemical mutagens, DES and EMS, and the recessive nature of the gene was confirmed. To minimize selfed pods during artificial hybridization, the ideal period of removing the flower buds was identified as before 7 am during the Kharif season.

- Mass multiplication of F was standardized through *in vitro* nodal culture using MS medium supplemented 1 ppm NAA and 1 ppm GA3 and 20 g l^{-1} sucrose.

- A compendium on elite germplasm was published and catalogues on 70 released cultivars and 700 germplasm accessions are in press.

- Fifty-one accessions of 19 *Arachis* sp. characterized for 32 qualitative and 16 quantitative traits and high intraspecific variation in *A.glabrata* accessions. The *A.glabrata* accessions 11828,12036,11840,11846 (shorter internodes), 11819, 11832,11833, (larger foliage) and 12033 (non-flowering). The 3 *A.monticola* accessions also varied in leaf shape, hairiness and size of the pods.

- Fiftyseven interspecific hybrids were isolated from the crosses J 11 x *A. duranensis*, J 11 x *A. kretschmeri*, and J 11 x *A. cardenasii*.

- Twenty-five co-cultures each with 50 explants were done to transfer the gene construct containing Cry I Ac gene and out of the putative transgenic plants identified, 60 were found to be positive to GUS assay.

- The AFLP protocols for groundnut was standardized and optimized and for the detection of the PCR products, silver staining was standardized. A preliminary observation of the screening of 64 primers reveals that over 10 combinations of primers s are capable of detecting polymorphism.

- Out of eighty-four genotypes, ICGV 86590, ICGS 1, ICGS 21, HNG (HPS) 2, GG 1 and CSMG 884 were identified as the high oil genotypes (≥51%) while S 206, TG 8, TMV 2, Tirupati 4, ICGS 76, M 522, BG 2 and Gangapuri were identified as the low oil genotypes. The values of oil content of groundnut seed samples as obtained by arachilipometer correlated well with those obtained by Soxhlet method.

About the Institute

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

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

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

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

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

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

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

Weather Data 2000-2001

Std week	Tmax	Tmin	HAvg	Rainfall	Rainy days	STemp (10cm)	STemp (20cm)	wind velocity	Sun shine
April'00	39.3	23.7	49.9	0.0	0.0	31.7	34.0	7.4	9.8
May	35.6	26.3	60.9	1.6	1.0	31.8	33.7	10.8	7.9
June	35.7	26.5	61.7	0.8	0.0	32.0	33.1	12.3	6.6
July	31.3	25.2	103.9	4.3	1.8	28.6	29.6	9.2	3.9
Aug	30.3	30.9	82.6	6.9	2.0	27.7	28.8	7.3	2.6
Sept	33.4	24.1	66.6	0.2	0.0	29.6	31.0	4.9	6.7
Oct	37.5	22.5	45.0	0.5	0.4	30.4	32.1	3.4	8.9
Nov	35.4	18.0	33.4	0.0	0.0	27.4	29.2	3.3	9.1
Dec	33.7	13.1	32.7	0.0	0.0	23.5	25.6	2.6	9.1

- Among 18 genotypes analyzed for their kernel methionine content, GG 2, ICGS 44 (1.55), JL 24 (1.12) TMV 7 (1.08), GG 20 (1.44) and J 11 (1.61) had more than 1% methionine in their protein.

- Studies on inheritance of seed mass indicated that cross combination of high seed mass x high seed mass and/or high seed mass x medium seed mass, would yield better transgressive segregants for higher seed mass than other combinations.

- Culture PBS 29055 exhibited a high potential for being promoted as a bold-seeded high-yielding culture. The trait of large-size pod was found to be a dominant one and two sets of duplicate gene symbols P_1/p_1; P_2/p_2 and Q_1/q_1; Q_2/q_2 were proposed for the same.

- Amongst four cellulolytic microorganisms tested for their efficiency in decomposing groundnut shell, *Phanerochaete chrysosporium* was found to be the most potent.

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

(R.K.MATHUR, P. MANIVEL, M.Y. SAMDUR, A.L. SINGH AND P.C. NAUTIYAL)

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

1 Hybridization

Twenty crosses were made to study of genetics of collar-rot resistance in the Kharif season involving 4 sources of resistance to collar rot as male parents.

1.1 Status of breeding material

Generations	Crosses/cultures	Objective of the crosses
F2	24	Collar rot resistance
F3	17	ELS, LLS, leaf miner
F4	4	Leaf miner,
F5	17	LLS, ELS, rust
F6	9	LLS, Spodaptera
Advanced generations (including mutants)	366	For different abiotic stresses
Inter-specific derivatives (involving *Arachis chacoense* and *A. cardenansii*, wild species)	26	For different abiotic stresses

Selections made Twenty-one in F_4, 56 in F_5 and 6 in F_6 generations were made for different desirable traits LLS resistance, rust resistance, resistance to *Spodaptera/Heliothis*, and sucking pest resistance.

2 Evaluation for yield

2.1 In-Station trials:

Two preliminary yield evaluation trials, one with Spanish and another with Virginia advanced breeding cultures were conducted in 5 row plots of 5 m length each in RBD with three replications. In Spanish trial, 29 cultures were evaluated along with four checks viz., JL 24 (national check), GG 2 (local check), Girnar 1 and TG 26. In Virginia trial, 14 cultures were evaluated along with two check varieties, GG 20 (local check), ICGS 44 and Kadiri 3 (national check). No culture could statistically outperform the respective best checks. But in Spanish trial, the cultures PBS 11065 (M 13 x *A. villosa*) had the highest yield of 1962 kg/ha and the culture PBS 24008 (CGC 7 x JL 24) had higher seed mass (57 g/100 seed) than that of JL 24 (53 g/100 seed). JL 24 is of on exported variety. The yield of PBS 24008 was also slightly higher than JL 24. In Virginia trial, the culture PBS 24030 (M 13 x Robut 33-1) had the highest yield of 3334 kg/ha, which is 8 and 25% higher yield than the check varieties GG 20 and Kadiri 3, respectively. PBS 24030 had 74% shelling outturn and 65 g seed mass for 100 seeds.

Table 1. Position of segregating material as on Kharif 2000

Generations	Crosses
F2	25
F3	29
F4	35
F5	37
F6	2

Selections made Twenty-five selections in F_4, 117 in F_5 and 27 in F_6 generations were made for different desirable traits.

3 Evaluation of F1 hybrids for specific leaf area (SLA)

A total of 15 hybrids derived from half diallel involving 6 parents (ICGV 86031, TAG 24, TMV 2 NLM, TG 3, Chico, and GG 2) were evaluated in a replicated trial. SLA was measured on 45, 65, and 85 days after sowing. It was found that the SLA measured at 65 days after sowing was more desirable than SLA measured at 45 and 85 DAS. GCA and SCA variance were highly significant for SLA indicating the importance of both additive and dominant gene action. However, since the GCA was higher than the SCA the role additive gene action is more predominant than the dominant. The parents ICGV 86031, TAG 24, and TMV 2 NLM were identified as good general combiners based on its higher negative gca effects (Table 2). The crosses TAG 24 x TMV 2 NLM, TG 3 x GG 2, TMV 2 NLM x GG 2 and TAG 24 x GG 2 had higher negative *sca* effects. Interestingly all crosses which showed negative *sca* effects involved at least one of the parents as good general combiner. The *sca* effects were negative in all the crosses where TMV 2 NLM involved as one of the parents (except in the cross ICGV 86031 x TMV 2 NLM).

Table 2. General and specific combining ability effects of half diallel cross for SLA (65 DAS)

	ICGV 86031	TAG 24	TMV 2 NLM	TG 3	Chico	GG 2
ICGV 86031	-7.14 (98.5)	19.73 (140.6)	6.29 (128.7)	-0.26 (131.5)	5.58 (142.9)	9.73 (135.4)
TAG 24		-5.33 (129.2)	-16.24 (108.8)	-2.79 (130.8)	-6.57 (132.5)	-7.30 (120.2)
TMV 2 NLM			-3.73 (138.5)	-4.68 (130.5)	-2.28 (138.4)	-8.41 (120.7)
TG 3				5.59 (151.8)	4.15 (154.2)	-11.05 (127.3)
Chico					11.13 (150.0)	10.37 (154.3)
GG 2						-0.53 (135.6)

Diagonal values are gca effects, Upper diagonal is sca effects and values in parenthesis a mean

2.2 *Evaluation of F_1 seeds for collar rot resistance*

The seeds of 18 F_1s were tested along with its parents to study the genetics of collar rot resistance. The F_1 seeds of the crosses JL 24 x ICGV 87280, R33-1 x ICGV 87280, R33-1 x ICG 3001 and R33-1 x ICG 899 was found to be highly resistant. Other crosses JL 24 x J11, JL 24 x ICG 899, R33-1 x J11, GG 13 x J 11, GG 20 x J 11, were found to be resistance to seed colonization under laboratory condition.

3 Screening

A total of 120 advanced breeding cultures were screened for the major diseases during the *Kharif* 2000 under field conditions and the results are presented in table 1. One spanish culture, 11023 (with pod yield 7.0g per plant) derived from the cross Dh 3-30 x NCAc 2214 and one virginia culture, PBS 23014 (with pod yield 9.2g per plant) derived from the crosses BG 2 x CGS 101 and three mutants viz., PBS 30102, 30143, 30156 (with pod yield 8.4, 10.2, 11.7g per plant respectively) derived by chemical mutagenesis of Girnar 1 were found to have field resistance to LLS.

Table 1. Advanced breeding lines with resistance to LLS and Alternaria under field condition (1-9 scale of scaling)

Diseases	Resistant (score <3)
Late leaf spot (LLS) (The susceptible check PBS 11019 had the score of 9)	PBS 11023, PBS 23014, PBS 30102, PBS 30143, and PBS 30156
Alternaria leaf spot	PBS 24041 and PBS 30027 (Moderately resistance, score 3-5)

4 Inheritance of pod reticulation

Three crosses were made using genotypes moderate pod reticulation as female parents (GG 2, PBS 12143 and NCAc 343) as female parent and genotype with smooth pod, JL 24 as the male parent. All F_1 had smooth pods. In F_2 all three crosses showed a good fit to digenic inhibitory ratio 13 smooth:3 moderate reticulation.

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

1 Hybridization

A total of 20 crosses were made two for genetics of SLA, HI and TE (2), genetics of lime induced chlorosis (11), genetics of seed coat colour (6), and cold tolerance (1).

2 Generation advancement and selections

Generation advancement The crosses made for different purposes like high yield, high water use efficiency, drought tolerance, resistance/tolerance to iron-deficiency induced chlorosis, cold tolerance, salinity tolerance, fresh seed dormancy, longer seed viability, earliness in Virginia/Spanish, high biological nitrogen fixation, high reproductive efficiency, and inheritance studies for different traits were advanced to its next generation. The details are given in the table 1.

4 Screening of advanced breeding lines for seed viability

Seventy-four Spanish advanced breeding cultures developed from the cross GAUG 1 X GG 2 were tested for seed viability after 10, 12 and 15 months of storage from summer 1998 produce. The same materials from 1999 summer produce were again tested for seed viability after 20 months of storage. Based on the two years evaluation, the genotypes, FSD 7, FSD 11, FSD 25, FSD 29, FSD 46, FSD 68, and FSD 71 with good seed viability (>75% germination) were identified even after 15 months of storage as compared to the parent GG 2 (<5% germination). Interestingly, the seed viability was very high even after 20 months of storage in FSD 11 (90%), FSD 29 (85%), FSD 68 (80%), and FSD 71 (80%) from the summer 1999 produce.

5 Studies on epicuticular wax content

Significant genotypic differences were observed in the epicuticular wax load (EWL) of leaves of 12 groundnut (*Arachis hypogaea* L.) genotypes grown in rainfed (*Kharif* 2000) season and sampled 45 days after emergence (DAE). The values of EWL ranged from 0.91 mg dm^{-2} in genotype Chico to 1.74 mg dm^{-2} in breeding line PBS 11049, with 1.27 mg dm^{-2} as value for the mean (Table 3). In six genotypes, EWL was also determined at 75 and 95 DAE, which indicated that EWL increased with increase in age of the crop (Fig.1). The mean values of EWL at 45, 75, and 90 DAE for six genotypes were 1.10, 1.58, 2.05 mg dm^{-2}, respectively. The studies on relationship between EWL and drought resistance is in progress.

Table3. Leaf EWL at 45 DAE of groundnut genotypes grown in rainy season.

Genotype	EWL (mg dm^{-2})
CSMG 84-1	1.02
ICGV 86031	1.14
JL 24	0.97
Chico	0.91
TAG 24	1.30
J 11	1.29
PBS 12067	1.12
PBS 12115	1.19
PBS 11049	1.74
PBS 20055	1.57
PBS 11023	1.58
Code 9	1.38
Minimum	0.91
Maximum	1.74
Mean	1.27
CD (P = 0.05)	0.21
CV (%)	13.1

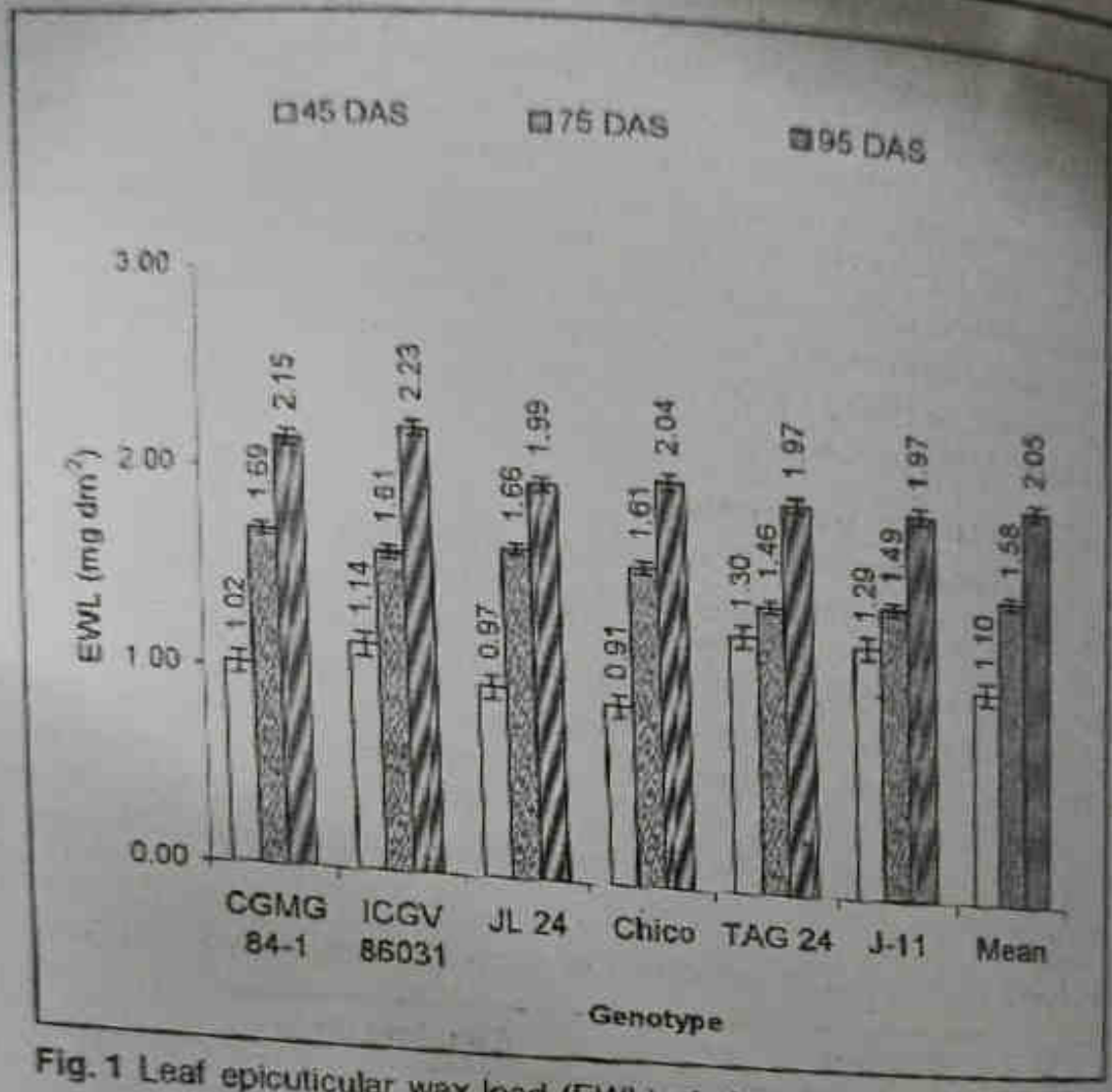


Fig. 1 Leaf epicuticular wax load (EWL) of six groundnut genotypes at three stages of crop growth

In another experiment, conducted in summer (February-May) season, significant genotypic differences were observed in the quantum of increase in water saturation deficit (WSD) and the EWL of leaves of six genotypes when crop was subjected to moisture deficit stress by withholding regular irrigation during the period of 42 to 75 DAE. The increase in EWL due to imposition of moisture deficit stress was, however, not commensurate with the increase in WSD. Besides influencing EWL, the imposition of water deficit stress also affected the harvest index (HI), total pod yield (TPY) and mature pod yield (MPY) of genotypes. Significant association was observed between the magnitudes of stress-induced changes in EWL and HI (r =0.81*), and also between EWL and TPY (r=0.81*) or MPY (0.90*). Thus any change in WSD, if at all, was accompanied by a change in EWL, it was also reflected in a corresponding change in HI. It was therefore apparent that the increase in EWL coupled with an increase in HI, afforded drought tolerance to plants by minimizing cuticular transpiration and also increasing partitioning of photosynthate and in this way these adaptations partially or wholly compensate for the loss of pod yield that would have occurred otherwise due to loss of biomass production under low water availability (Table .4)

Table 4 Yield and harvest index of groundnut genotypes under irrigated (I) and protracted soil moisture deficit (S) conditions

	TPY (g plant^{-1})			MPY (g plant^{-1})			HI (%)		
	I	S	△	I	S	△	I	S	△
PBS 11023	13.37	13.43	0.06	3.14	5.45	2.31	25.41	29.58	4.2
Code 9	10.10	24.26	14.16	4.82	14.49	9.67	23.76	33.21	9.5
PBS 20055	16.71	14.51	-2.20	8.82	9.58	0.76	27.57	33.19	5.6
PBS 11049	21.91	11.75	-10.16	9.97	6.79	-3.18	39.93	40.10	0.2
PBS 12067	23.97	10.57	-13.40	13.01	5.64	-7.37	42.23	28.61	-13.6
PBS 12115	16.40	14.90	-1.50	8.80	6.03	-2.77	24.54	22.70	-1.8
Mean	17.08	14.90		8.06	8.00		30.57	31.23	
Min	10.10	10.57		3.14	5.64		23.76	22.70	
Max	23.97	24.26		13.01	14.49		42.23	40.10	
CD (P=0.05)									
Genotype		0.51			NS			NS	
Treatment		NS			2.70			3.81	
Interaction		5.18			3.81			5.39	

NS=not significant, △ =change, TPY= total pod yield, MPY= mature pod yield, HI= Harvest index, CD=critical difference.

6 Genetics of lime-induced iron-deficiency chlorosis in groundnut

Four parents (two susceptible I2 and PBS 14021 and two tolerant ICGV 86031 and PBS 21063) were selected to study the genetics of iron deficiency chlorosis. Twelve crosses in all combinations including reciprocal were made in *Kharif* 1999 and these crosses were planted in rabi-summer 2000 with their 4 parents in randomized block design with three replications. Observation on chlorophyll contents was recorded at 50 ad 70 days after emergence (DAE). There was significant variation in the means of F_1 and parents for chlorophyll a, chlorophyll b, total chlorophyll and carotenoid contents (Table 5). The significant results are presented below

Significant reciprocal differences were observed in the means of F1s' I2 x ICGV 86031 and ICGV 86031 x I2 with chlorophyll 'a' content 6.14 and 7.29 mg/g respectively and PBS 14021 x ICGV 86031 and ICGV 86031 x PBS 14021 with chlorophyll content 6.16 and 7.03 mg/g respectively on dry weight basis. This showed that in variety ICGV 86031 possess some gene(s) in the cytoplasm, which contribute for chlorophyll pigments.

For chl b significant reciprocal difference was observed in the cross I2 x ICGV 86031 and ICGV 86031 x I2 its' with value 1.68 and 2.51mg/g on dry weight basis. Similar results were found for total chlorophyll content.

In few crosses reciprocal differences were observed for carotenoid contents. The parents with less chlorophyll content (PBS 14021 and I2) had high carotenoid content and parents with high chlorophyll content had less chlorophyll content.

Results of combining ability analysis reveal that mean squares for general combining ability were significant for all the characters in all the stages indicated role of additive genetic variance in the inheritance of these characters. Though in some crosses reciprocal differences were observed but mean squares for reciprocal were non-significant in general.

The parents I2 and PBS 14021 had significant but negative general combining ability effects suggesting their poor combining ability hence they are undesirable. Parents ICGV 86031 and PBS 21063 had positive and significant general combining ability effects suggesting these parents are desirable for increasing chlorophylls content and could be used in hybridization programme (Table 6).

Table 5 Analysis of variance for combining ability (gca, and sca).

	Source	df	MS				F			
			Chl a	Chl b	TC	Caro	Chl a	Chl b	TC	Caro
50 DAE	GCA	3	4.74**	0.83**	9.52**	0.06**	32.87	34.4	34.90	14.64
	SCA	6	0.24	0.03	0.43	0.001	1.67	1.37	1.59	0.44
	Reciprocal	6	0.33	0.06*	0.64	0.01**	2.30	2.76	2.36	4.34
	Error	30	0.14	0.24	0.27	0.004				
70 DAE	GCA	3	5.01**	0.77**	9.71**	0.02**	14.2	16.2	15.06	5.49
	SCA	6	0.32	0.06	0.65	0.01	0.92	1.30	1.01	2.39
	Reciprocal	6	0.16	0.02	0.30	0.006	0.46	0.49	0.47	1.41
	Error	30	0.34	0.04	0.64	0.004				
Over Stages	GCA	3	9.42	1.53	18.63	0.08	38.26	43.90	40.60	18.29
	SCA	6	0.08	0.006	0.11	0.005	0.33	0.18	0.26	1.25
	Reciprocal	6	0.24	0.05	0.51	0.01**	0.98	1.62	1.12	3.75
	Error	60	0.24	0.03	0.45	0.004				

** Significant at 1% level, * Significant at 5% level.

7 Screening of advanced cultures for tolerance to iron chlorosis

Thirty advanced breeding lines with four checks were grown in randomized block design with three replications during rabi-summer 2000. The first fully opened leaf of main axis from 10 randomly selected plants from each genotypes were collected and read for estimation of chlorophyll 'a' and 'b' and total content at 30, 45, 60, and 75 days after emergence and simultaneously visual chlorotic rating (VCR) was also done on the same day in the field. Genotypes PBS 21031, 12012, 24004, 12124, and 12126 were categorized as tolerant and had 8.08, 8.03, 7.97, 7.89, and 7.58 mg/g total chlorophyll and 2.08, 1.5, 2.00, 2.00, VCR (on 1 to 5 scale), respectively.

Table 6 Estimates of GCA (diagonal value), SCA (above diagonal value), and reciprocal (below diagonal value) effects over the mean of two stages for chl a, chl b, TC and carotenoid content

Characters	Parents	I2	PBS 14021	ICGV 86031	PBS 21063
Chl a	I2	-0.70	0.16	-0.06	-0.05
	PBS 14021	0.19	-0.59	0.18	-0.12
	ICGV 86031	0.41	0.32	0.87	0.01
	PBS 21063	0.03	-0.15	-0.10	0.42
Chl b	I2	-0.27	0.07	-0.01	0.00
	PBS 14021	0.05	-0.25	0.01	-0.01
	ICGV 86031	0.26	0.09	0.36	0.00
	PBS 21063	0.08	-0.02	-0.05	0.15
TC	I2	-0.97	0.24	-0.08	-0.05
	PBS 14021	0.25	-0.84	0.17	-0.15
	ICGV 86031	0.67	0.44	1.23	0.01
	PBS 21063	0.11	-0.20	-0.15	0.58
Carotenoid	I2	0.03	-0.05	0.05	0.00
	PBS 14021	0.02	0.06	0.03	0.02
	ICGV 86031	-0.09	-0.03	-0.09	-0.03
	PBS 21063	-0.11	-0.06	0.00	-0.03

8 Testing of advanced breeding lines developed for seed viability and fresh seed dormancy

Multiplication was not taken up because of scarcity of water. However, the pods of these cultured harvested during summer 1999 were tested for seed viability after 15 months of storage. The genotypes, FSD 7, FSD 36, FSD 46, and FSD 68 with good seed viability (>75% germination) were identified even after 15 months of storage as compared to the parent GG 2 (<5% germination).

9 Studies on varietal mixture (Varietal blending) with reference to yield

A trial on varietal mixture was taken up with five cultivars ALR 2, GG 2, JL 24, SB XI, and TG 26 and their all-possible ten combinations, each containing three varieties in equal number of seeds. The trial was conducted in two environments (one in normal irrigated and another in induced moisture stress from 40 to 65 days after sowing) in Split plot design with two replications. There was significant difference for 100-pod weight, 100-kernel weight, shelling percentage, pod yield/ha and kernel yield/ha. Under moisture-stress condition TG 26 (1384 kg / ha) and GG 2 (1120 kg/ha) among the cultivars and the blends (GG 2 + JL 24 + SB XI), (ALR 2 + GG 2 + SB XI) and (ALR 2 + SB XI+ TG 26) recorded higher yield. The ranking of genotypes and mixtures in irrigated and moisture stress condition for different traits were different.

10 Studies on selection methodology

Three crosses viz., GG 3 x ICGS 44, Girnar 1 x NRCG 7233 and GG 2 x PBS 190 were used for studying influence to early selection based on pod number. The selection with more than 15 pods per plant in F2 resulted in 85% plants with less than 5 pods, 18 % plants with 5-15 pods and no plants with more than 15 pods in F3 in all the three crosses. The preliminary results indicated that selection based on number of pods was not effective in early generations.

11 Registration

The following three advanced breeding cultures have been sent to NBPGR, New Delhi, for registration.

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

12 International trials

12.1 Multi-location trial on WUE

A total of 201 entries (96 from empirical, 96 from trait selections, 8 parents and 4 checks cultivars) were evaluated in alpha design during *Kharif* 2000. Observations were made on initial plant population, SPAD reading and leaf area. Yield and related traits of the top ten entries are presented in table 10. In top ten entries 60% was from trait selections and remaining from empirical selections. There was an increase in dry matter, pod yield and kernel yield in entries from trait selections than empirical selections. Similarly the frequency for higher SPAD values was more in trait selections than empirical selections. But, high frequency for higher kernel yield was observed in empirical selections than trait selections (Table 7).

12.2 Drought resistant groundnut varietal trial

None of the test culture out yielded the check cultivar, GG 2. However, six genotypes viz., ICGV # 92116, 92109, 92113, 93269, 86635, and 93277 yielded statistically at par with GG2 and the first four genotypes had higher seed mass than the GG 2 (35.28g).

12.3 Confectionary groundnut varietal trial

None of the test culture out yielded the check cultivar (GG 20). However seven genotypes viz., ICGV # 93058, 95172, 95165, 95163, 95179, 96066 and 92160 yielded statistically at par with GG 20. The range of seed mass obtained was from 43.09 (G 20) to 91.55g (ICGV 95179). Interestingly all the fifteen genotypes had significantly higher seed mass than the check, GG 20 (43.09g).

Table 7. Yield performance of top ten entries

Genotype	Cross	M	Pod weight (Kg/ha)	Kernel weight (Kg/ha)	SPAD	Dry plant weight
JUN 17	ICGS 44 x CSMG 84-1	I	2139	1546	38.12	3078
TIR 44	K134 x TAG 24	E	2064	1541	33.91	2615
JUN 15	ICGS 76 x CSMG 84-1	I	2097	1530	42.35	3097
JUN 13	ICGS 76 x CSMG 84-1	I	2091	1522	41.74	2971
JAL 11	JL 220 x TAG 24	D	2028	1514	35.41	2723
TIR16	ICGV 86031 x TAG 24	I	2079	1506	36.80	2847
ICR 40	TAG 24 x ICGV 86031	E	2114	1482	38.04	3161
JUN 24	GG 2 x ICGV 86031	I	1981	1478	37.66	2979
JAL 30	ICGS 76 x CSMG 84-1	E	2016	1453	39.07	2196
JAL 33	ICGS 44 x CSMG 84-1	E	1944	1419	37.63	2729
			2065	1499	37.87	2840

M = Breeding method, E = Empirical selections, I = Trait selections from irrigated, D = Trait selections from drought

12.4 Medium duration groundnut varietal trial (SB)

Only one culture ICGV 94031 recorded non-significantly higher yield and significantly higher seed mass than the check cultivar GG 2 and matured in 101 days. None of the test culture matured earlier than the GG 2 (98 days).

12.5 Medium duration groundnut varietal trial (VB)

Four cultures ICGV # 94063, 94068, 94088, and 92307 had higher pod yield than the check, GG 20, but non-significant. Of which ICGV 92307 matured in 115 days as against 120 days by GG 20.

12.6 Short duration groundnut varietal trial

Two cultures ICGV 95299 and 95248 had significantly higher yield than the best check GG 2 (983 kg/ha) with same duration like GG 2 (97 days). None of the culture matured earlier than the check Chico (91 days).

PROJECT 02: IPM IN GROUNDNUT BASED CROPPING SYSTEM

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

Sub-Project 01: Integrated Insect Pests Management in Groundnut based cropping system

1 IPM module for the rainy season

The project aims at development of IPM system in groundnut by integrating feasible components of management tactics excluding synthetic pesticides, to derive the maximum benefit of IPM, causing least possible harm to the environment and food chain.

1.1 Module Detail in IPM (*Kharif* 2001)

Module 1 Groundnut + 2% Crude Neem Oil (CNO) in Teepol (need base)

Module 2 Module 1+ Pheromone traps for *Spodoptera, Helicoverpa* and leafminer

Module 3 Module 2+ Trap crops (soyabean, redgram and castor)

Module 4 Control (Farmers' practice- Spray of Endosulfan, Monocrotophos Ilematic once in 20 days)

In the rainy season the crop was sown on the first week of July, 2000 and the crop was harvested on 18.10.2000. The population load of the jassid (*Balclutha hortensis*) was very high ranging from 23 to 28 numbers /5 sweepnet trap during 85 days after sowing. Spray of CNO at 2% was sprayed thrice at 20-day intervals was found to be sufficient to contain jassids (Table 1). During the early period of the crop growth the sucking insects are not a problem (Table 1 and 2). The pheromone traps for S. *litura* trapped 394 males with a mean of 30 males/trap/week. There was less males of *H. armigera* trapped during the whole of the crop period (8 numbers). The population of leaf miner males trapped ranged from 1 to 18 indicating its meager population. The cost of inputs and treatment in the IPM module is given in the table 3. The IPM module which included trap crop (soyabean as intercrop, castor as border crop & pigeon pea as intercrop) + pheromone traps for *Spodoptera, Helicoverpa* and leaf miner + 2% Crude Neem Oil in Teepol (based on ETL) gave the highest gross return of Rs 17950/ha compared to the farmers practice (Rs 9641/ha) (Table 4).

Table 1. Population of jassid per 5 sweeps in IPM (*Kharif*-2000)

Trt	First spray		Second spray		Third spray	
	Pre	Post	Pre	Post	Pre	Post
M1	5.75	7.50	17.00	5.75	28.25	16.50
M2	1.25	10.75	13.25	5.00	23.00	17.00
M3	1.00	8.75	12.75	5.50	24.25	15.50
M4	4.50	6.50	12.25	3.25	27.50	12.00
CD	NS	NS	NS	NS	NS	5.85*

Table 2. Population of thrips per 5 sweeps in IPM (*Kharif*-2000)

Trt	First spray		Second spray		Third spray	
	Pre	Post	Pre	Post	Pre	Post
M1	13.75	6.00	2.00	0.75	7.75	12.75
M2	4.50	8.25	1.50	0.50	6.25	3.00
M3	7.50	7.75	1.75	0.50	6.75	1.00
M4	11.25	5.25	3.00	0.75	6.50	2.75
CD	NS	NS	NS	NS	NS	NS

Table 3. Total cost of cultivation (Rs./ha)

Moduler	Seed Treat-ment	Phero-mone	Soy-bean	Castor	Red gram	Basic production cost	Additional cost due to treatment	Total cost of cultivation
M1	110	–	–	–	–	5086	260	5346
M2	110	300	–	–	–	5086	560	5646
M3	110	300	120	25	400	5086	1105	6191
M4	110	–	–	–	–	5086	710	5796

Table 4 Yield (Kg/ha) and Return (Rs) in IPM (*Kharif*-2000)

Trt	Groundnut	Soybean	Castor	Red gram	G.Return/(Net Return)	CBR
M1	7785	—	—	—	7785 (2439)	10.45
M2	8122	—	—	—	8122 (2476)	10.43
M3	4962	668	1750	10570	17950 (11759)	11.189
M4	9641				9641 (3845)	10.66

2 Life cycle of thrips

Caliothrips indicus has four instars in its life cycle. The first instar took from one to two days and the 2nd instar two to four days. The third and fourth instars took about one to two days only. Here the interesting observation was that as per (Heming (1973) there are two larval instars and two pupae i.e., pre-pupa and pupa. In our studies there were four instars and the later two were actually feeding, while the pre-pupa and pupa did not feed.

3 Monitoring of major insects

The aphids were monitored using drum trap and sticky trap. The aphid (*Aphis craccivora*) density was the highest in February with 1190 aphids/trap/week in the drum trap and was 197 aphids /trap/week in the sticky trap. Leaf miner was active throughout the year, but recorded low populations during April to December (Fig.1). The jassids and thrips population were high during October (ranging 21 to 38/five sweep net).

to (by 87 %) and LLS by 81%. The soil application of fresh leaves of karanj @ 500 kg/ha gave maximum control of stem rot (53 %) followed by neem seed powder @ 500 kg/ha (48%) and fresh leaves of neem @ 500 kg/ha (44%). However, maximum pod yield of 963 kg/ha was realized in the treatment of soil application of wild sorghum fresh leaves @ 500 kg/ha (Which reduced stem rot incidence by 28.34 %) followed by soil application of fresh neem leaves (pod yield of 938 kg/ha). Soil application of parthenium fresh leaves @ 500 kg/ha also reduced stem rot incidence by 34%. In our experiments mustard cake has given valuable free of control of foliar diseases both with foliar application and soil application. In laboratory experiments to find the reason it was found that. Aqueous extract of mustard cake inhibited germination of spores of late leafspot and rust fungi effectively. The extracts used after soaking of the mustard cake for more than 8 h showed significant inhibition of the germination of both the pathogens (Table 1 and 2).

Table 1. Germination of spores of rust and late leaf spot fungi in different concentrations of mustard cake extract kept for different durations

Treatment		% Spores germinated	
		LLS	RUST
CONTROL		37.5	44.6
2 HR.	100%	28.5	26.1
	50 %	30	34.1
4 HR.	100 %	20	11.5
	50 %	25	22.0
6 HR.	100 %	12.5	5.1
	50 %	14.2	7.6
8 HR.	100 %	12.5	2.8
	50 %	0	4.5
16 HR.	100 %	0	0.1
	50 %	0	2.9

These preliminary findings are being confirmed to use mustard cake extract as one of the probable components in the integrated disease management package fore the foliar pathogens.

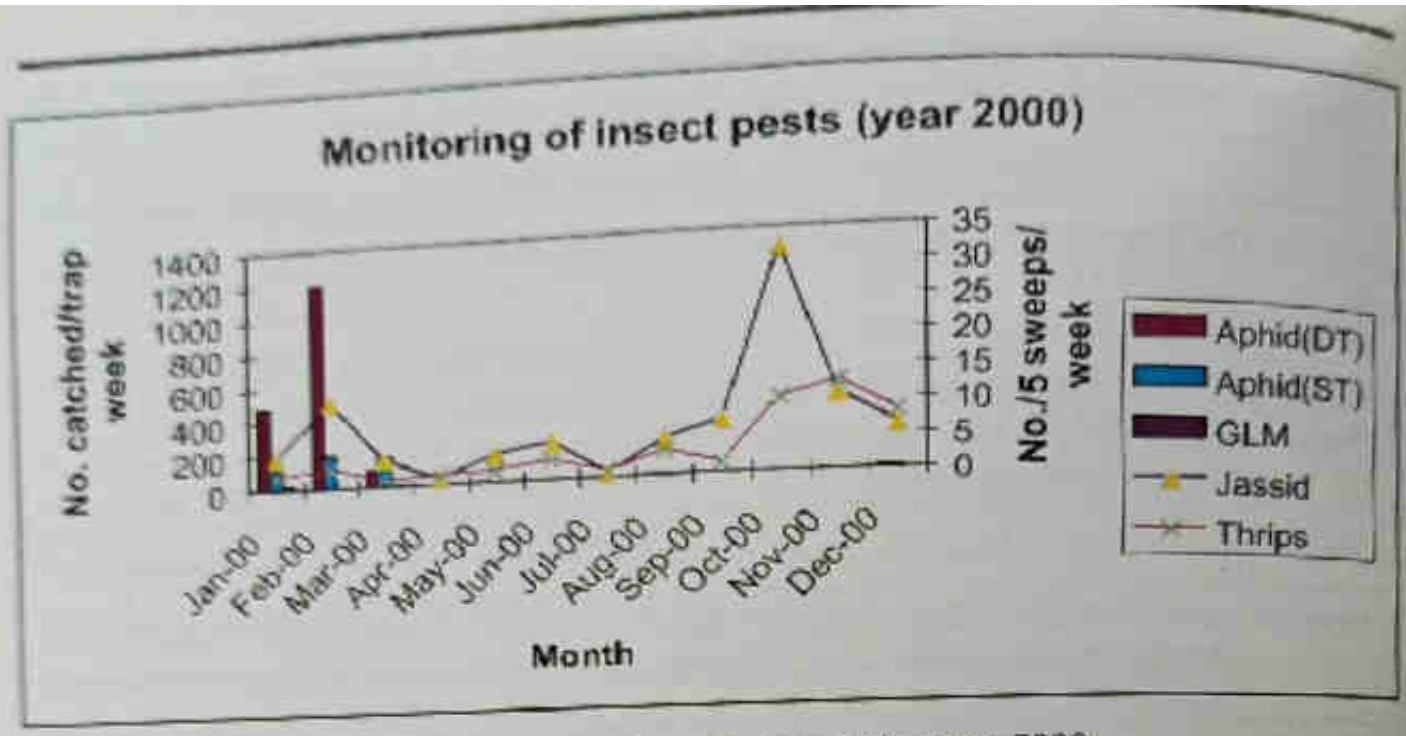


Fig.1 Monitoring of insect pests during year 2000

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

1 Disease resistance

In all 81 genotypes including released cultivars advanced breeding lines and germplasm accessions were evaluated against aflaroot , collar rot, stem rot, ELS, LLS, rust and PBND under field condition. The disease pressure of ELS, LLS, rust, collar rot and PBND was low. Therefore, meaningful conclusion could not be drawn in case of these diseases. However, the incidence of stem rot was considerable. It ranged from zero to 30. Out of the 81 genotypes, 13 genotypes viz., M 197, RS 138, TMV 12, ALR 2, Dh 3-30, TKG 19 A, Karad 4-11, TG 17, TMV 7, ICGV 86594, (Released verities), PBS- 29030, PBS - 20507 (advanced breeding lines of NRCG) and ICG 7887 (germplasm lines) were found to be free from stem rot infection under field condition.

Thirty genotypes including some cultivars and advanced breeding lines were also screened against in-vitro seed colonization by *Aspergillus niger* and *Sclerotium rolfsii*. Ten genotypes viz., TKG 19 A, TG 45, TG 48, TG49, K 4, M 552, VRI 3, LGN 2, Code 4 and Code 1-1, showed resistant reaction to seed colonization by *A. niger*. Seven genotypes viz., TKG 19 A, TG 45, TG 48, K 4, VRI 3, RG 141, and NeAc 383 showed dry seed resistance to seed colonization by *S. rolfsii*. Five genotypes viz., TKG 19 A, TG 45, TG 48, K 4, and VRI 3 showed dry seed resistance to both the pathogens (*A. niger*, *S. rolfsii*). Results need confirmation.

2 Disease management

Soil application of castor cake @ 500 kg/ha gave 26 % control of stem rot and realized pod yield of 1654 kg/ha. Groundnut intercropped with bajara (3:1) + foliar spray of aqueous extract of mustard cake @ 5% at 55 DAS significantly reduced the intensity from of ELS

(11) of bands were in the seed dried in windrows. A prominent protein-band of the high molecular weight range (rf = 0.43) was observed only in the seed dried following NRCG-method. Another protein-band of the low molecular weight (rf = 0.78) was present in the seed dried following different drying methods, but was very thick and prominent only in the seed obtained from the NRCG drying method

3 Nature of fresh-seed dormancy

In spanish groundnut fresh-seed dormancy is a desirable character, because considerable spoilage of the produce occurs due to *in situ* sprouting in the field. The quality of the produce also deteriorates seriously, if crop experiences rains at maturity. Our previous studies revealed that the fresh-seed dormancy in groundnut is related mostly to the seed testa in the spanish types, and related to the testa and cotyledons in the Virginia types. To study the inheritance pattern of fresh-seed dormancy four crosses TAG 24 (non-dormant) x ICGS 11 (spanish but dormant), and M 13 (virginia, dormant) x ICGS 11 (spanish, dormant) and its reciprocals, were made. In the F2 generation seed obtained from the cross between TAG 24 x ICGS 11 showed a range of germination, i.e. 100% in 4 plants, 80-95% in 2 plants, 50-66% in 7 plants, 15-<50% in 6 plants, and 0% in 1 plant. In the F2 generation the reciprocal cross between ICGS 11 as a female parent and TAG 24 as male parent showed complete seed dormancy, however after ethrel treatment the germination was between 80-100%. Seed of the crosses between dormant (dormancy factor seed testa) vs dormant (seed testa + cotyledons), and its reciprocal showed 100% dormancy. To understand the nature of fresh-seed dormancy studies are required on various segregating generations with more number of crosses

Table 1 Germination (%), root length, seedling vigour index (SVI) and number of secondary roots of groundnut seed dried following different drying methods for storage.

Drying methods	Germination (%)		Root length (cm)		SVI		Number of secondary roots	
	Storage Period (months)							
	0	6	0	6	0	6	0	6
D.O.R	91	69	11.2	7.0	1019	483	32.73	5.0
Ring	79	58	9.9	5.63	782	326	25.03	1.43
Shade	92	80	12.76	6.80	1173	544	37.46	6.70
Random	85	60	9.73	6.00	827	360	32.20	3.10
NRCG	96	84	13.63	7.28	1308	611	36.46	6.86
Windrow	69	30	8.20	4.68	566	140	27.46	0.56
Pod-E	85	61	10.50	6.80	892	414	32.93	1.60
Pod-W	80	64	9.93	5.76	894	368	30.00	0.90
Pod-N	90	63	11.00	6.20	990	390	32.20	1.20
Pod-S	81	66	10.93	6.41	921	435	34.60	3.26

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

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

1 On farm demonstration of NRCG drying method

Loss of seed viability and quality is mainly a problem related to groundnut production in the summer season. High pod-temperatures and untimely rains during curing in the field affect the seed quality and storability. Therefore, a suitable, simple, and economic drying method (NRCG-method) developed at NRCG was demonstrated to the farmers of the village Kodinar, Junagadh district.

Pod-in-plants immediately after harvest were dried following one of the method mentioned below

i.) DOR-method ii.) Ring method iii.) Shade drying iv.) Random heap, v.) NRCG-method vi.) windrows, and vii.) plants in small heaps with pods facing the four different direction i.e. east, west, north and south. Pods were allowed to dry for 5 days. However on the 2nd and 3rd day about 15 mm rain was received.

Drying methods significantly influenced the seed germinability, root length, seedling vigour, and number of secondary roots, recorded 7 days after incubation at 30°C. Germinability of the seed obtained from the pods dried following the NRCG method was 96% and 84% after 0 and 6 months of storage in ambient conditions, respectively; whereas, germinability of the seed dried in windrows started to decline immediately after drying, and lost drastically in storage. Thus curing of pods in direct sunlight deteriorated the quality of seed, and care must be taken to provide shade at least during first two days. For example, after 6 months of storage germinability was highest in NRCG (84%) and shade (80%) drying methods and least in windrows (30%). In general, during storage the capacity to produce secondary root decreased drastically (Table 1). Despite the 2nd and 3rd day of rains on the curing, produce dried following NRCG-method could maintain more natural coloration of the pod (whitish) and the testa of the seed (pinkish) better than any other method, but no significant change in total oil and sugar content of the kernels noticed.

2 Effect of drying methods on protein pattern

After harvest pods start loosing moisture quickly, while seed remains biologically active. It is well known that during drying or desiccation of seed it forms some special proteins known as dehydrins. A group of late embryogenesis proteins, which is reported, may be responsible to determine seed viability during storage. Therefore, experiments were initiated to understand the role of Late Embryogenesis Active Proteins (LEAs). Groundnut plants with pods were dried following different drying methods. PAGE analyzed seed for protein.

The protein profile of seed dried following different drying methods was significantly different in terms of the number of protein bands, both in the low and high range of molecular weight. The maximum numbers (16) of protein-band were recorded in the seed dried by heap method followed (14) by the NRCG-method, while the lower number

three consortia (consortium A comprising four non-fluorescent pseudomonads, consortium B comprising four fluorescent pseudomonads and a combination of A and B as the third consortium) comprising compatible and competent strains of PGPR enhanced pod yield (Table 2). However, the best result was achieved with the application of consortium B (combination of fluorescent pseudomonads). The combined application of the two consortia, however, failed to exhibit synergistic effect. This could happen due to antagonisms in the natural environment among the individual populations of the consortium though they showed compatibility *in vitro*.

2 Status of the contents of N and P in plant and kernel of AICRP (G) trial conducted at NRCG

The N content in all the treatments (Table 3) except the treatment inoculated with PGPR 4 was significantly more than the control with the maximum in the case of PGPR 2. In the case of kernels, though all the inoculated treatments had higher N content in the kernels the differences were not significant. The P content in plants (Table 3) was significantly more in the treatments inoculated with PGPR 1 and PGPR 2, with the maximum in case of PGPR 2. The same pattern was observed in the case of kernels as well. The maximum P content in kernels was observed in the treatment inoculated with PGPR 1 (8.65%).

For initial colonization, capability of utilizing the seed exudates provides added advantage to PGPR cultures. Thus, growth patterns of the PGPR isolates were studied using groundnut kernel exudates of cultivar JL 24 as sole source of C and N. It was observed that all the PGPR isolates could utilize the seed exudates for their growth. However, PGPR 4 was the best in utilizing seed exudates (Fig. 1).

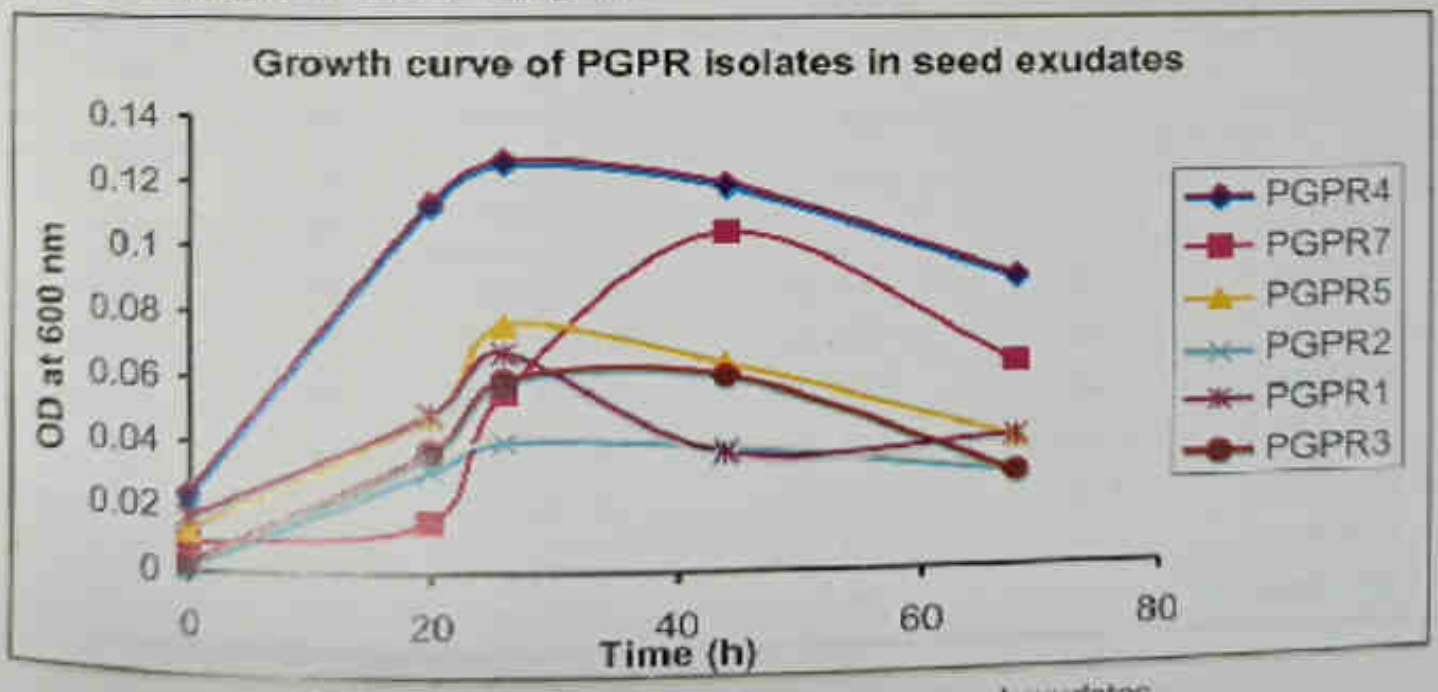


Fig. 1. Growth curves of PGPR isolates in seed exudates

Spontaneous rifampicin resistant mutants of seven PGPR cultures were developed for studying rhizosphere competence.

PROJECT 04: INTEGRATED NUTRIENT MANAGEMENT IN GROUNDNUT

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

Sub-project 01: Development of biofertilizer packages for groundnut

1 Plant Growth Promoting Rhizobacteria (PGPR)

In continuation to the experiments conducted in 1999, experiments were also conducted in rabi-summer as well as in *Kharif* seasons of 2000 to evaluate the performance of PGPR cultures. Majority of the PGPR isolates were fluorescent pseudomonads (Plate 1).

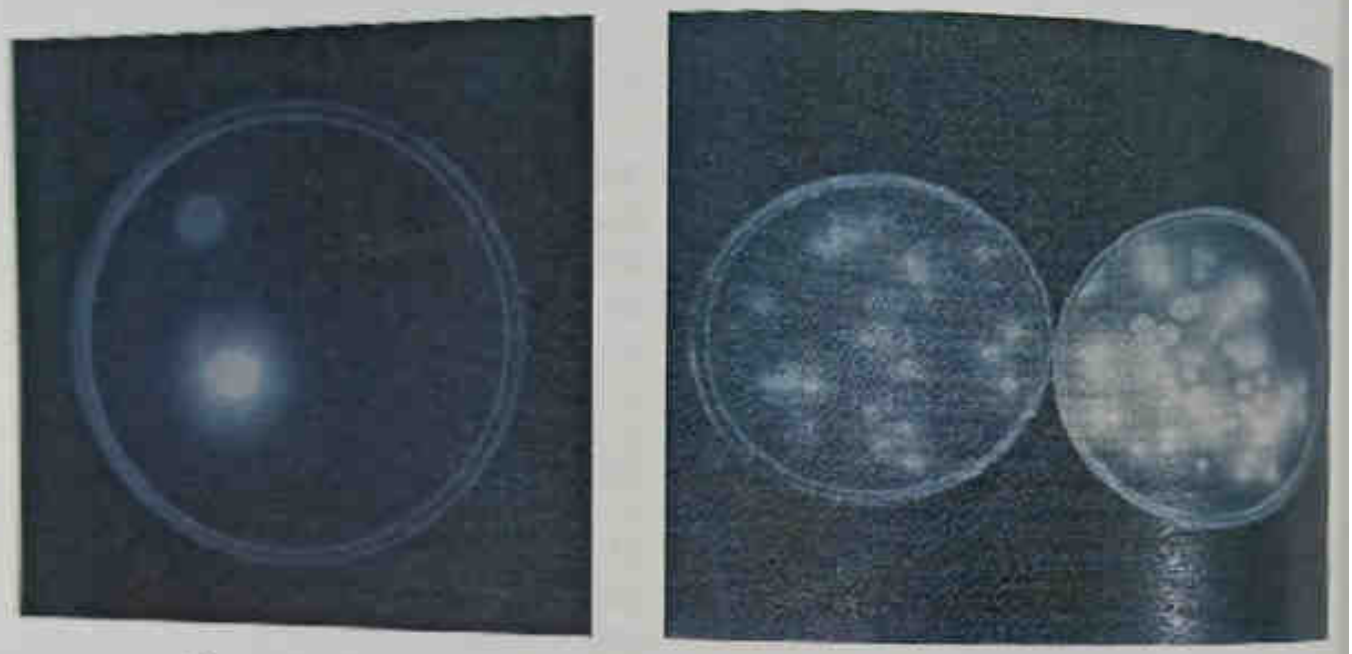


Plate 1. Fluorescent colonies of PGPR isolates onto King's B medium

In general, seed inoculation with the PGPR isolates resulted in increased root length, nodule number/plant, shoot weight/plant, nodule dry weight/plant and pod yield/plant in pots during the rabi-summer season of 2000 (Table 1). However, best results were obtained with the inoculation of PGPR 1, PGPR 2 and PGPR 4. Maximum root length (38-41%), nodule number/plant (26-28%), pod yield (23-25%), and shoot dry weight (24-33%) were obtained in treatments inoculated with PGPR 1, PGPR 2 and PGPR 4. Analyses of the uptake of plant nutrients also showed that inoculation with PGPR 1, PGPR 2 and PGPR 4 isolates gave significantly higher P content in root and shoot. Similar results were also obtained in the rainy season of 2000.

In a field trial, seed bacterisation with majority of the PGPR isolates enhanced pod yield significantly (13-23%) except PGPR 1, PGPR 2 (on a par with control) and PGPR 5 (significantly less than control). However, plant growth and biomass were enhanced by all inoculants except PGPR 6. Nodule number and nodule dry weight at 45 days after sowing were also enhanced due to seed inoculation of PGPR (Table 2). Application of

Table 2. Effect of PGPR on the growth & yield of groundnut, cultivar, GG2, *Kharif*, 2000 in field (mean of four replications)

Trt	Pod yield (kg/ha)	Nodule dry weight (mg/p)	Plant biomass (kg/ha)	HI	Seed mass/100 seed (g)	Shelling %
Control	1938	102	2332	45.38	37.61	74.45
PGPR1	1900	119	2932	39.32	36.41	74.77
PGPR2	1917	117	2830	41.02	36.40	74.17
PGPR3	2192	137	3252	40.26	38.38	73.77
PGPR4	2288	114	2950	43.65	36.77	73.10
PGPR5	2366	127	2722	46.50	37.70	74.50
PGPR6	2566	121	2550	50.17	36.71	73.83
PGPR7	2315	115	2640	46.72	36.86	74.67
PGPR8	2538	113	2775	47.70	37.20	73.80
PGPR9	1785	104	3037	47.02	37.54	74.32
Cons. A	2506	109	3025	45.31	34.88	74.90
Cons. B	2966	109	2982	50.03	35.90	73.30
Cons. AB	2462	119	2552	48.85	36.60	74.63
CD (0.05)	182	16	252	—	NS	NS

Table 3. Effect of the inoculation of PGPR on the nutrient status in plants and kernel (cultivar JL 24, Kharif '00, AICRP(G) trial) at the NRCG, Junagadh

Treatments	N content (%)		P content (%)	
	Plant	Kernel	Plant	Kernel
Control	2.10	4.45	0.101	0.370
PGPR1	2.57	5.02	0.125	0.402
PGPR2	2.70	4.75	0.136	0.394
PGPR4	2.02	5.03	0.119	0.351
PGPR1+2+4	2.52	4.87	0.112	0.336
CD (0.05)	0.34	NS	0.019	0.026
CV (%)	9.32	5.87	10.48	4.62

3 Phosphate solubilizing microorganisms

3.1 Mutational improvement of strains

As overproduction of organic acid may lead to better phosphate solubilization capability obtaining regulatory mutants of isolates are essential. Thus, for the improvement of the strains for enhancement of phosphate solubilizing capacity, NTG mutagenesis was carried out in two phosphate solubilizing microorganisms viz., PSM3 and PSM5 (both fluorescent pseudomonad isolates). Sixty three mutants of PSM3 and fifty six mutants of PSM5 were obtained. Among the mutants of PSM3, four mutants produced larger solubilization zones and higher TCP solubilization compared to wild type whereas in case of PSM5 three mutants exhibited better phosphate solubilization compared to wild type, *in vitro*.

4 Supply of biofertilizer to AICRP(G) centers and Agril. Universities

Two bradyrhizobial isolates (IGR6 and IGR40) and three PSM cultures (*Pseudomonas striata*, *Bacillus polymyxa* and *Bacillus circulans*) were supplied to different AICRP(G) centres and Agril. Universities and in our experiments to NEH region. Four PGPR cultures were also supplied to Aliyarnagar, Dharwad, GAU(Junagadh), Chintamani, Jalgaon, Kalla, Vriddhachalam for AICRP(G) trials.

Table 1. Effect of PGPR on the growth & yield of groundnut, cultivar, JL24, rabi-summer 2000 in pots (mean of three replications)

Trt	Pod yield (g/p)	Nodule dry weight (mg/p)	Shoot weight (g/p)	Nodule Number /p	RL (cm/p)
Control	3.02	109	18.12	63	25.3
PGPR1	3.78	184	24.25	80	35.8
PGPR2	3.73	161	22.50	81	35.1
PGPR3	3.75	131	21.57	72	33.6
PGPR4	3.78	165	26.55	81	35.5
PGPR5	3.39	139	21.25	72	33.6
PGPR6	3.48	157	20.80	60	30.3
PGPR7	3.57	163	20.69	72	35.4
PGPR8	3.77	159	22.17	80	33.9
PGPR9	3.41	158	21.82	61	29.5
CD (0.05)	0.23	26	3.28	8.65	4.09

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

1 Nutrition of large seeded groundnut

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

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

2 Screening for P-efficient groundnut genotypes

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

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

3 Screening for Calcium-efficient groundnut genotypes

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

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

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

4 Experimentations on groundnut grown with no synthetic inputs:

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

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

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

Table 2. Effect of various organic farming approaches on the groundnut yield, weed biomass and availabilit of soil micronutrients

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

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

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

1 Cropping systems

1.1 Effect of groundnut genotypes in intercropping systems

Performance of 31 groundnut genotypes (11 virginia and 20 spanish) was evaluated during the *Kharif* season of 2000 in two intercropping systems viz groundnut-pearl millet and groundnut-pigeon pea. For Virginia types, 1 (groundnut):1 (intercrop) and for Spanish 3(groundnut):1(intercrop) row ratios were followed. Sole crop of each genotype was also maintained as a control. In generals, yield reduction of groundnut was more with pigeon pea (up to 54.6 %) than with pearl millet (up to 37.2 %). There were large genotypic differences for reduction in pod yield due to intercropping systems. Genotypes, Kadiri 3, ALR 2 and GAUG 10 among virginia and J 11, GG 4 and DRG 12 among spanish types showed less reduction in pod yield as intercrops.

pH of groundnut rhizosphere(0-15cm) slightly increased when groundnut was grown as an intercrop as compared to sole crop, and the increase in pH was more with pigeonpea than with pearl millet.

1.2 Response to nutrients in the intercropping systems

Very little information is available on nutrient dynamics and requirement of intercropping systems rather than the respective individual components of systems. In groundnut+pearl millet intercropping, nitrogen was applied in different splits (1 to 4) either in the soil or as foliar sprays in the form of 2% urea solution. Observations on soil NO_3 accumulation in 0-15 cm of soil was recorded at 25 day intervals. The maximum yield of the system was when 1/3rd of the recommended dose of nitrogen for pearl millet was applied as basal and remaining 2/3rd was applied in three equal splits either in the soil or on the foliage. Higher amount of nitrogen applied in the soil increased nitrate nitrogen in soil (19.39-24.39ppm) as compared to when 1/3rd or 1/4th of recommended N of pearlmillet applied to the soil (12.16-13.60ppm).

1.3 Long term experiment on Nutrient dynamics

Meager information is available on cumulative as well as residual fertility build up in the long run for whole groundnut based cropping systems. A long term experiment with five popular groundnut based cropping systems viz monocropping of groundnut, two intercropping systems (with pearl millet and pigeon pea) and two sequential cropping systems (groundnut-wheat and groundnut-wheat-green gram) was initiated during *Kharif* 1998 under different combinations of organic and inorganic fertilizer regimes to study the nutrient dynamics and crop sustainability. After 3 years, the following changes in productivity of groundnut and soil properties were observed.

Among the cropping systems pod yield of *Kharif* groundnut was the maximum (1637/ ha) in groundnut - wheat-cropping system, which was 10% higher than that recorded in monocropping of groundnut.

Soil maintained higher organic carbon content (0.40%) under groundnut+pigeonpea intercropping system and groundnut-wheat-green gram sequential cropping system as compared to sole groundnut (0.38%). Groundnut+pigeonpea intercropping system and groundnut-wheat-green gram sequential cropping system maintained higher available nitrogen in the soil (60 ppm) as compared to sole groundnut (56 ppm).

The population of free nitrogen fixing microbes were the maximum (50.50X104 colony forming unit/g of soil) followed by groundnut-wheat-green gram (28.75X104 colony forming unit/g of soil). The least were in sole groundnut (5.10X104 colony forming unit/ g of soil).

There was a slightly higher pH (7.64-7.71) in the rhizosphere of groundnut+pearl millet and groundnut+pigeon pea intercropping system than that in sole groundnut (7.41) was observed.

2 In-situ moisture conservation techniques for rain fed groundnut

Studies on in-situ moisture conservation techniques was initiated during *Kharif* 2000 with an objective to improve water use efficiency of rain fed groundnut by conserving moisture in the soil profile and minimizing evaporation losses through improved cultural practices.

Effects of fore cultural practices viz; flat bed (60cm x 10 cm, two blade harrowing at 20 and 40 days after sowing DAS), sub-soiling (60 cm x 10 cm, two sub-soiling at 20 & 40 Das), broad bed furrow,BBF, (105 cm bed, 35 cm roe to row) alternated with 30 cm wide and 20 cm deep furrow, inter row water harvesting,IRWH, (105 cm bed, 45 cm row-to-row, alternated with 30 cm wide and 20 cm deep furrow) on two cultivars, GG 2 (a bunch type variety) and GG 20 (virginia type variety) were studied in split plot design replicated three times.

Crop was planted with the on-set of monsoon on July 8, 2000. In all the treatments plant population was kept the same.

A total of 529 mm rainfall was received during the cropping season. Major portion of rainfall, 307.8 mm (58%) was received between July 1 to 15, 2000 and 197.0 mm (37%) from August 1 to 29. Remaining rainfall incidences were quite low and irregular to meet the evapotranspiration demand of the crop. Hence, crop experienced two droughts, one at vegetative stage (July 16 to August 9, 2000, 24 days) and September 1 to crop harvesting.

Soil moisture was monitored gravimetrically at 7 days interval during the cropping season to compute evapotranspiration. Water use pattern showed that inter row water harvesting observed highest ware use (238 mm) followed by broad bed furrow (237.3 mm) and lowest (228 mm) was recorded in flat bed system in cv. GG 2. While in GG 20, water use with BBF was maximum (275.0 mm) and lowest (259.3 mm) was recorded in flat bed system. (Fig. 1 and 2).

2.1 Yield and yields attributes

Seeding was done to have uniform plant stand of 1.66 lakh per ha. In each treatment, Initial plant stand ranged in between 1.46 to 1.47 lakh/ha, which was around 88% of total seed sown. Final plant stands ranged in between 89000 to 96000/ha in GG2 and 1.09 to 1.32 lakh/ha in GG20. This mortality was due to stem/collar rot. The mortality was more (32%) in flat bed and lowest (23%) in IRWH/BBF. Better soil moisture condition by restricting evaporation losses owing to better canopy spread might have caused less mortality. IRWH provided 19% and BBF 16% higher yield over flat bed. The difference between varieties was non significant. Water use efficiency (WUE) was maximum (6.3kg/ha/mm) with IRWH in GG2 and 5.4 kg/ha/mm with BBF in GG 20 (Fig. 3 and 4).

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

A new pre-emergence herbicide, Napropamide (amide group) was evaluated in groundnut based cropping system during *Kharif* 2000. Two rabi crops namely, wheat and gram and two summer crops (pearl millet and green gram) were grown to assess the residual effect of the herbicides. Four doses of Napropamide (1,2,3 and 4 kg ai/ha) were evaluated along with recommended herbicide (Pendimethalin, 1.5 kg ai/ha). Effect of Napropamide in controlling weeds (monocots/dicots) was similar to Pendimethalin. However, there was considerable residual effect on succeeding wheat crop and germination, growth and yield (29.4%) of wheat were drastically reduced under Napropamide treatment. No residual effect on gram was, how ever, observed. In summer crops also, no significant reduction in dry matter of green gram and pearl millet was observed due to residual effect of Napropamide. Thus any new herbicide must be tested in a cropping system mode rather than in sole crop.

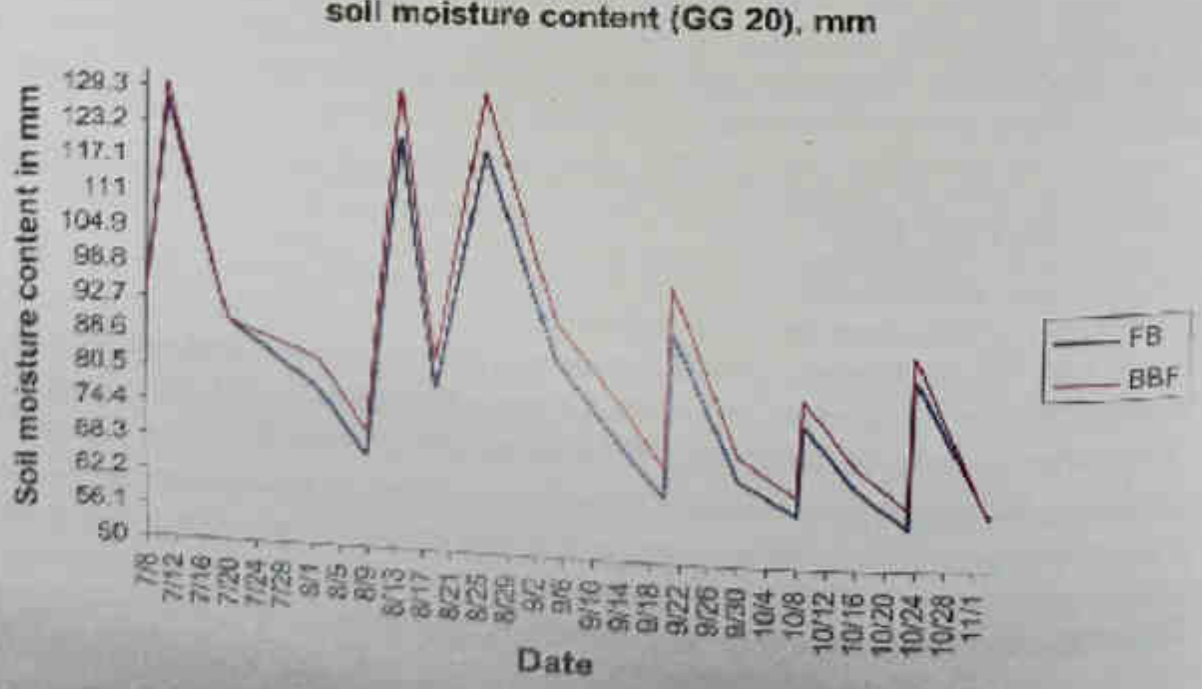


Fig. 1

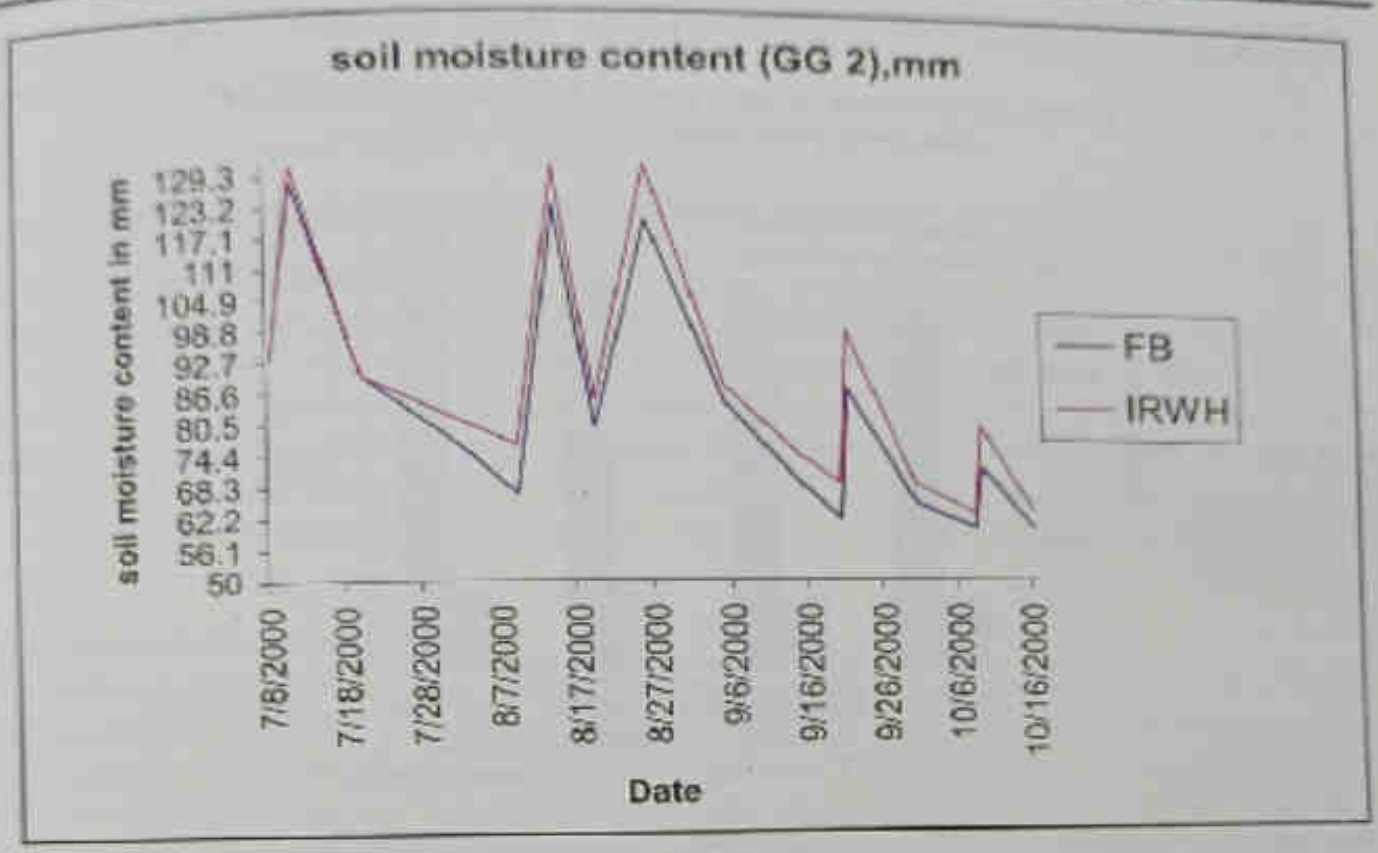


Fig. 2

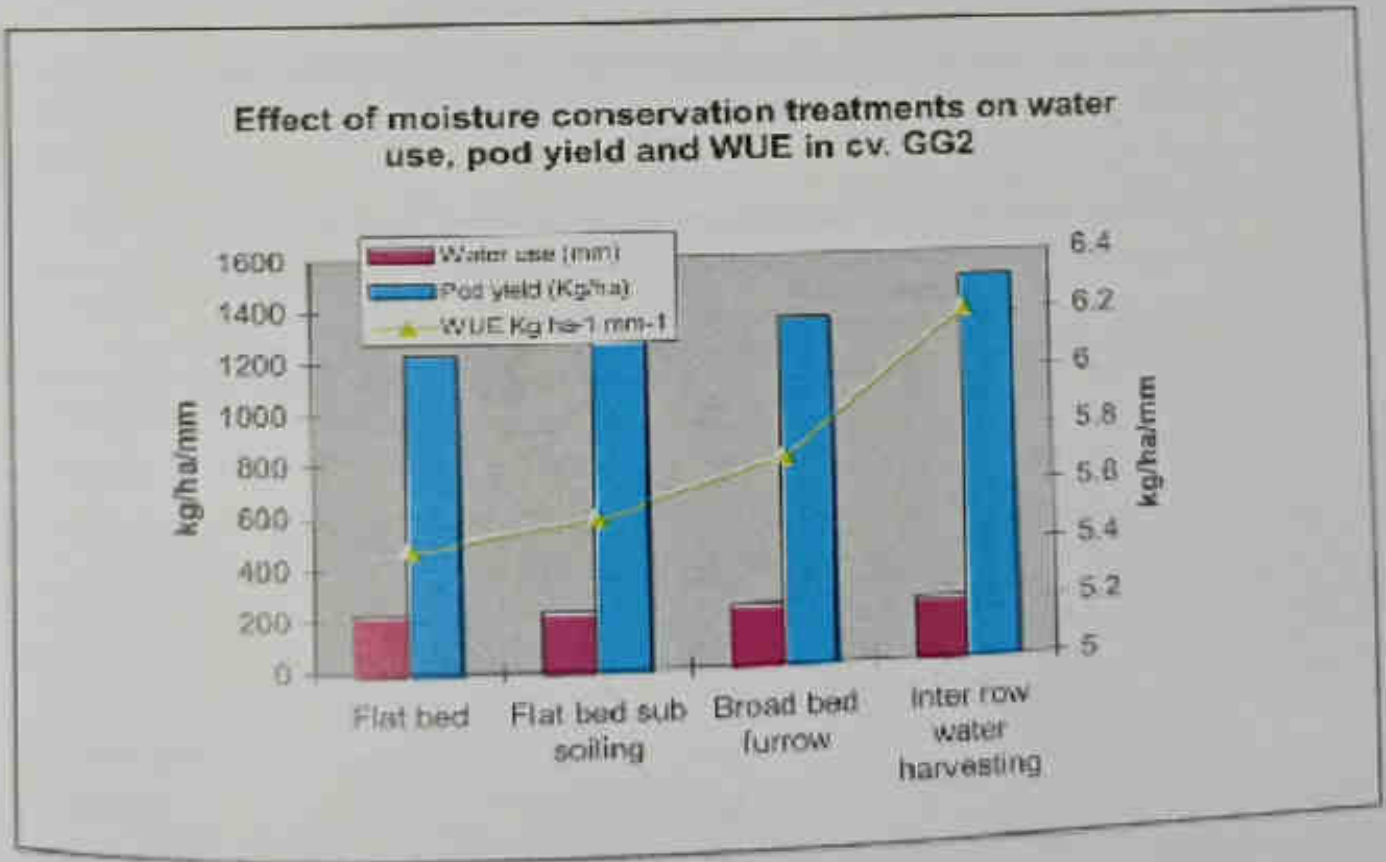


Fig. 3

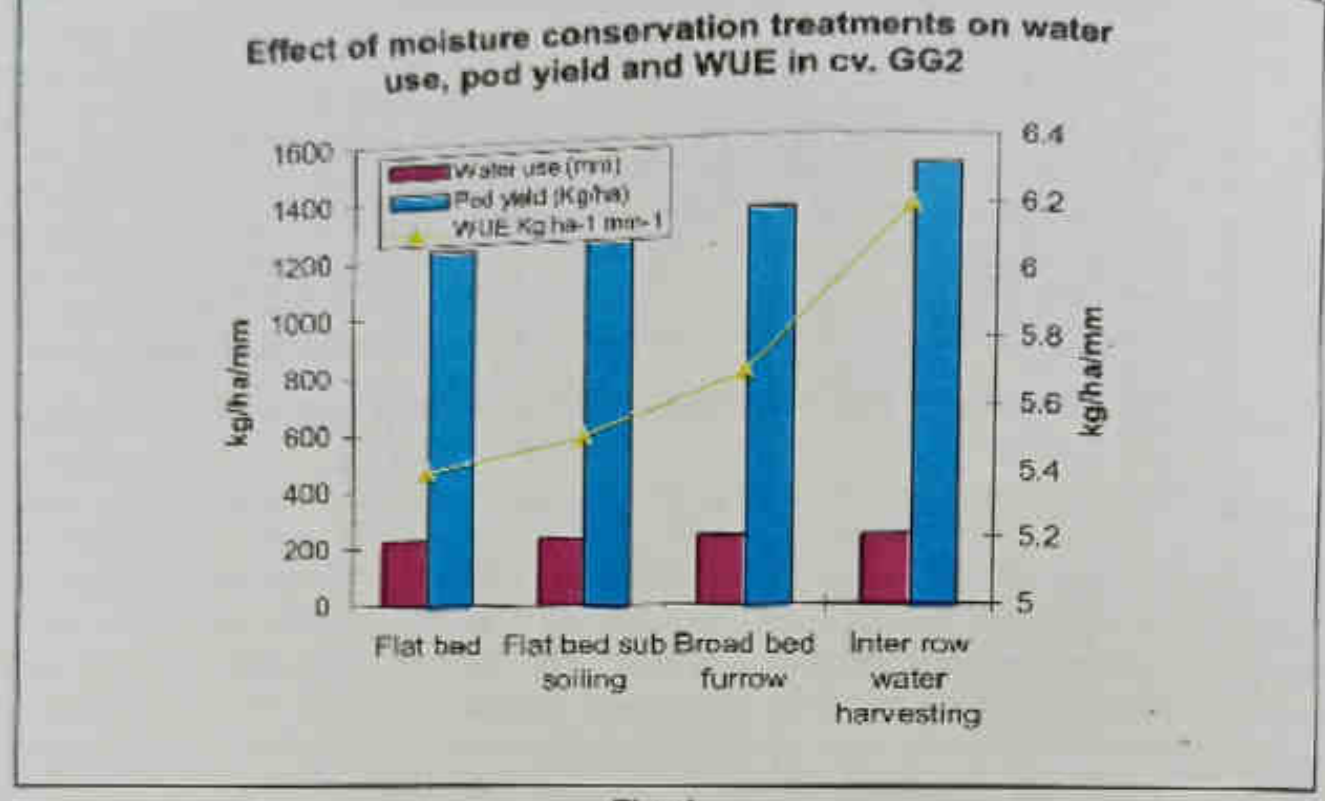


Fig. 4

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

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

Sub-project 01: Physiological Studies on abiotic stresses

1 Screening for salinity tolerance

Eighty cultivars and 40 germplasm accessions were screened for the tolerance to salinity in trays. After sowing saline water irrigation (4 Ece) was given, in addition to this cultivars were also irrigated with normal water regularly. Seedling emergence was recorded and final mortality was calculated 45 d after sowing. Mortality ranged between 40% in GG 20 and 100% in MH 2, ICGS 37, Spanish improved, TG 3, and ALR 1. Forty germplasm accessions screened in the saline soil also showed genotypic variation in the rate of mortality.

2 Leaf membrane thermostability

In our previous studies significant genotypic variations for leaf relative injury index (RI) were observed. Therefore, 9 cultivars varying in their SLA were studied for leaf membrane thermostability, under irrigated and rain-fed situations. Thermostability in control plants, in general, decreased with the increasing age of the plants and was maximum at 75 DAS. Plants encountered water-deficit stress did not show much change in the RI values at various growth stages. In cv. ICGS 44 the relative membrane integrity was least under controlled conditions and thermostability was maintained under stress conditions. Majority of the genotypes under stress conditions showed higher accelimination, the result indicated that low SLA lines i.e. ICGV 86031, CSMG 84-1 were able to acclimatize more to water deficit situation.

Table 1. Relative injury in leaf membrane thermostability in groundnut cultivars.

Variety	Treatment	
	Control	Stress
ICGS 44	23	23
GG 2	25	28
Chico	33	16
ICGS 76	33	22
TAG 24	30	19
TG 3	34	22
ICGV 86031	40	22
TG 26	32	18
CSMG 84-1	36	24

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

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

1 Experimentations in North-East Hill regions

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

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

Ten recently released groundnut varieties were evaluated for their pod yield, tolerance of Al- and Fe-toxicities and Ca- and P- deficiencies in acid soils and resistant to early and late leaf spot diseases and insects pests at Barapani (Meghalaya), Lembucherra (Tripura), Imphal (Manipur) and Tura (Meghalaya). Pod yields of the cultivars ranged from 938-1838 kg/ha against 938kg/ha of the check (JL 24) at Barapani in Meghalaya and 522-2087 kg/ha against 671 kg/ha of the check (JL 24) at Lembucherra in Tripura. The average pod yields were 1225 and 1250 kg/ha in Meghalaya and Tripura, respectively. The cultivars K 134 (1838 kg) R 9251 (1630 kg/ha) and TKG 19A (1375 kg/ha) were high yielder in Meghalaya. However ICGS 76, and ICGV 86590 and DRG 12, were the high yielders in Tripura during Kharif 2000. The high yielding groundnut genotypes were also tolerant of Al-toxicity, resistant to ELS, LLS and rust diseases and hence can be grown in NEH region.

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

1.2 Screening and evaluation of germplasm lines

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

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

3 Seasonal variation in SLA under moisture-deficit conditions

Our previous studies had shown inverse relationship between water use efficiency (WUE) in terms of drought tolerance (DTI) based on dry matter production. In present study SLA was studied in two contrasting seasons i.e. summer and *Kharif* . The RWC and SLA showed significant cultivar and seasonal variations in their response to prevailing climatic conditions and water deficit. For example, SLA of cultivars was higher in the rainy season then the summer season (Table 2). The relationship between SLA in the experiments conducted in two different seasons suggested that cultivar ranking for SLA was consistent across contrasting environment.

Table 2. Specific leaf ares (SLA) of groundnut cultivars in two contrasting seasons under moisture-deficit conditions.

Cultivar	Rabi summer		*Kharif*	
	Control	Stress	Control	Stress
CSMG 84-1	139	149	169	172
ICGV 86031	117	139	160	157
Chico	180	210	218	215
GG 2	144	150	185	189

4 Root studies

Pilot experiments were conducted in incubator, in small plastic pots and large earthen pots (10kg cap.) to study the groundnut root growth under moisture-deficit conditions. Significant findings of the experiments are that there was no effect of stress on root length dry mass and root volume changes substantially under stress conditions; however, root shoot ratio increased under stress.

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

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

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

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

1.3 Integrated nutrient management in groundnut

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

In general very good response of *Bradyrhizobium* and PSM was noted with phosphatic fertilizer and lime at all the three locations in NEH Region. However their effect was only marginal without P and Ca. The soil amelioration with lime and P increased the productivity of groundnut. The groundnut crop inoculated with PSM and *Bradyrhizobium* showed green canopy but the crop without *Bradyrhizobium* and PSM showed shunted growth with chlorotic leaves, poor nodulation and N and P deficiency symptoms. At Tripura, lime+P+ *Bradyrhizobium*, and lime+P+PSM increased 45 and 31% more nodulation, respectively and 50 and 50% more nodule mass, respectively over control at 30 days after emergence (DAE). However these increases were 18 and 22 % and 78 and 67%, respectively at 60 DAE. Application of lime + P + PSM produced 1580 kg/ha pod yield as 1050 kg/ha against control, however Lime + PSM only produced 1280 kg pod/ha. Combined application of lime+P+ *Bradyrhizobium* and lime+P+PSM could increase 40 and 50 % pod yield and 11 and 20 % haulm yield, respectively. At Barapani, maximum pod yield (2700 kg/ha) was obtained by inoculation of NC 92 + NPK (206040) against 1500 kg/ha of the control and 2310 kg/ha with NPK.

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

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

1.4 Experiment on organic farming

The various organic farming approaches were tested in, Manipur taking TG 22 groundnut variety where organic fertilizers showed its superiority over inorganic one and FYM (at 10 t/ha) alone doubled the productivity (Table 4). Application of Mustard cake (at 1 t/ha) increased 51 % pod yield over control, but when it was combined with *Bradyrrhizobium* it could increase 102 % pod yield over control. However, application of NPK (305040 kg/ha) fertilizers showed 46 % increase in pod yield over control.

1.5 Amelioration of Al-toxicity

The ameliorative role of lime and FYM was noticed in experiments conducted at Barapani to overcome the Al-toxicity through soil amelioration (Table 5). The three years of data reveals that addition of 10t/ha FYM alone increased pod yield varying from 28-100%. Addition of 2.0 t/ha of lime, on the other hand, increased 31-46%, and NPK (206040 kg/ha) increased 30-97% pod yield over control. The combined application of these ameliuratives though increased pod yield, over their alone application, but were not always beneficial. Application of lime and FYM increased the nutrient contents particularly of Ca and P in the plant facing Al-toxicity and increased growth and yield. Thus application of lime and FYM ameliorate the Al-toxicity and any one of these could be used.

1.5.1 Basic studies on Al-toxicity at NRCG

1.5.1.1 Standardization of Al-doses and creening groundnut genotypes

The various Al doses when tested in sand culture experiments showed that in general 200 uM Al, as $AlCl_3$, was beneficial to groundnut, but the doses above 400 uM Al were toxic and caused reduction in growth and yield. However the effects of Al-toxicity varied with groundnut genotypes.

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

Based on the data for the consecutive two years study revealed that the genotypes NRCG 7599 and 1038, 3498 and, 6919 showed comparatively more tolerance than others. However the genotypes GG 4 and GG 5 and GG 20 were most sensitive.

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

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

Table 1 Performance of groundnut varieties in acid soils of NEH region during *Kharif* 2000

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

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

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

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

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

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

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

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

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

Symbol	Treatments	Pod Yield (kg/ha) During the various years		
		1998	1999	2000
T1	Control (no fertilizer)	1550	1625	1080
T2	FYM (10 t/ha)	1983	2125	2163
T3	NPK (206040 kg/ha)	2022	2150	2123
T4	Lime (2 t/ha)	2261	2271	1420
T5	T2 + T4 (10 t/ha FYM + 2 t/ha Lime)	2100	2500	1747
T6	T3 + T4	2344	2950	1663
T7	T2 + T3 + T4	2021	3250	2290
	LSD (0.05)	238	225	350

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

(K. RAJGOPAL, K. CHANDRAN, S.K. BERA, V. NANDAGOPAL, S. DESAI, P. MANIVEL, R. K. MATHUR AND M. Y. SAMDUR)

Sub-project 01: Collection, Evaluation, Documentation and distribution of cultivated groungnut and related arachis species

1 Acquisition of Germplasm

A total of seven hundred and fifty six accessions have been assembled from different sources out of which 723 accessions were from International Crops Research Institute for Semi Arid Tropics, Patancheru. Fourteen accessions were procured through National Bureau of Plant Genetic Resources, New Delhi from Plant Science Research Lab., USDA, ARS, USA. Three new botanical varieties *aequatoriana* (2), *peruviana* (1) and *hirsuta* have been introduced from USDA through NBPGR, New Delhi. Remaining accessions were assembled from other institutes within the country.

2 Supply of Germplasm

Four hundred ninety nine accessions were supplied within the Centre to six indenters and 164 accessions were supplied to six other Centres engaged in crop improvement.

3 Characterization of germplasm

One thousand seven hundred ninety nine accessions, procured from the International Crops Research Institute for Semi-arid Tropics (ICRISAT), Hyderabad and NRCG Outreach Station, Bhubaneshwar were evaluated for 19 qualitative and 27 quantitative traits. The collection comprised 447 virginia bunches, 323 virginia runners, 588 spanish and 441 valencia types. The characterization has been undertaken using IPGRI/ICRISAT Groundnut descriptors. The salient findings are as under

3.1 Qualitative traits

On thousand two hundred and thirteen accessions showed decumbent-3 type of growth habit. The distribution of accessions irrespective of habit forms for various qualitative traits are presented in Table 1. In general, Valencia collection showed higher pigmentation in stem and pegs with garnet colour flowers but one accession showed yellow flower. A yellowish-green coloured leaf, which is of a rare occurrence, was found in two accessions (NRCG 10632 and 12329). Although simple and multiple pegs at the leaf nodes are of common the relatively rare elongated inflorescence was found in 45 accessions representing 2.5 % of total population. Woolly nature of stem was found in five accessions (NRCG11957, 12065, 12150, 12151 and 12657). Variation for pod characters like pod beak, pod constriction and pod reticulation was more in Valencia types, the descriptor states ranged from "absent to "very prominent". The testa colour in valencia types ranged from white to dark purple. Majority of the accessions (69.8%) in the collection had rose and salmon testa.

The Valencia accessions (NRCG's 12886, 12905, 12907, 12916, 11065,and 11610) had cent percent three seeded pods whereas in NRCG 12700, 11999, 5001 and 6519 had complete four seeded pods in the sampled lot. Similarly some accessions having 100 seed

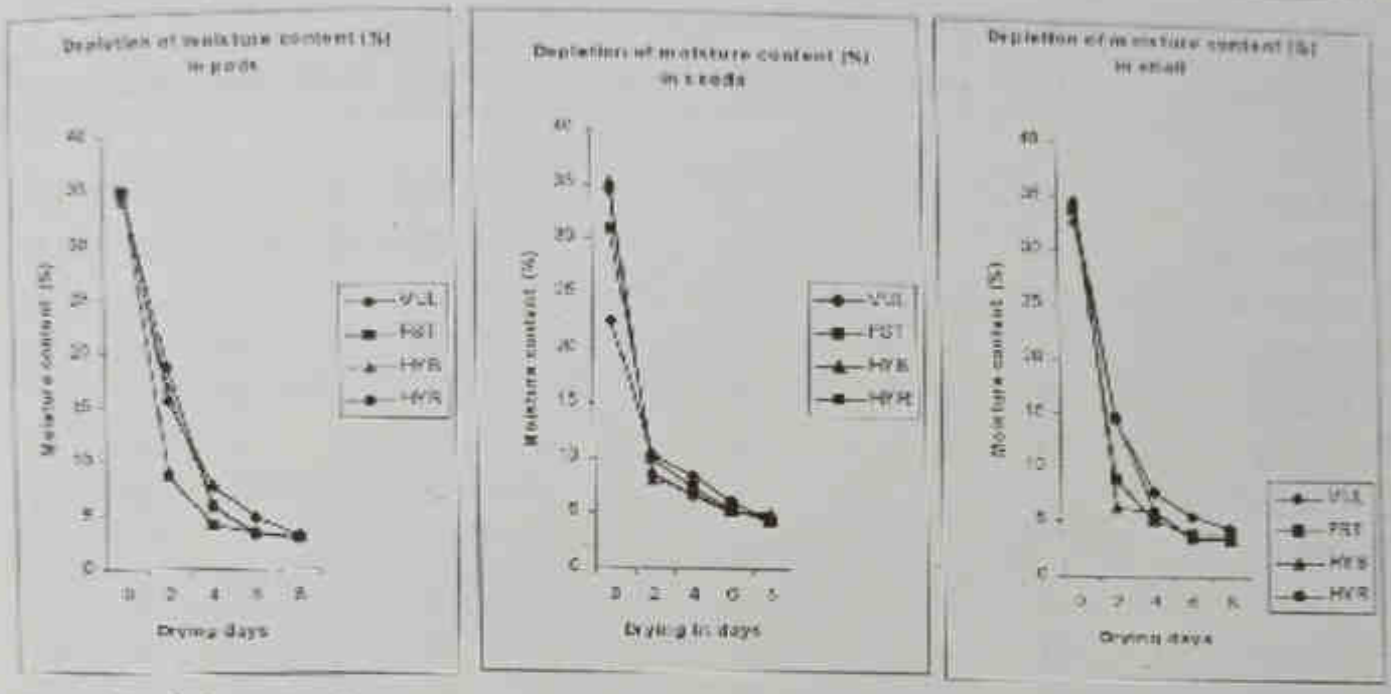


Fig 1. Depletion of moisture content in whole pods, seeds and shells of cultivars belonging to four habit types

There was a significant variation in moisture content over the period of drying, moisture content in three components (whole pods, shell and seeds) and among the cultivars. The interactions among these factors were also significant. The shelling percentage showed significant differences among the cultivars and interaction for period of drying and cultivars. No significancy was observed for other factors.

5 Characterization of released cultivars

The distinctness of the cultivar from the other extant cultivar is the first of the triode of the DUS prerequisites for granting any form of protection to the rights of its breads. Keeping this in view as a continuing efforts for the last five years a set of seventy cultivars were characterized for three years. A second set of 21 cultivars now being characterized since 1999. Seven of the 21 belongs to the virginia bunch type, 5 virginia runner type (ssp. hypogaea) and 12 belongs to the spanish types (ssp. fastigiata) were studied. Each cultivar was scored for stem, leaf, flower, fruit and seed traits using the Descriptors for Groundnut developed by IPGRI/ICRISAT. These cultivars showed overlapping variation for most of the traits. The cultivar Tirupati 3 showed red testa colour and CSMG 884 had large pods compared to other cultivars. Some of the important descriptor states, which are consistent over two years, of the 21 cultivars are given in table 3

Table 2. Mean, range and standard deviation (sd) for some quantitative traits in 1799 germplasm accessions

Variable	Range	Mean	SD
Percentage of one seeded pods	0-98	14	10
Percentage of two seeded pods	0-100	72	24
Percentage of three seeded pods	0-100	14	24
Percentage of four seeded pods	0-64	1	5
Pod length (mm)	14-56	28	6
Podwidth (mm)	9-18	12	1
Seed length (mm)	9-21	13	2
Seed width (mm)	6-11	8	1
Shelling out-turn	37-80	66	8
Sound mature Kernel(%)	50-100	89	7
Hundered Seed mass (g)	18-68	40	10

4 Study on moisture depletion in groundnut pods over period of drying.

The plants of groundnut are harvested when the inner surface of pods turn black in colour. The moisture content of the whole pods at the time of harvest varies from 35-60 % depending on the cultivars. The moisture content has to be reduced to less than 10 % within a short period to avoid the loss of keeping quality. This study was undertaken to know the variation in the rate of moisture depletion over a period of time under sun drying in eight cultivars of groundnut. The cultivars belonged to the virginia bunch (BAU 13 and GG 20), virginia runner (M 13 and GAUG 10), spanish (GG 2 and JL 24) and valencia (Gangapuri and MH 2) habit types. They were sown in the first week of July. The spanish and valencia types were harvested in the third week of October and the virginia types were harvested in the first week of November. About 60 well-developed pods were selected at random from the produce immediately after harvest for determination of moisture content in seeds. The harvested pods were spread on the threshing floor for sun-drying and samples were drawn at an interval of every two days for estimation of moisture content. The temperature during the period of drying ranged from19.4 to 36.2 0C and relative humidity from 18.3 to 55.8 %. Sampling was done till the moisture content was reduced to about 4%.

The moisture content ranged from 31% to 38 % in pods immediately after the harvest. The moisture content in shell did not vary among cultivars but the seed showed higher moisture content in the two virginia types at the time of harvest. After two days of drying there was a drastic reduction in moisture content in the pods of the two valencia cultivars but the content in seed and shell were on a par with other cultivars. There was a reduction of about 50% in moisture content after two days of drying (Fig 1). After sun drying of eight days the moisture in seeds ranged from 4.3 to 4.9 %, which is very ideal for germplasm storage.

weight in the range of 52 to 63 grams was recorded in Valencia collection (NRCG 12755, 11909, 5001, 6213, 6993 and 10824) and in Spanish collection (NRCG 5405, 10571, 11251, 11505, 11716 and 12482). These lines could be further exploited in the breeding programme for large seed export quality cultivars.

Table 1. Distribution of accessions for some important qualitative traits among 1799 germplasm accessions

Sr. No.	Descriptor	Descriptor states								
1	Growth habit	Decumbent1 (117)	Decumbent2 (231)	Decumbent3 (1213)	Erect (238)	-				
2	Stem pigmentation	Absent (1015)	Slight (740)	Prominent (44)	-	-				
3	Peg pigmentation	Absent (294)	Present (1505)	-	-	-				
4	Flower colour	Orange (1189)	Dark orange (28)	Garnet (25)	Yellow (1)	-				
5	Leaf colour	Yellowish green (2)	light green (718)	Green (1010)	Dark green (69)					
6	No. of pegs/node	Single (869)	Multiple (884)	Elongated (45)	-	-				
7	Stem hairiness	Glabrous (100)	Slight (535)	Moderate (961)	Profuse (198)	Woolly (5)				
8	Leaflet hairiness	Almost glabrous (453)	Slight (1126)	Mderate (218)	-	-				
9	Leaflet shape	Lanceolate (1509)	Oblong (290)	-	-	-				
10	Leaflet tip	Acute (1509)	Obtuse (290)	-	-	-				
11	Pod beak	None (150)	Slight (1176)	Moderate (387)	Prominent (75)	Very Prominent (11)				
12	Pod constriction	Absent (16)	Slight (708)	Moderate (981)	Prominent (70)	Very prominent (24)				
13	Pod reticulation	Absent (28)	Slight (1220)	Moderate (346)	Prominent (142)	Very prominent (61)				
14	Seed shape	Round (267)	Fusiform (1486)	Elongated (46)	-	-				
15	Seed size	Small (68)	Medium (1554)	Large (177)	-	-				
16	Shell thickness	Thin (423)	Moderate (978)	Thick (397)	-	-				
17	Seed colour	White (1)	Off white (9)	Tan (31)	Rose (580)	Solmon (656)	Light red (5)	Red (303)	Dark red (38)	Purple (7)
		Dark purple (54)	Variegated (121)							

6 Documentation

The data generated on evaluation of germplasm was documented in a electronic database developed by NRCG. The inventory has been updated whenever new accessions were annexed.

7 Activities undertaken at Out Reach Centre, Bhubaneswar

7.1 Multiplication of germplasm

A working collection of 2184 accessions has been multiplied during *Kharif* season. In post rainy season 1794 accessions have been multiplied to increase the seed quantity. Eleven released groundnut cultivars were also multiplied to use as national check in the AICRP trials.

7.2 Distribution of germplasm

Three hundred accessions were supplied to three centers in North eastern region for screening against Al toxicity in accordance with the ongoing research programme. Thirty-nine released cultivars were supplied to 7 indentors.

Evaluation of germplasm

7.2.1 *Virginia bunch*

One hundred Virginia bunch accessions were evaluated through augmented block design during rainy season under red laterite soil for yield and yield related traits. Twenty-one accessions registered higher pod yield in comparison to local check AK 12-24. Similarly, six accessions (NRCG 10152, 11111, 11117, 11720,11766 and 11771) appeared promising for yield and related traits.

7.2.2 Spanish

One hundred and eleven accessions appeared promising for yield and related traits in the initial trials were further tested for confirmation of results. Fifty-two accessions produced significantly higher yield than controls.

Sub-project 02: *In vitro* conservation of groundnut germplasm

Multiple shoots induced from the de-embryonated cotyledons of A.monticola, A.duranensis, A.correntina and A.kempff-mercadoi from the earlier experiment were used for in vitro conservation studies. Shoots were cultured on different media listed below.

MS+ BA 5mg L^{-1} + Sucrose 30 g L^{-1} (Control)
MS+ BA 5mg L^{-1} + Sucrose 30 g L^{-1} + ABA 2 mg L^{-1}
MS+ BA 5mg L^{-1} + Sucrose 30 g L^{-1} + Mannitol 2% (w/v)
MS+ BA 5mg L^{-1} + Sucrose 30 g L^{-1} + Mannitol 2% (w/v) + ABA 2 mg L^{-1}
MS+ BA 5mg L^{-1} + Sucrose 30 g L^{-1} + Mannitol 4% (w/v)
MS+ BA 5mg L^{-1} + Sucrose 30 g L^{-1} + Mannitol 4% (w/v) + ABA 2 mg L^{-1}

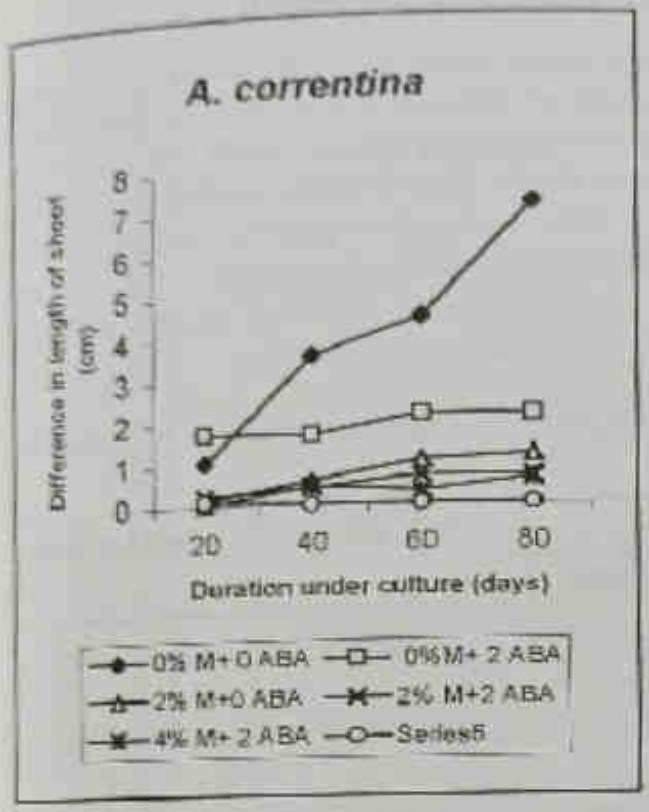
Table 3. Important qualitative traits among the released cultivars

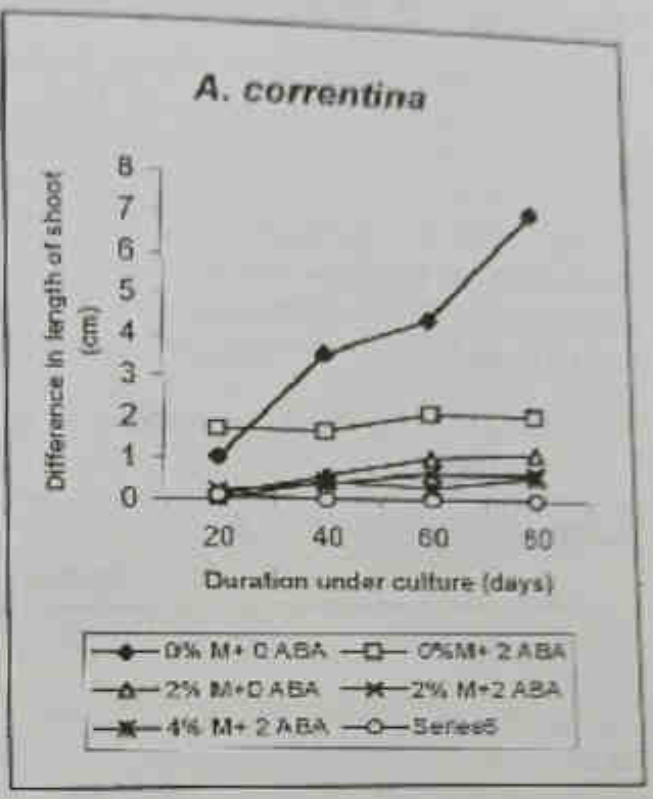
Cultivars	LFC	PGP	NOP	PDB	PDC	PDR	SDC	SDS	SDZ	PDZ	SHT
HYB											
ALR 3	4	+	2	3	5	5	10	s	2	2	2
CSMG 884	4	+	2	5	5	7	10	2	3	3	3
Kadiri 2	4	0	2	3	5	3	10	2	2	2	2
LGN 2	4	+	2	3	5	3	10	2	2	2	2
R 8808	3	0	3	3	3	5	11	2	2	2	1
R 9251	3	+	1	3	3	0	10	2	2	2	1
Tirupati 3	4	+	2	3	3	3	14	2	2	2	2
HYR											
DRG 12	3	+	1	3	5	3	10	2	2	2	2
DRG 17	3	+	1	0	5	3	10	2	2	2	2
DSG 1	4	-	1	0	5	3	10	2	2	2	2
KADIRI 71-1	4	0	2	3	3	3	10	2	2	2	2
S 230	4	0	1	3	5	3	10	2	2	2	2
VUL											
ICG(FDRS) 10	3	0	3	3	3	7	11	2	2	2	3
ICG(FDRS) 4	3	0	2	3	0	7	11	2	2	2	3
ICGS 37	4	0	1	3	5	3	10	2	2	2	2
JAWAN	2	+	1	5	5	3	11	2	2	2	1
JYOTI	3	+	2	3	3	3	11	1	2	2	1
Kadiri 4	4	+	1	3	3	3	11	1	2	2	2
KISAN	2	+	1	3	3	3	11	2	2	2	1
KRG 1	2	+	1	3	3	3	11	2	2	2	1
S 206	2	+	1	3	3	3	11	2	2	2	1
Tirupati 4	2	+	1	5	5	5	11	2	2	2	2
VRI 2	3	+	1	5	5	3	11	2	2	2	2
VRI 3	3	0	2	3	3	3	11	2	2	2	1

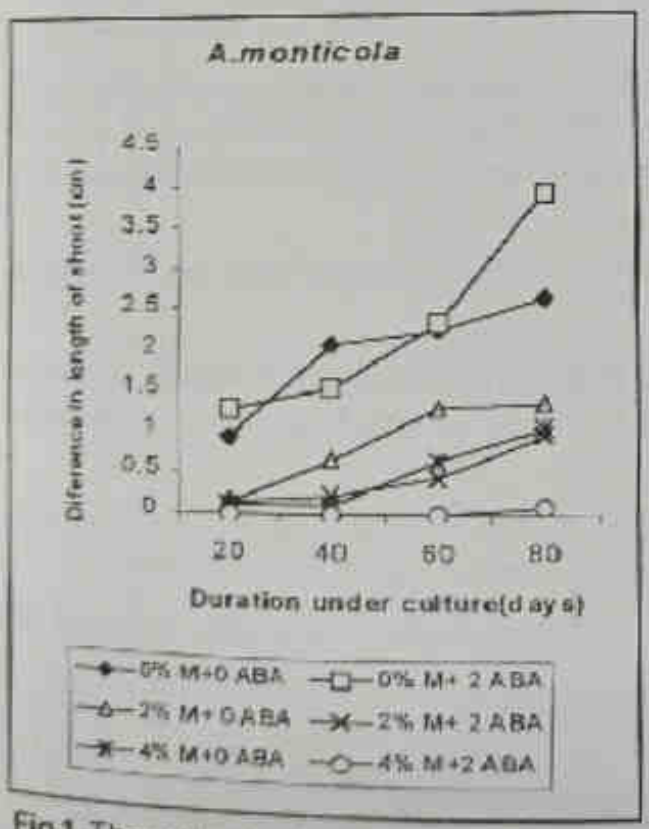
HYB= Virginia bunch, HYR= Virginia runner, VUL= Spanish, LFC= Leaf colour 2=light green, 3=green, 4=dark green, PGP=Peg pigmentation0=absent, +=present, NOP= Nature of peg 1=simple, 2=multiple, 3=elongated reproductive axis, PDB=Pod beak, PDC=pod constriction, PDR=pod reticulation 0=none, 3=slight, 5=moderate, 7=prominent, SDC= Seed colour10=rose, 11= salmon,13=red, SDS=Seed shape 1=round, 2=fusiform, SDZ=seed size 2=medium, PDZ= Pod size2=medium, 3=large, SHT= Shell thickness, 1=thin, 2=medium, 3=thick

Among the six treatments tried, the control had the maximum elongation of shoots followed by the treatment with 2ppm ABA. High coefficient of variation was observed for both fresh weight and dry weight (69 and 50 % respectively). This is probably due to irregular lateral growth of the shoots especially from the portion in contact with the culture medium and due to irregular callusing behavior where a high concentration of mannitol was used. The culture media supplemented with 2% mannitol alone could show uniform (fig 1) retarded growth with healthy shoots (fig 2). Though growth was retarded in the treatments 4, 5 and 6 the shoots remained lanky and started wilting after 60 days in culture and so would not be suitable for maintaining the culture. The medium supplemented with 2% mannitol found suitable for prolonging the duration between sub culturing to the next 80 days.

Fig 2. *In vitro* grown shoots after 80 days of culture in 2% mannitol medium 1= *A. monticola*, 2= *A. kempff-mercadoi* 3= *A. duranesnsis*, 4= *A. correntina*







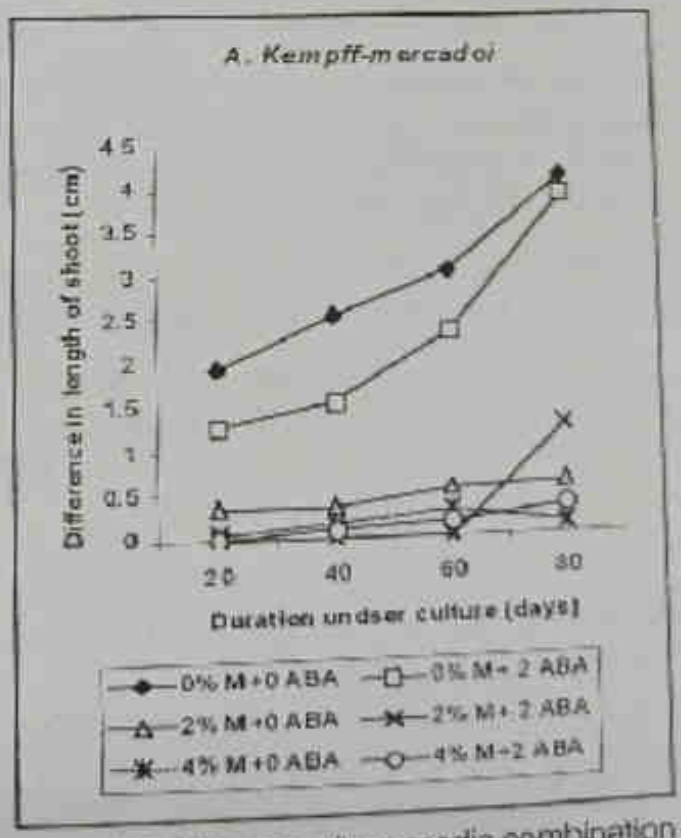


Fig 1. The pattern in shoot growth of four different species in 6 different culture media combination

Sub-project 03: Enhancing recombination frequency in groundnut

Studies on the F_2 generation of cross between Male sterile mutants x male fertile genotypes: The male sterile mutant (Girnar 1 MS) of the cultivar Giranar 1 was crossed with three different male parents (Girnar 1, PBS 11003 and M 13) during *Kharif* 1998 and F_1's were studied during *Kharif* 1999. All the F_1 plants were fertile. The F_2 were studied during the *Kharif* 2000. F_2 segregated for male sterility. The segregation pattern varied widely depending on the male parent (Table 1). The inheritance pattern is complex and will be confirmed in the F_3 generation. Tentatively, the segragation with Girnar 1 as male fits the ratio 31, with M 13 the ratio 151 and with PBS 11003, the ratio 225 32.

Table 1. Studies on the F_2 generation of cross between Male sterile mutants x male fertile genotypes

Crosses	F_1	F_2		χ^2	Gene action
		Fertile	Sterile		
Girnar 1 MS x Girnar 1	Fertile	39	12	0.455 (31)	Recessive
Girnar 1 MS x M 13	Fertile	97	4	0.902(151)	Duplicate
Girnar 1 MS x PBS 11003	Fertile	290	44	0.138 (22532)	?

A cross was made between a Spanish cultivar GG 2 and the Virginia cultivar Kadiri 3 during *Kharif* 1998. Three hundred seed each of GG2, Kadiri 3 and their F_1 were treated with 0.1% EMS and sown along with each 300 seed of untreated GG 2, Kadiri 3 and their F_1 in the *Kharif* 1999.

Variance and range were invariably high in mutated populations than the untreated populations for most of the traits (Table 2).

There was increase variance in all the three (GG 2, Kadiri 3 and GG2 X Kadiri 3) treated mutants over their respective untreated controls for plant height, branch height, primary branches, hanging pegs and immature pod weight.

The Virginia genotype (Kadiri 3, male parent) had higher variance and higher mean for most of the pod and kernel traits than the Spanish genotype GG 2 (female parent).

Higher variance was observed in the heterozygous EMS treated F1 for twelve traits out of eighteen than the untreated F_1.

Table 2. Variance and range in EMS treated and untreated homozygous and heterozygous populations for some traits in groundnut

	PH	BH	PB	SB	NN	NHP	NMP	NIM	NTP	NSK	NUS	NTK	MPW	IMP	TPW	SMK	USK	TK
Variance																		
GG 2	10	11	1	9	5	6	9	4	10	29	14	29	5	1	4	3	0	3
Kadiri 3	12	22	1	13	3	7	9	8	15	18	14	34	7	2	6	4	1	4
GG2 x Kadiri3	30	94	1	24	7	51	20	16	39	79	22	100	20	7	32	15	1	18
GG2 (M_1)*	13	22	1	9	5	14	7	6	11	24	16	32	6	1	7	4	1	4
Kadiri 3 (M_1)*	18	34	1	19	4	10	9	10	15	26	23	38	7	3	8	5	2	5
GG2 x Kadiri 3 (M_1F_1)*	20	57	1	16	4	25	14	23	38	58	27	90	17	5	21	11	1	12
Range																		
GG 2	14-30	19-35	4-7	0-13	7-19	0-11	3-15	0-9	4-22	1-31	0-23	7-37	2-11	0-4	2-12	0-9	0-4	2-10
Kadiri 3	10-30	19-44	4-7	0-18	8-16	0-17	1-16	0-15	5-23	0-24	0-20	8-34	1-12	0-8	3-14	0-9	0-4	2-11
GG2 x Kadiri3	12-40	14-68	4-8	0-19	9-19	0-52	1-20	0-18	3-34	0-42	0-23	5-56	1-22	0-12	1-34	0-21	0-6	1-25
GG2 (M_1)*	12-30	15-36	2-7	0-14	7-18	0-22	0-13	0-13	2-21	0-24	0-20	3-35	0-14	0-7	1-15	0-12	0-5	1-12
Kadiri 3 (M_1)*	11-32	17-46	4-8	0-23	5-18	0-17	0-16	0-22	2-27	0-35	0-26	3-40	0-14	0-10	2-19	0-13	0-6	1-14
GG2 x Kadiri 3 (M_1F_1)*	16-43	24-62	4-8	2-18	10-19	0-24	1-22	0-30	3-39	0-40	0-23	4-53	1-22	0-16	2-26	0-17	0-5	2-19

* = Treated with 0.1% EMS. Values in parenthesis are range

PH= plant height, BH= maximum branch height, PB= number of primary branches, SB= number of secondary branches, NN= No of nodes on main stem, NHP= No. of hanging pegs, NMP= No. of mature pods, NIM= No. of immature pods, NTP= No. of total pods per plant, NSK= No. of sound mature kernels, NUS= No. of unsound mature kernels, NTK= No of total kernels, MPW= Mature pod weight, IMP= Immature pod weight, TPW= Total pod weight, SMK= sound mature kernel weight, USKW= Unsound mature kernel weight, TK= Total kernel weight.

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

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

1 Morphological characterization of wild species of *Arachis*

Fifty-one accessions of 19 *Arachis* species were characterized for 32 qualitative traits and 16 quantitative traits. Wide variation was observed for most of traits. The leaflet on lateral branches is smaller than those of main stem and even the leaflet shape also different in some of the accessions. At intraspecific level, *A.glabrata* showed wide variation (Table 1). The *A.glabrata* accessions were found more desirable based on morphological traits for using as a fodder crop were 11828,12036,11840,11846 (shorter internodes), 11818, 11832,11833, (larger foliage) and 12033 (non-flowering) (Fig 1).

Fig. 1. Non-flowering and flowering, *A. glabrata* accessions

Flowers on main stem were observed for *A. duranensis* (12043), *A. appressipila* (11786), *A. paraguariensis* (11793,12042), *A. stenophylla* (11811), and *A. batizocoi* (11810). In *A. helodes* both yellow and orange flowers were observed in the same season and the leaflet of the same are having red pigmentation and can easily be distinguishable from other species at the seedling stage itself. *A. paraguariensis* showed very elongated pegs extended up to 62 cm (Fig 2).

Between three *A.monticola* accessions also morphological variation was observed for leaf shape, hairiness and size of the pods.

Both direct and reciprocal crosses were made between Chico and Robot 33-1 during *Kharif* 1999. In *Kharif* 2000, the F_1 seeds were treated with EMS 0.1% (sub-lethal dose) and sown. The crosses were made among the treated F_1 plants and the resulting hybrids were harvested for further study.

Fig. 2. Pegs and pods of *A. Pusilla*

Table 1. Variation for some important morphological traits in *A. glabrata* collection

NRCG	SP	SH	LC	LH	LS	FC	PP	LI	LL	LW	HL	SL	SW
11817	+	3	3	0	9	6	+	3.0	3.0	1.0	5.0	2.0	2.0
11818	+	3	4	0	9	6	+	5.0	4.0	2.0	7.0	2.0	2.0
11821	+	5	4	0	9	5	-	5.9	3.8	1.9	6.4	1.7	2.1
11823	+	0	4	0	9	5	+	5.5	3.4	1.7	6.2	1.6	2.1
11826	0	0	4	0	9	5	+	2.9	2.5	1.3	6.7	2.0	2.5
11828	+	3	4	0	9	6	+	2.2	3.1	1.4	5.4	1.7	2.2
11830	+	3	3	3	9	5	+	2.7	3.4	1.4	7.0	1.8	2.3
11832	0	0	3	0	12	5	+	4.2	4.2	2.0	7.0	1.8	2.5
11833	+	3	4	0	12	6	+	2.6	4.5	2.0	8.5	2.1	2.5
11834	+	0	4	0	9	6	+	3.3	3.0	1.9	5.3	2.0	2.6
11835	+	0	4	0	9	6	+	3.0	3.3	1.6	4.8	1.9	2.5
11837	+	0	4	0	12	6	+	2.7	2.7	1.3	7.7	1.9	2.5
11840	0	0	3	0	12	6	+	2.5	3.0	1.0	7.1	2.0	2.6
11841	+	0	3	0	12	6	+	4.3	3.3	1.3	6.3	2.8	2.2
11845	+	3	3	0	9	5	+	2.4	3.2	1.2	4.8	1.5	2.3
12033	+	0	3	0	9	-	-	3.7	3.9	1.5	-	-	-
12036	+	0	3	0	12	5	-	2.5	3.4	1.6	7.9	1.6	2.2

SP=Stem pigmentation, SH= stem hairiness, LC leaflet colour, LH=leaflet hairiness, LS= leaflet shape, FC flower colour, PP=peg pigmentation, LI= length of internodes, LL= leaflet length, LW leaflet width, HL= Hypanthium length, SL= Standard petal length, SW= Standard petal width

2 Interspecific hybridizations

The following crosses were attempted and the probable hybrid pods were harvested (hybrid isolation is to be done in the next season)

3	*A. glaranensis*	1455 pollinations
} 11 x	*A. kretschmeri.*	934 pollinations
} 11 x	*A. cardenasii*	1200 pollinations

Five crosses were attempted to generate marker combinations.

3 Standardization of transformation protocols

Twenty-five co-cultures each with 50 explants were taken up with explants embryonal axes, deembryonated cotyledons and immature leaves as explants. Of these, 40 explants with shoots are now growing in cultures. Two hundred explants have survived the selection with hygromycin. Rooting was induced in thirty shoots and then hardened. The total survival was 90% after hardening (before field planting). Fifty shoots are in the rooting medium for inducing the roots.

The leaf disks from the hardened plants were collected and assayed for the expression of GUS.

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

For standardising the protocols for AFLP, the genomic DNA from the cultivar UF 70-100 and tomato DNA as a standard was used. The Genomic DNA was restriction digested with Eco R1 and Mse 1. Then double stranded DNA adapters specific to the Eco R1 and Mse I sticky ends were ligated. After ligation, the product was amplified with non-selective Eco R1 and Mse 1 primers in a polymerase chain reaction so as to produce templates for the selective amplification. The non-selective amplification products were then amplified with 64 combinations of the 8 Eco R1 and Mse1 primers.

The amplification products were run in a denaturing sequencing gel and stained using silver staining. Of these the producrs from primer combinations 33 combinations showed amplifications. In this process, gel casting and subsequent detection of amplification products were standardised.

5 Optimisation of and fingerprinting protocol

Genomic DNA from the cultivar DRG 7 as well as Tomato DNA (Control) were restricted and then ligated and non-specific amplification was done. In the second amplification 3 dilutions were taken up (11, 110 and 150). For the selective amplification the eight primers were used. Twenty micro litres of the amplified product was run on a denaturing sequencing PAGE gel. In one set of the products glycerol and in the other ficoll was used for increasing the density during loading in the gel. The gels after run were stained using silver staining.

For silver staining, the method was improved by removing the urea from the gel prior to staining using CTAB and then sensitised and treated with silver nitrate. The use of ficoll instead of glycerol solved the problem of distortion of run in the starting point of the gel.

The optimum concentration of ficoll in the loading dye To deduce any limitation in the amplification by the Taq polymerase, the non-selective amplification was done with the restricted and ligated genomic DNA of the cultivars, DRG 7, Dh 3-30, UF 70-103. Two levels of Taq polymerase viz. 1 and 2U were used. In the selective amplification the products from the two treatments were again amplified with four sets of primers and two levels of Taq polymerase (5 and 10 U).

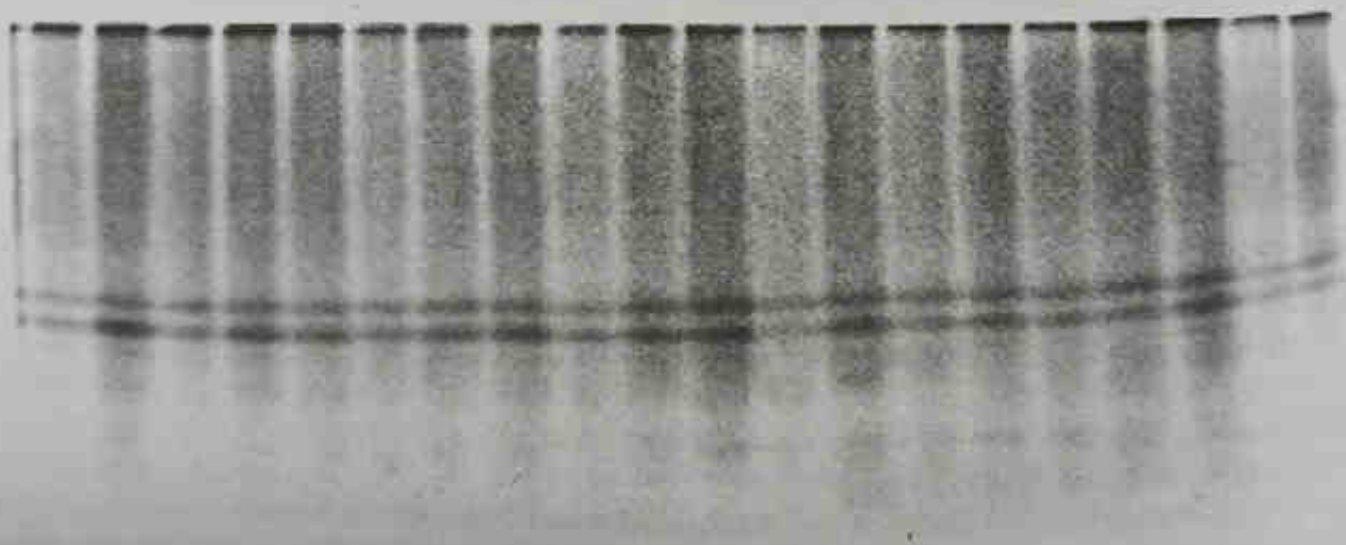
The amplification products were separated on denaturing sequencing gels and it was concluded that for the non-selective amplification 2U of Taq polymerase and for the selective amplification 5U Taq polymerase was optimum for getting resolvable amplification products. These conclusions were confirmed by using the control i.e Tomato DNA with the same set of primers

6 Iso-enzyme analysis in some germplasm accessions

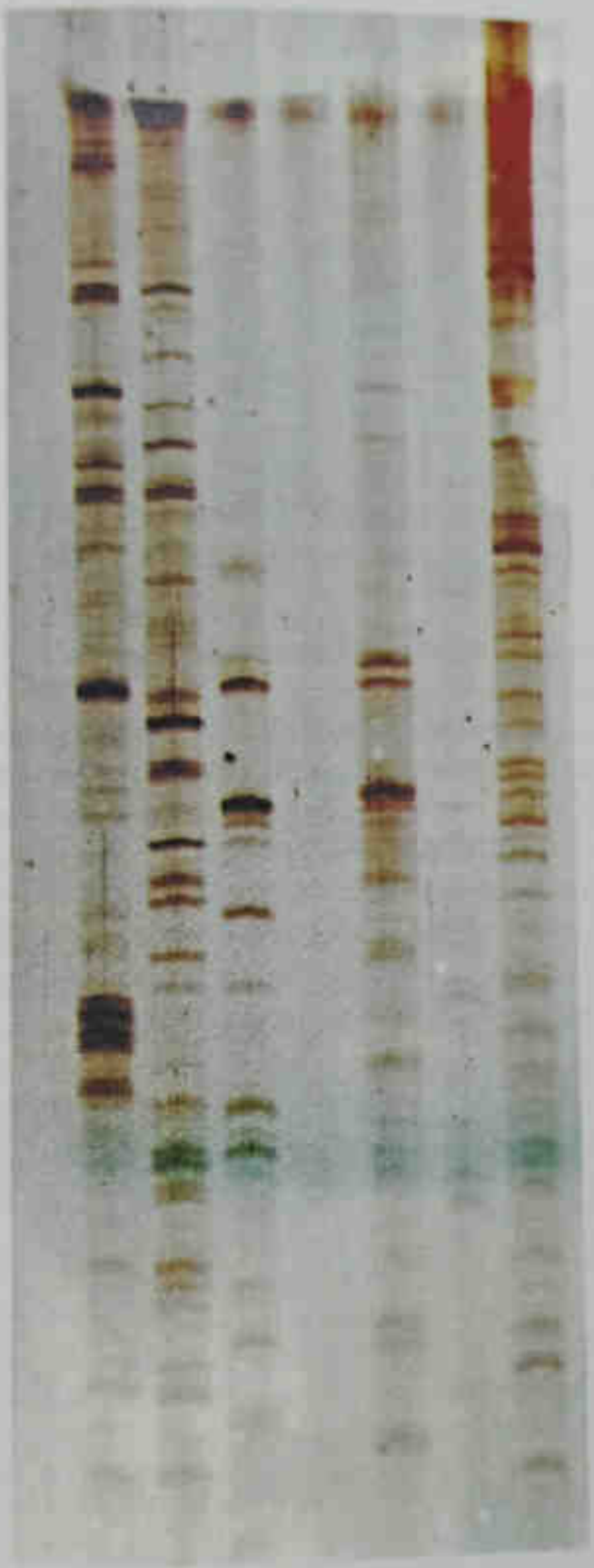
The following accessions, which are known to be resistant to Rust, were studied for their variation in the isoenzyme activity.

Resistant ICGs 10927, 10932, 10964, 10032, 10062, 10954, 10047, 10030, 10073, 10074, 10021, 10049, 10022, 10061, 11183, 10048, 10056, 10070, 10064, 10037, 10054, 10042
Susceptible TMV 2 and Kadiri 3

Isoenzyme patterns of Esterase, Polyphenoloxidase, Catalase and Peroxidase were studied using different activity staining protocols, in native polyacrylamide gels. Considerable polymorphism for isoenzyme activity of these enzymes was not apparent. In the case of polyphenoloxidase, one additional iso enzyme was observed in the genotype ICGV 10062. The experiment is being repeated for the confirmation of the results.



Esterase activity stained in polyacrylamide gel



An AFLP gel showing DNA polymorphism

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

(J. B. MISRA, P. MANIVEL, R. DEY, K. K. PAL)

Sub-project 01: Assessment of qualty in gremplasm collection, breeding material and produce of other experiments

1 Oil content of groundnut cultivars and genotypes

In *Kharif* 2000, 84 genotypes (40 spanish bunch, 19 viginia bunch, 1 valencia and 24 virginia runner) were multiplied in field. The kernels of these genotypes were analyzed for their oil content, which ranged from 41.6 to 53.4% (mean 47.4%, s.d. 2.5). The means oil content of spanish, virginia bunch and virginia runner were 46.8, 48.0, and 48.2%, respectively. Genotypes ICGV 86590, ICGS 1, ICGS 21, HNG (HPS) 2, GG 12 and CSMG 884 were identified as the high oil genotypes (≥51%) while S 206, TG 87, TMV 2, Tirupati 4, ICGS 76, M 522, BG 2 and Gangapuri were identified as the low oil genotypes (table 1).

2 Calibration of the new model of arachilipometer

For evaluating the performance of the new model, the oil content of seed samples of 15 genotypes was determined by the new model of archilipometer as well as by the conventional Soxhlet method. For Soxhlet method the values for the range and the mean were 41.6-53.3% and 47.6%, respectively while the corresponding values for arachilipometer were 42.8-54.3% and 48.4%, respectively for the arachilipometer (table 2). The samples showing the maximum and the minimum oil contents were identical for both the methods. The value of coefficient of correlation was 0.977 (significant at 1% level). Thus the arachilipometer was found to be an economic, simple and rapid device for determination of oil content of groundnut seed samples.

3 Methionine content of some groundnut cultivars

The conent of methionine, a sulfur containing amino acid, was analyzed in seed samples of one valencia, five spanish bunch, two virginia runner and eight virginia bunch cultivars. The values ranged form 0.65 to 1.62 % of protein for CO 1 and GG2, respectively. The other genotypes which had more than 1% methionine in their protein were ICGS 44 (1.55), JL 24 (1.12) TMV 7 (1.08), GG 20 (1.44) and J 11 (1.61).

4 Service to other sections

Oil content was determined in kernel samples received from Microbiology (93), Plant Physiology (124+36), Plant Breeding (16), Genetics & Cytogenetics (18+3), Genetic Resources (21) and PC Unit (66). Fatty acid composition of 36 samples received from Plant Physiology section was analyzed.

Sub-project 02: Breeding and genetic studies on HPS and confectionary groundnut

1 Hybridization

Twenty crosses were attempted in line x tester (4 x 5) design for incorporation of large-seed trait coupled with some desirable quality traits. A total of 3446 buds were pollinated and 309 putative hybrid pods were obtained.

2 Evaluation of crosses made for study of the genetics of seed mass

Twenty-eight crosses made in half-diallel and involving 8 parents were evaluated in a replicated trial. General combining ability was found to be significant whereas the specific combining ability was non-significant suggesting thereby that for seed mass the additive gene action has a predominant role. Of the eight parents, B 95, HPS 20 and PBS 161, were identified as the best general combiners for seed mass. All the crosses with B 95 gave improved seed mass. It was concluded that cross combination of high seed mass x high seed mass and/or high seed mass x medium seed mass, would yield better transgressive segregants for higher seed mass than the other combinations.

3 Generation advancement

Twenty-eight F_1 hybrids and their parents, which were evaluated for confectionery trait during in *Kharif* 1999, were again evaluated in *Kharif* 2000 along with 16 additional F_1 hybrids. Thirty crosses from F_2 and 18 crosses from F_4, were advanced to next generations. Nine confectionery type advanced breeding cultures were selected from the advanced generations and assigned the identity numbers from PBS 9056 to 9064. Five new germplasm accessions viz. ICGV 92206, 93382, 97243, 99206 and 96240, were identified as the parental material for hybridization purpose.

4 Yield evaluation trial

Twelve large-seeded advanced breeding cultures and four check cultivars viz., B 95, BAU 13, Somnath, and GG 20 were evaluated during *Kharif* 2000. Three cultures viz. PBS 29055, 29054, and 29047 recorded yields higher than the best check cultivar GG 20, however, compared to the best check, significantly higher yield was observed only in case of culture PBS 29055 (table 3). Hence culture PBS 29055 was recognized to have a good potential for being promoted as a bold-seeded high-yielding genotype. Good bearing, cluster bearing, deep reticulation, medium constriction, medium beak, bold pods and medium bold seeds and medium duration are some of the special features of PBS 29055.

Another culture PBS 29039, although not a good yielder (2745 kg/ha) was recognized as a culture resistant to late leaf spot (score of 1 compared to of 8 by the check variety BAU 13 and Somnath) and hence could be used as a parent in future crossing programs. For shelling out turn and 100-seed mass, the culture PBS 28014 was rated as the best.

5 Selection of advanced breeding cultures through participatory breeding approach

Twenty farmers hailing from the villages adopted by the center under TAR-IVLP were invited to the experimental fields to use their discretion for identifying good cultures from the ongoing yield evaluation trials. The rank orders of the cultures selected by the farmers

Table 1 Oil content of some groundnut cultivars and genotypes (*Kharif* - 2000)

Spanish bunch		
1	S 206	41.6
2	TG 87	42.1
3	TMV 2	42.7
4	Tirupati 4	43.2
5	ICGS 76	43.5
6	ICGS 11	44.6
7	Dh 8	44.7
8	K 134	44.7
9	TPT 1	44.8
10	VG 9521	45.2
11	TMV-12	45.3
12	SG 84	45.3
13	J 11	45.4
14	JL 24	45.4
15	TG 3	45.5
16	DH 3-30	45.6
17	SB XI	45.8
18	TG 26	46.2
19	VRI 2	46.6
20	TPT 2	46.7
21	TMV 7	46.7
22	Spanish improved	46.9
23	Jawan	46.9
24	KRG 1	47.5
25	GG 3	47.7
26	AK 12-24	48.0
27	VRI 3	48.0
28	RG 141	48.4
29	Jyoti	48.5
30	Girnar 1	48.7
31	ICG(FDRS)4	48.8
32	MH 1	48.8
33	TKG 19-A	48.8
34	TG 17	49.1
35	TAG 24	49.2
36	ICGS 44	49.5
37	ALR 2	50.2
38	ICGV 86590	51.3
39	ICGS 1	52.4
40	ICGS 21	52.8
Virginia bunch		
41	M 522	43.6
42	BG 2	43.8
43	T 28	44.6
44	Somnath	45.8
45	LGN 2	46.8
46	M 145	46.9
47	ALR 3	47.2
48	Kadiri 3	47.3
49	R 9251	47.5
50	ICGS 5	48.3
51	BAU 13	48.8
52	R 8808	48.9
53	RSB 87	49.0
54	ALR 1	49.2
55	T 64	49.4
56	ICGV 86325	49.5
57	B 95	50.6
58	TMV 10	51.0
59	HNG(HPS)2	53.3
Valencia		
60	Gangapuri	43.9
Virginia runner		
61	CSMG 84-1	45.2
62	M 335	45.4
63	M 13	45.6
64	GG 4	45.7
65	GG 20	46.8
66	GG 13	46.8
67	Kaushal	47.0
68	Chandra	47.0
69	RS 1	47.4
70	DRG 12	47.6
71	GG 11	47.7
72	Karad 4-1	48.0
73	DRG 17	48.0
74	GAUG 10	48.2
75	Punjab 1	48.5
76	S 230	48.7
77	M 197	49.0
78	GG 20	49.2
79	Chitra	49.5
80	M 37	50.2
81	NRCG 750	50.5
82	UF 70-103	50.7
83	GG 12	51.3
84	CSMG 884	53.4

were more or less the same as was later determined on the basis of yield data. The top five genotypes selected by the farmers were PBS 29047, PBS 29054, PBS 29055, PBS 24005, and BAU 13.

6 Genetics of pod size

Spanish cultivars, GG 2 and NRCG 1339, identified as the female parent for small pod size and the male parent for large pod size, respectively, were crossed and the F_1 and F_2 generations were studied for their pod size. The trait of large-size pod was found to be a dominant one. In F_2, the ratio of 17024 for plants with large size pods and the plants with small size pods had a good fit to the ratio of 22531(~7.251), thereby indicating the control of two sets of duplicate loci interacting together with epistasis between the loci. Two sets of duplicate gene symbols P_1/p_1; P_2/p_2 and Q_1/q_1; Q_2/q_2 are being proposed for pod size for this pair of parents.

7 Supply of segregating material/advanced breeding lines to other research centers under NARS

A total of 18 large-seeded advanced cultures were supplied to institutions like NDDB, Anand (5), BARC, Mumbai (4), and TNAU, Coimbatore (9). Pods of nine released varieties were supplied to Tura (NEH region). Six genotypes were supplied to other sections within the NRCG for experimental purpose.

Sub-project 3: Biotransformation of groundnut shell into useful products

1 Cellulolytic and groundnut shell decomposition potential of micro-organisms

Determination of cellulase production potential of some microorganisms for their use in decomposition of groundnut shell.

Four cellulolytic microorganisms (*Phanerochete chrysoporium*, *Bacillus* spp., *Streptomyces* spp. and an unidentified fungus) were tested for their efficiency in decomposing groundnut shell and cellulase production potential. *Phanerochaete chrysosporium* was the most potent (35.7 mg CO_2 kg^{-1} shell d^{-1}) in decomposing groundnut shell (Table 4). Under *in vitro* conditions, *Bacillus* spp. was the most potent producer of cellulase (0.1115 IU ml^{-1} broth). Under *in situ* conditions, the cellulase production by these microorganisms, were commensurate with those obtained under *in vitro* conditions. *Bacillus* spp. produced 0.0591 IU of cellulase g^{-1} shell. The new isolates having good cellulase production potential may be utilized for enhancing the rate of decomposition of groundnut shell.

2 Fermentation of soluble sugars of groundnut shell for industrially important products

Preliminary experiments were conducted to utilize groundnut shell as a substrate for production of industrially important chemicals through microbial process. *Saccharomyces cerevisae* was successfully used for conversion of soluble carbohydrates available in the groundnut shell into some organic acids and esters. Studies on the quantification, optimization and down-stream processing of the products are underway.

Table 3. Yield and other characteristics of HPS advanced breeding lines identified from the trial

Genotypes	Hundred pod mass	Shelling turnover	Hundred kernel mass	Maturehundred kernel mass	Podyield	Crop duration	Rank	Disease score (1-9)		
								Late Leaf spot	Rust	Alternaria
	g	%	g	g	Kg ha^{-1}	days				
PBS 24005	154.2	73.8	60.3	66.8	3931	130	9	7	3	2
PBS 24041	150.8	70.9	61.3	70.4	3672	125	11	7	3	3
PBS 28014	161.8	78.8	71.0	78.6	3535	125	12	7	5	4
PBS 29007	170.9	67.8	61.9	73.7	4076	145	6	7	5	5
PBS 29025	156.2	72.7	65.4	73.6	4006	135	8	7	5	6
PBS 29028	145.2	70.5	59.4	68.1	2825	135	16	7	5	6
PBS 29039	157.7	71.4	64.5	71.8	2745	145	16	1	4	6
PBS 29047	199.6	67.4	73.2	85.7	4352	125	3	7	4	6
PBS 29048	165.9	70.7	65.5	77.2	3772	130	10	7	4	7
PBS 30056	144.1	53.8	55.6	60.6	3455	135	13	5	3	6
PBS 29054	184.9	65.5	69.3	83.8	4461	130	2	8	4	5
PBS 29055	183.6	66.7	66.9	84.5	4577*	130	1	8	4	6
Checks										
BAU 13	243.0	69.8	96.5	111.0	3334	145	14	8	5	5
Somnath	165.3	70.5	66.3	79.4	4070	125	7	8	5	7
B 95	176.1	65.7	72.2	85.1	4211	145	5	6	4	5
GG 20	154.1	74.1	62.1	69.4	4340	130	4	5	4	4
Grand mean	169.6	69.4	67.1	77.6	3835					
SE	11.63	1.0	4.2	4.9	413					

Table 2 Determination of oil content of seed samples of groundnut genotypes by Soxhlet method and by Arachilipometer

Sr. No.	Genotype	Oil (%)	
		Soxhlet method	Arachilipometer
1	TPT-1	44.79	45.00
2	GH-3-30	45.77	46.75
3	GG-2	49.19	48.50
4	GG 20	46.77	47.75
5	GAUG 10	48.23	49.50
6	GG - 3	47.28	48.50
7	ICGV 86590	51.32	51.25
8	HNG (HPS) 2	53.76	54.25
9	S 206	41.58	42.75
10	ICGS 76	43.53	44.25
11	TG 17	49.12	50.75
12	ALR 3	47.15	48.50
13	Jyoti	48.47	49.75
14	GG 12	51.35	51.25
15	J 11	45.37	46.25
16	VRI 2	50.63	50.25
17	VRI 4	45.67	44.50
18	VG 9521	52.43	51.75

Correlation coefficient = 0.966**
Significant value of "r" = 0.468 (5%), 0.59 (1%)

Table 4. Cellulase production potentials of and rates of decomposition of groundnut husk by some microorganisms

Microorganism	*In vitro* (ml^{-1} broth)		*In situ* (g^{-1} shell)		Rate of Decomposition(mg CO_2 kg-1 shell d-1)
	Cellulase (IU)	Reducing sugars (mg)	Cellulase (IU)	Reducing sugars (mg)	
Unidentified fungus	0.0475 (± 0.0069)	0.488 (±0.043)	0.0216(±0.0017)	0.047 (±0.006)	20.3 (±1.0)
P. chrysosporium	0.0705 (±0.0025)	0.425(±0.007)	0.0427 (±0.0021)	0.118 (±0.032)	35.7 (±2.6)
Streptomyces spp.	0.0587 (±0.0064)	0.375 (±0.004)	0.0081 (±0.0008)	0.060 (±0.008)	27.6 (±1.5)
Bacillus spp.	0.1115 (±0.0160)	0.854 (±0.061)	0.0591 (±0.0058)	0.106 (±0.004)	17.8 (±1.4)
Control	0.0028 (±0.0003)	0.051 (±0.016)	0.0010 (±0.0001)	0.235 (±0.011)	0.20 (±0.03)

PROJECT 11: PREVENTION AND MANAGEMENT OF MYCOTOXINS IN GROUNDNUT

(S. DESAI AND M.P. GHEWANDE)

The work under this project is being carried out under various externally funded projects. For the year of reporting, major work was done under the externally funded project namely Aflatoxin contamination in groundnut Mapping and management in Gujarat, Andhra Pradesh and adjoining areas.

EXTERNALLY FUNDED PROJECTS

IDENTIFICATION AND EVALUATION OF BIOPESTICIDES EFFECTIVE AGAINST THE STORAGE PEST OF GROUNDNUT BRUCHID BEETLE (CARYEDON SERRATUS) OLIVIER

(K. K. PAL AND RINKU DEY)

FUNDING AGENCY: CSIR (TMOP)

1 Microorganisms

Two new fungal isolates viz., *Beauveria bassiana* and *Metarrhizium anisopliae* were obtained from USDA which had been originally isolated from dead bruchid. The efficiency of these isolates against bruchid larvae was tested *in vitro*. *Beauveria bassiana* strain 1186 showed the maximum larvicidal action (68%). The larvae were totally covered by mycelial growth after infestation.

Twenty isolates of Bt were evaluated for the protein and plasmid profiles (Fig.2). There was wide variation in the crystal proteins and plasmid profiles of the isolates.

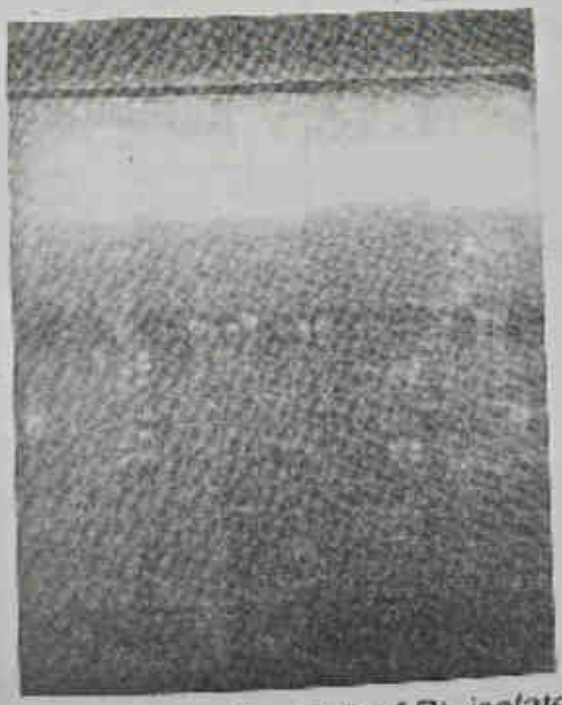


Fig. 2. *Plasmid profile of Bt isolates*

3 Parasitoid

The detection capacity of *Anisopteromalus calandrae* was so precise that it could identify a single infested kernel having only one egg on it from a heap of 1000 healthy kernels. Only five pairs of the parasite gave 66% parasitization in a heap of 250 g kernel having 50 g of infested kernels. The degree of parasitization increased with the number of pairs, one to five, released.

Bruchid larvae come out of the pods through a hole for pupating. When one or more larvae come out a few relatively immature remain inside. *A. calandrae* was very efficient in locating even the remaining larvae present inside the damaged pods by going through the hole made. The efficiency of *A. calandrae* in locating and parasitizing the bruchid larvae varied from 28-48% with the application of different doses of the parasite (Table 4). The pupae emerged from the damaged pod were also killed by the parasite. The significance of this finding is that the parasite can also be used for tracking the hidden creatures when groundnut is stored as pods.

Table 4. Efficiency of *A. calandrae* in parasitizing the larvae hidden inside the pod. *A. calandrae* was released once the first larvae emerged from the pod for pupation*

Pairs of *A. calandrae* released	No. of atched eggs of bruchid	No. of dead larvae/ pupae	No. of bruchid adults	No. of *A. calandrae* adults	%Mortality of bruchid larvae
Control	110.66	0.66	77.66	-	0.84
One	106.66	18.66	46.00	7.33	28.05
Two	98.00	19.33	31.33	7.00	38.15
Three	97.00	20.00	34.33	9.33	36.80
Four	89.66	22.00	26.33	7.33	45.47
Five	91.66	22.33	24.00	12.00	48.19

*100 g of the infested pods was taken with three replications

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

(K. K. PAL AND RINKU DEY)

FUNDING AGENCY : DBT

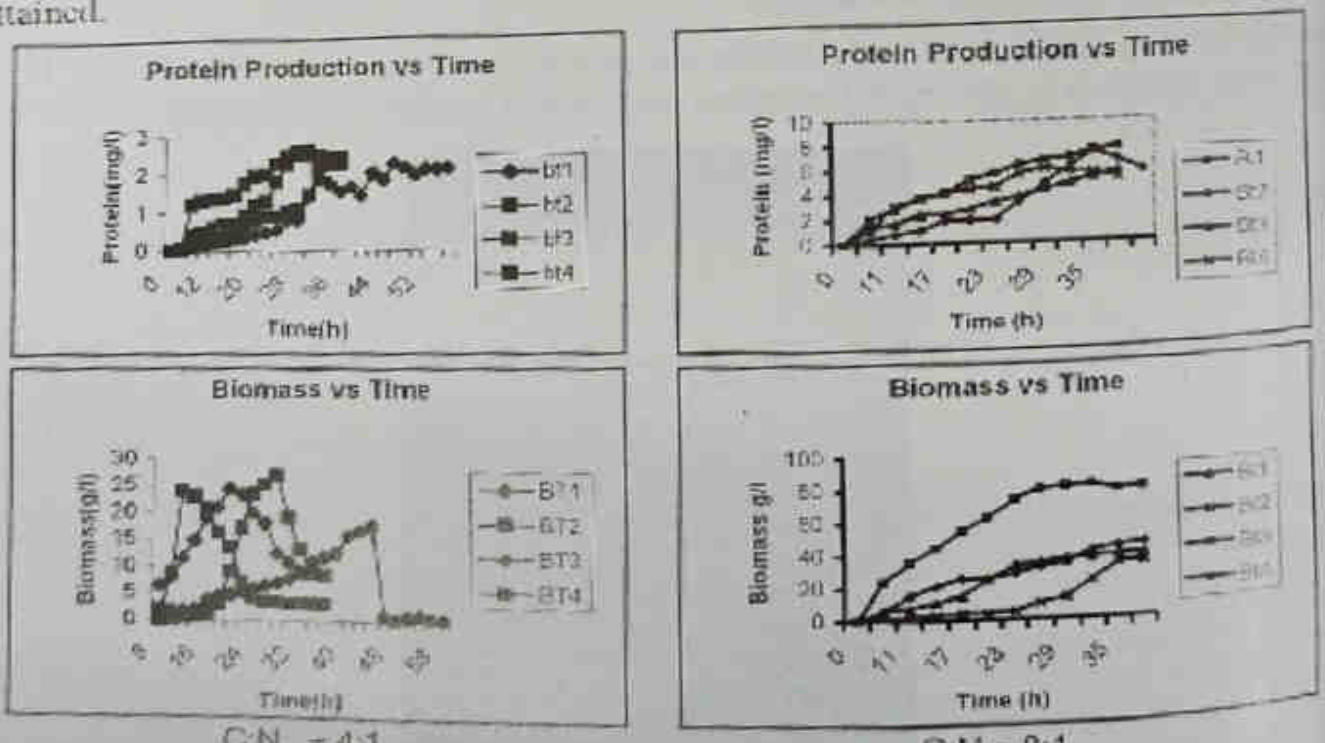
Artificial inoculation quite often fails especially in groundnut because of competition from native rhizobia and the fact that groundnut can be nodulated by a whole plethora of rhizobial strains. Therefore, the project aims at identifying efficient strains of bradyrhizobia from the native soil which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

Plate 3. Differential shape of the insecticidal crystal proteins of the Bt isolates

Staining of spore and crystal protein of different Bt isolates exhibited morphological variation of the insecticidal crystal proteins among the Bt isolates. While HBN1 and HBN2 produced bipyramidal crystals, DHL1 isolate produced rectangular crystal proteins (Plate 2).

2 Fermentation of Bt isolates

A total of eight fermentations were run taking different CN ratios. Glucose and ammonium sulphate were used as C and N sources, respectively. The temperature was kept at 32°C with a stirrer speed of 500 rpm and dissolved oxygen of 3 lpm. Production of crystal protein and biomass was concomitant with the increase in CN ratio from 4:1 to 8:1 (Fig. 3). However, there was not much variation in the pattern of growth and glucose utilization. Increase in quantity of glucose prevented the rise in the pH after the optimum growth was attained.



C:N = 4:1 C:N = 8:1

Fig 4. Growth patterns and crystal protein production by different Bt isolate in batch fermentation in a 10L fermentation vessel

1 Competitiveness of *Bradyrhizobium* strains

In order to study the competitiveness of the inoculants strains in occupying nodules, an efficient isolate NRCG 12, was mutated by Tn5 *lac*Z molecular marker and one hundred sixty-two different mutants were obtained. All the mutant expressed the *lac* Z gene. These mutants were monitored for nodule occupancy in a pot experiment under natural conditions. While the wild type strains occupied 46% of the nodules, 22 of the mutants occupied 50-66% of the nodules. The mutants M50 and M55 showed 66% occupancy. Detailed characterization is underway.

2 Competitiveness and Plant growth promoting attributes of the efficient bradyrhizobia.

Although *Bradyrhizobium* is associated with nitrogen fixation very intensively, they can also have some other growth promoting attributes helpful to the plants that they nodulate. These very interesting but little studied aspects of bradyrhizobia were initiated at NRCG.

Efficient *Bradyrhizobium* isolates were also tested for the production of siderophore which help in the chelation of iron and quantified for both catechol and hydrooxamate types of siderophores. While NRCG 1, NRCG 2, NRCG 6, NRCG 13, NRCG 14, NRCG 16, NRCG 22, NRCG 25 and NRCG 26 (0.093, 0.072, 0.126, 0.105, 0.078, 0.126, 0.141, 0.101 and 0.103 mg/mg protein, respectively) produced catechol type of siderophores, rest of the isolates produced hydrooxamate type (Table 5).

These rhizobial isolates were also evaluated for the production of the growth promoter indole acetic acid using L-tryptophane as the sole source of carbon. While NRCG7 and NRCG24 produced IAA like substances (1mg/l), NRCG 22, NRCG 23 and NRCG 25 produced 0.87, 0.85 and 0.98 mg/l of IAA, respectively (Table 5). Interestingly, ten strains had even some antibiosis activities also, the best being NRCG 4 and NRCG 7.

3 Field test

In a field trial (5 rows of 5 m length for each culture, replicated thrice), significantly higher pod yield, biomass production and nodule number at 30 DAS was obtained with seed bacterisation using rhizobial isolates viz., NRCG 1, NRCG 2, NRCG 3, NRCG 4, NRCG 5, NRCG 6, NRCG 7, NRCG 8, NRCG 9, NRCG 10, NRCG 11, NRCG 12, NRCG 13 and NC 92 strain than the uninoculated control (Table 6, Plate 3). However, significant difference was not obtained with other isolates and TAL1000 strain in pod yield, biomass production and nodule number as compared to control. Seed treatment with rhizobial isolates like NRCG 2, NRCG 3, NRCG 4, NRCG 6, NRCG 7, NRCG 8, NRCG 10, NRCG 11, NRCG 12, NRCG 14 and NC 92 significantly enhanced the nodule biomass at 30 DAS. There was also significant difference in the number of mature pods at the time of harvest in the treatments inoculated with isolates like NRCG 2, NRCG 3, NRCG 4, NRCG 7, NRCG 9, NRCG 11, and NRCG 12. Similar trend was also obtained in terms of shelling turn-out. Biologically fixed nitrogen as measured by ARA was enhanced significantly in treatments inoculated with the isolates NRCG 1, NRCG 2, NRCG 3, NRCG 4, NRCG 5, NRCG 6, NRCG 7, NRCG 8, NRCG 9, NRCG 10, NRCG 11 and NRCG 12 as compared to the un-inoculated treatment.

Plate 3. Effect of bradyrhizobia inoculation on growthand pod yield of groundnut, cultivar GG 2

To study the nodule occupancy under field conditions spontaneous rifampicin resistant mutants of all the efficient strains were obtained and field inoculation was done during the rabi/summer season of 2001.

Table 6. Effect of Rhizobium inoculation on the BNF, growth and yield of groundnut in field (cultivar GG2, Kharif , 2000)

Isolates	Pod yield (Kg/ha)	Haulm yield (Kg/ha)	Nodule number / plant at 30 DAS	Nodule dry wt. mg/plant) At 30 DAS	ARA (µmole C_2H_4/plant/hr) At 30 DAS	Pods/ plant	Shelling (%)
Control	2241	2242	28	32.3	56	14.7	58.67
NRCG 1	2316	2386	51	45.3	74	17.0	71.10
NRCG 2	2905	3210	84	119.8	127	23.3	71.65
NRCG 3	2853	2602	61	85.1	73	28.3	68.27
NRCG 4	2702	2559	63	71.6	89	22.6	70.93
NRCG 5	2543	2652	38	45.9	49	18.3	68.49
NRCG 6	2824	2860	51	62.5	81	19.3	67.40
NRCG 7	2687	2800	85	105.7	119	21.7	65.09
NRCG 8	2553	2651	51	73.5	93	20.6	69.16
NRCG 9	2761	2973	37	43.2	74	27.0	70.06
NRCG 10	2615	2764	54	72.9	101	20.8	69.03
NRCG 11	2443	2499	48	73.5	77	22.3	68.55
NRCG 12	2846	2666	58	86.6	113	30.7	70.93
NRCG 13	2547	3234	40	40.5	70	20.3	66.16
NRCG 14	1877	2553	35	54.7	51	11.2	54.69
NRCG 15	2158	2092	34	50.3	63	17.3	62.11
NRCG 16	1960	2175	36	42.2	58	13.0	57.40
NRCG 19	1944	1871	31	41.3	47	16.7	56.23
NRCG 20	1834	2226	31	37.7	53	18.7	60.85
NRCG 22	1991	2319	27	34.6	48	14.3	56.28
NRCG 23	2516	2068	38	46.4	61	19.3	63.36
NRCG 24	2382	2283	26	38.7	54	11.3	62.31
NRCG 25	2032	1984	35	43.5	51	17.7	63.11
NRCG 26	2384	2370	31	41.8	63	16.0	59.31
TAL 1000	2162	2315	31	36.9	53	18.3	60.90
NC 92	2527	2377	43	54.2	71	18.7	66.76
CD (0.01)	286	287	11.7	17.7	14.6	06.5	04.04

ARA=Acetylene reduction activity

Table 5. Some competitive and plant growth promoting attributes of selected isolates of bradyrhizobia isolated from the Saurashtra region of Gujarat

Isolates	Siderophore-Catechol type (mg/mg protein)	Siderophore-Hydroxamate type (mg/mg protein)	IAA (mg/L)	Antibiosis	IAR
Control	-	-			
NRCG1	0.093	-	0.58	+	$Ap^{100}Cm^{50}$
NRCG2	0.072	-	0.61	+	$Ap^{100}Cm^{50}$
NRCG3	0.186	-	0.55	+	$Ap^{100}Cm^{50}$
NRCG4	0.177	-	0.53	+++++	------
NRCG5	0.116	-	0.45	++	Ap^{100}
NRCG6	0.126	-	0.85	++	$Ap^{100}Cm^{50}$
NRCG7	0.199	-	1.00	++++++	$Ap^{100}Cm^{50}Str^{45}$
NRCG8	0.134	-	0.71	+	$Ap^{100}Cm^{50}$
NRCG9	0.201	-	0.35	+	$Ap^{100}Cm^{50}$
NRCG10	-	-	0.37	+	$Ap^{100}Cm^{50}$
NRCG11	-	-	0.39	-	$Ap^{100}Cm^{50}$
NRCG12	-	-	0.67	-	$Ap^{100}Cm^{50}$
NRCG13	0.105	-	0.32	-	$Ap^{100}Cm^{50}$
NRCG14	0.078	-	-	-	$Ap^{100}Cm^{50}Str^{45}$
NRCG15	-	-	0.29	-	$Ap^{100}Cm^{50}$
NRCG16	0.126	-	0.46	-	$Ap^{100}Cm^{50}$
NRCG17	0.236	-	0.51	-	------
NRCG18	0.220	-	0.27	-	Ap^{100}
NRCG19	-	0.211	0.39	-	$Ap^{100}Nal^{50}$
NRCG20	-	0.181	-	-	$Ap^{100}Cm^{50}Nal^{50}$
NRCG21	-	0.168	-	-	$Ap^{100}Cm^{50}Nal^{50}$
NRCG22	0.141	-	0.87	-	------
NRCG23	-	-	0.85	-	------
NRCG24	-	-	1.0	-	$Ap^{100}Cm^{50}$
NRCG25	0.101	-	0.98	-	$Ap^{100}Cm^{50}$
NRCG26	0.103	-	0.21	-	$Ap^{100}Cm^{50}$

IAA= Indole acetic acid; IAR= Intrinsic antibiotic resistance

Table 2. Details of soil samples analyzed in Andhra Pradesh and Adjoining areas

District	Total soil samples	Soil samples analyzed	*A.flavus* population (x10³)
Anantapur	54	54	0-144
Chittoor	93	93	0-480
Cuddapah	23	23	3-92
Kurnool	26	26	3-740
Kolar	115	115	0-69
Tumkur	133	133	0-420

Among the four districts of A.P., Cuddapah and Chittoor had fewer populations of *A. flavus* than those in Anantpur and Kurnool. Three samples from Krishnagiri mandal covering three villages in Kurnool district recorded the highest range of *A. flavus* population (37-470 × 10^3 cfu g^{-1} soil). The *Trichoderma* population in these samples ranged from 034 × 10^3 cfu g^{-1} soil with no clear indication of dominance of population in any region. In 109 samples the fungus could not be isolated. Isolates of *A. flavus* have been isolated and stored for further studies. From the soil samples, simultaneously *Trichoderma* (a biocontrol agent against several soil-borne plant pathogens) was isolated using a selective medium. Wherever the *A. flavus* populations were high, corresponding *Trichoderma* populations were relatively low. This study needs confirmation.

2 Laboratory studies

Protocol for estimation of aflatoxins using ELISA method has been established. All the seed samples collected during the survey have been used for extraction of aflatoxins. The samples are being processed for estimation of aflatoxins.

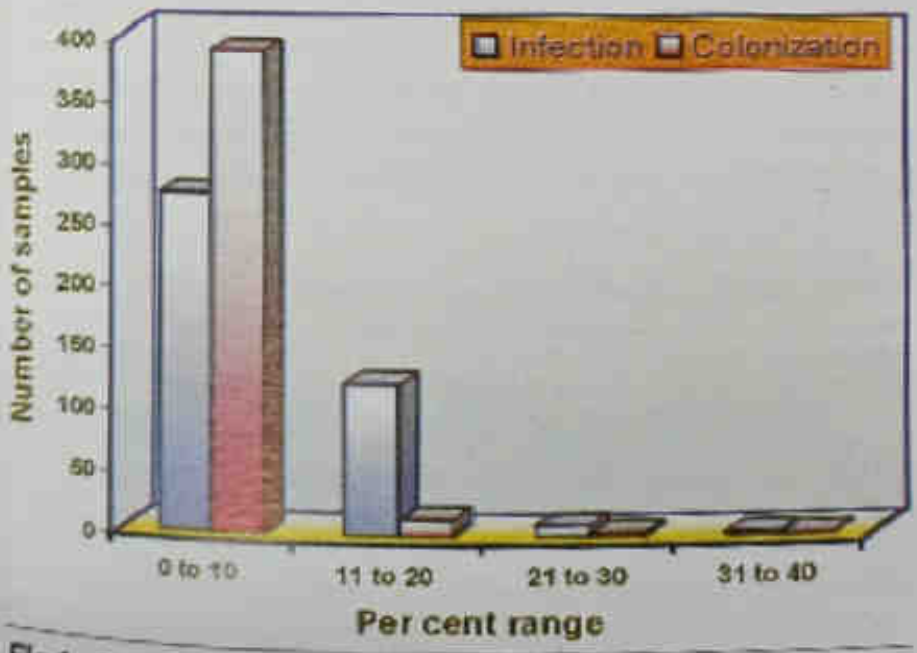


Fig 1. Seed infection and colonization of samples collected from Junagadh, Rajkot, Porbandar and Amreli districts of Gujarat

The seed samples collected during survey were plated for assessing the infection and colonization by *A. flavus*. In all, 401 samples of seeds were plated. Seed infection and colonization were recorded after plating on *A. flavus* specific medium. As seen from the figure 1, majority of the samples showed 0-10 percent infection. None of the samples showed more than 50 percent infection showing that the degree of infection or colonization is relatively less.

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

(S. DESAI, A. BANDYOPADHYAY, S. N. NIGAM, R. P. THAKUR, R. R. KHANDAR, I. U. DHRUJ)

(FUNDING AGENCY: NATP, AED, Rainfed Farming)

Research and development activities on mycotoxin contamination in groundnut and its extractions was given a high order of priority during the year 2000-2001 due to the known ill-effects of these toxins on human- and animal-health. Funding from external sources such as NATP was also obtained for expanding the horizons of work. A consolidated report of the achievements hence, is presented here. Under the NATP funded project, mapping and management of aflatoxin contamination in ten target districts of Gujarat (Junagadh, Rajkot, Amreli, and Porbandar), Andhra Pradesh (Kurnool, Cuddapah, Ananthpur and Chittoor) and Karnataka (Kolar and Tumkur) was taken up. The project is being implemented through active collaboration from ICRISAT and the Gujarat Agricultural University.

1 Mapping of low- and high-risk regions of aflatoxin contamination

A questionnaire has been developed for assessing the awareness among the different clientele and also for the collection of the pod and soil samples. The questionnaire included four main heads viz., Client's profile; farmer's awareness and knowledge about groundnut based production systems; sample details, and socio-economic details of the client. This information was useful for deducing the information about the cropping systems of groundnut, differences in farmers' perceptions across different agro-ecological zones.

Based on the historical data on the area under groundnut in each of the target districts and on an average for every 1000 ha of groundnut cropped area, one sample was worked out.

The sampling started during the harvesting period of *Kharif* 2000. In all, 1041 pod samples and 767 soil samples were collected from target districts. The distribution of samples from different districts is given in Table1.

Table 1. Number of samples from target districts of Gujarat, A.P., and Karnataka

State	District	Number of seed samples
Gujarat	Junagadh	235
	Rajkot	77
	Amreli	77
Andhra Pradesh	Ananthpur	85
	Kurnool	90
	Cuddapah	78
	Chittoor	138
Karnataka	Kolar	124
	Tumkur	137
Total		**1041**

The soil population of *Aspergillus* spp. was enumerated in 345 samples (Table 2).

Similarly, 323 soil samples collected from four target districts were plated using specific medium for *A. flavus-A. parasiticus* specific medium for assessing the load of A. flavus in the soil (Fig 3).

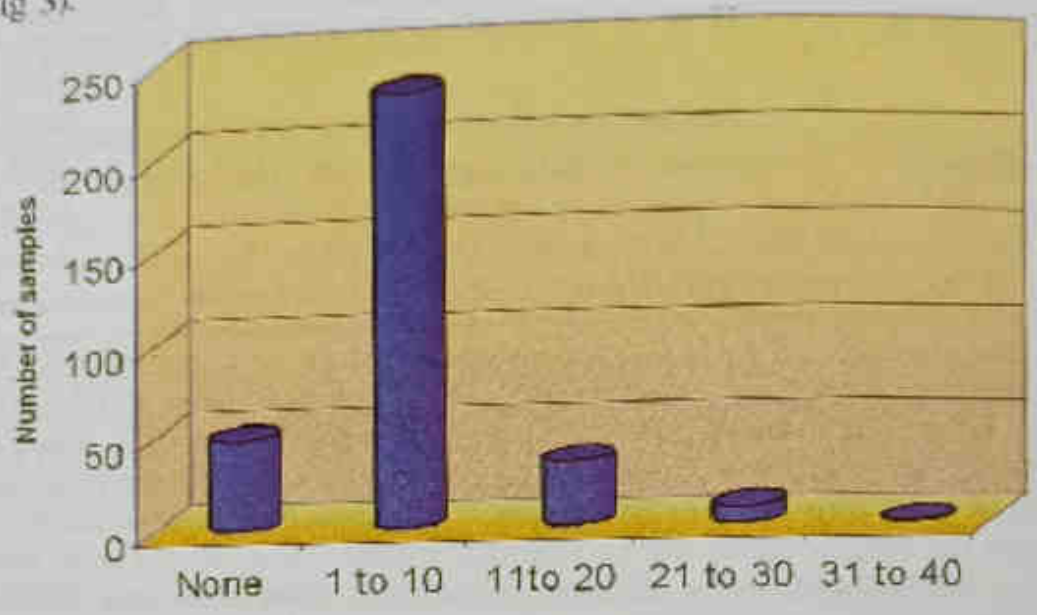


Fig 3. Distribution pattern of by *A. flavus* in soil samples collected from Junagadh, Rajkot, Porbandar and Amreli districts of Gujarat

As many as 48 soil samples were free from *A. flavus* and maximum number of soil samples fell in the range of 1 to 10.

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

(S. DESAI)

FUNDING AGENCY: AP-NL Biotechnology Programme, Hyderabad.

For the mass multiplication of fungal biocontrol agents, five liquid media were evaluated. Among them, Molasses-yeast extract broth supported maximum growth of *Verticillium leccanii* and *Penicillium islandicum* both in stationary as well as shaking conditions (Table 3).

Table 3. Growth of fungal biocontrol agents on different broth media under stationary and shaking conditions

Medium	Yield of biocontrol agents (g fresh mass/litre)			
	Penicillium islandicum		*Verticillium lecacani*	
	Stationary	*Shaking*	*Stationary*	*Shaking*
Potato dextrose broth	0.4	0.6	0.1	0.4
Maltose peptone broth	0.2	0.5	0.3	0.6
Glucose-nitrate broth	0.6	1.0	0.9	1.5
Souborond's broth	0.9	1.6	0.7	1.3
Molasses-yeast extract broth	2.7	3.1	2.0	2.9

Further testing is in progress to assess the suitability of these media for liquid fermentation of the biocontrol agents. Similarly, a bacterial biocontrol agent, naturally occurring on late leafspot, was isolated and its mass multiplication was tried using three broths (Table 4).

Table 2. Growth of Bacillus sp. on different liquid media at 10^7 dilution

Medium	Mean Number of colonies/ml
King's B broth	1.12×10^3
Molasses-yeast extract broth	0.95×10^3
Nutrient broth	0.81×10^3

The nutrient media did not differ significantly. However, among the three media tested, Molasses-yeast extract broth is cheap and hence, could be cost effective. Its suitability for liquid fermentation is being evaluated.

SYNTHESIS OF SEX PHEROMONE OF GROUNDNUT LEAF MINER (APROAEREMA MODICELLA DEV.) AND DEVELOPMENT OF DISPENSER FOR IPM IN GROUNDNUT

(V. NANDAGOPAL)

Funding Source: A.P. Cess Fund

The groundnut leaf miner pupae about 2000 numbers collected from Tindivanam were used for the following studies using Electro Antennogram Detector (EAD). Electro Antenna Gram (EAG) and Wind tunnel. The work was carried out with our collaborating Scientists working in the pheromone laboratory of the Indian Institute of Chemical Technology, Hyderabad.

1 Electro Antennagram Detector (EAD).

This is a equipment which has a main processing unit and a monitor. Two boxes each have a lead which in turn connects to the main processing unit. In one box, 10 males were kept and in the other females were kept and run for 24 hrs continuously. The activation in the form of wing flittering, antennal vibration was recorded in terms of μ volt. This observation was very crucial so that the use of wind tunnel and the EAG in the specified time of the male and female can be ascertained.

1.1 Using Electro Antennagram (EAG)

The antennae of one-day-old males, maintained in the laboratory was cut using a micro-scissor and fitted to the holder of the EAG with the help of a special gel which was connected to the EAG main equipment. At the end of a rubber tube projecting out from the main instrument was connected with a micropipette, inside which the different components of the sex pheromone in doses, as given below, were smeared in filter paper in a concentrations of 1 μ g/1 μ l and inserted in to the broader end of the micropipette, which in turn was connected with a metallic cylindrical tube whose one end was connected with the tube, carrying filtered air and the other end kept near the antenna fitted in the holder. The narrower end of the micropipette was inserted into a small hole on the metallic cylindrical tube. When the foot pedal was pressed the air flowed carrying the sex pheromone compound, which in turn passes the pheromone on the antenna. On the receipt of the pheromone the antenna responded in terms of μ volt (Table 5).

Table 5. Compounds of pheromone tested and the response of male

Delivery	Compound	Response of the antenna (μ volts)
Filter paper	Hexane (medium)	0.5
"	Z - 7 compound-	2.0
"	E- 7 compound	2.7
"	Precursor of 7-9 compound	2.06
"	its natural blends in the ratio of 1021.4	3.31

The response of antennae to the pheromone compounds clearly higher (from 2 to 3.31 μvolts) than the blank (medium of extraction i.e., Hexane) giving only 0.5 μ volts.

2 Wind tunnel

It is a huge structure having a transparent PVC cylinder, one side fitted with a filter and another side with a suction motor having a speed regulator which can be adjusted to any wind speed. In side the transparent PVC cylinder, two holders are provided. One for the pheromone source and the other for holding freshly emerged males in a small box. The lid of the plastic box was removed allowing the males to respond to the pheromone source. Each time four to ten males were used for their response. The number of males moved towards the source of the pheromone and the distance moved in terms of % distance were noted. The results are given in then table 6.

Table 6. Response of males to the different dispensers of pheromone of GLM

Delivery	Replication	Compound	Number of males moved towards the source of pheromone		
			100%	50%	0%
Filter paper	1	Z - 7 compound-	2	2	3
"	2	Z - 7 compound-	2	2	6
Septa	1	Z - 7 compound-	1	1	2
"	2	E- 7 compound	-	-	7
Plastic vials	1	Z - 7 compound-	2	1	2
NRI vial (10 year stock)	1	Its natural blends in the ratio of 1021.4	2	-	6
"	2	E- 7 compound	4	-	5
Blend	1	Z - 7 compound-	2	1	2

TECHNOLOGY ASSESSMENT AND REFINEMENT (IVLP) PROGRAMME

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

Funding Source: NATP

1 Integrated Nutrient Management (INM) in Groundnut + Pigeonpea intercropping system

Fifteen farmers from three villages (7 in Vadhavi, 2 in Umatwada and 6 in Nandurkhi)were identified for *Kharif* 2000. The soil samples were collected before sowing and at harvest for nutrient analysis. There was an improvement in initial plant stand of groundnut by 8.65 % over farmers' practice. The results indicated that application of recommended NPK as single super phosphate, muriate of potash and ammonium sulphate along with PSM, gave the highest yield of pigeon pea (125 kg/ha) compared to farmers practice (95

3.1 Integrated Management of stem rot and collar rot Diseases in groundnut

Twenty five farmers from four villages (3 in Zanjarda, 3 in Umatwada, 7 in Nandarkhi, and 12 in Vadhavi) were identified for conducting OFT under this programme. Results showed that, there was an increase in plant stand by 8.46 % in the treatment(castor cake 1000 kg/ha) over farmers' practice . The application of castor cake @ 1000kg/ha gave maximum control of collar rot (39 %), while in the case of stem rot control, soil application of castor cake realized 50.57 % control of stem rot over farmer's practice. The maximum pod yield of 1793kg/ha was obtained which increased pod yield by 22.84 %and fodder yield by 21.29 % in the soil application of castor cake @ 1000kg/ha as against 1459.51kg/ha in farmers' practice. The gross monetary return of Rs. 33,501 was highest in the castor cake as compared to farmers' practice (Rs. 27,365/ha).

4 Management of yellowing in groundnut due to Fe-S deficiency complex

This experiment was conducted in 15 farmers' fields (6 in Vadhavi, 1 in Umatvada, 5 in Nandarakhi and 3 in Zanjarda villages). Basal application of 20 kg elemental Sulphur per hectare increased the pod yield by 11% and fodder yield by 6 %over the farmers practice. However, maximum pod and haulm yield were recorded when elemental Sulphur @ 20kg/ha (basal application) and foliar spray of 0.5% FeSo4 along with 0.2% Citric acid at 45 and 60 days after sowing was undertaken. Pod yield increased by of 12 % and fodder yield of 9 % over the farmer's practice. The same treatment recorded the maximum gross return of Rs.33,353 per hectare as compared to Rs.29,942 per hectare under the farmer's practice.

5 Soil Management through deep tillage in rain-fed Groundnut in soil with more than 45 cm depth

Ten farmers (8 in Vadhavi, 1 in Umatwada and 1 in Zanjarda villages) were identified under this programme. The results indicated that deep tillage increased pod yield by 18. % compared with shallow tillage a farmers practice. Haulm yield was also increased by 29 % under deep tillage over the farmers practice. This could be attributed to the fact that deep tillage conserved more soil moisture as compared to shallow tillage during dry spells of crop season. There was considerable reduction in soil borne disease incidence of collar rot by 51%, stem rot by 47% and aflaroot by 80% over farmer's practice i.e. (shallow tillage). Maximum gross monetary return of Rs. 25,881 was also recorded in the deep tillage treatment which was 21.% higher than the farmers practice(Rs. 21,376/ha).

6 Feeding diet using locally available crop residues (wheat straw) for dairy cattle

This experiment was undertaken by 10 farmers (1 in Umatwada, 6 in Vadhavi and 3 in Zanjarda villages). An enriched fodder was given to the buffaloes along with farmers practice for 30 days. The average milk production per day indicated that milch animal gave 17% higher milk yield per day when fed with enriched (urea treated wheat straw + mineral mixture) compared with farmers practice of groundnut fodder. Enriched fodder besides giving higher milk yield also increased the maximum gross monetary return of Rs. 172 as against Rs. 147 per day/animal in farmers practice.

kg/ha). In case of groundnut , the maximum pod yield of 1769 kg/ha was recorded under recommended NPK through single super phosphate, muriate of potash and ammonium sulphate and PSM which increased pod yield by 34 % and fodder yield by 23 % over farmers' practice (pod yield 1319 kg/ha, fodder yield 3165.98 kg/ha) . The gross monetary return of the system was higher (Rs.35753/ha) in the treatment where the recommended NPK through single super phosphate, muriate of potash and ammonium sulphate along with PSM was applied as compared to the farmers' practice (application of DAP only) where a gross monetary return of Rs. 27335/ha was realized. The analysis of nutrient in plant and soil samples will be undertaken shortly.

2 Integrated Nutrient Management (INM) in Groundnut + Castor intercropping system

Fifteen farmers (7 in Vadhavi, , 6 in Nandarkhi and 2 in Zanjarda) were identified for *Kharif* 2000. The soil samples were taken before sowing and at harvest for nutrient analysis.The results indicated that application of recommended NPK through single super phosphate, muriate of potash and ammonium sulphate and PSM increased pod yield of groundnut by 22.89 % and fodder yield by 18.28 % over farmers practice. Application of recommended NPK through single super phosphate, muriate of potash and ammonium sulphate along with PSM, gave 557.31 kg/ha yield of castor compared to farmers' practice (432kg/ha) . In case of groundnut yield, the recommended PSM resulted in a higher yield of 1718 kg/ha as compared to the farmers' practice (1398 kg/ha). The gross monetary return of the system was higher (Rs.44,402/ha) in the treatment where the application of recommended NPK through single super phosphate, muriate of potash and ammonium sulphate along with PSM as compared to farmers' practice (application of DAP only) where a gross return of Rs. 35,978/ha was realized.

3 Integrated Pest Management (IPM) in Groundnut

Fifteen farmers from the three villages (6 in Nandarkhi, 7 in Vadhavi and 2 in Umatwada) were identified under this programme. Observations on sucking pests (jassids and thrips), defoliators (*Helicoverpa/ Spodoptera*), leaf spots (early and late), rust, collar rot, stem rot, aflaroot and peanut bud necrosis disease (PBND) and yield of both groundnut and trap crop (castor) were recorded.It was observed that there was an improvement in initial plant stand by 7 % and reduction in defoliators by 43 %, jassid by 15 %, thrips by 38 %, early leaf spot by 38 %, late leaf spot by 46 %, rust by 49 %, collar rot by 19 %, stem rot by 67 %, afla root by 15%, and PBND by 51. % where IPM components were used over farmers' practice. The male moths of *Spodoptera* and *Heliothis* trapped were 43/trap/ week and 9/trap/week respectively in IPM treatment. This resulted in increased in pod yield of groundnut by 19 % (2204 kg/ha) and fodder yield by 7 % (3020 kg/ha) over the farmers' practice (pod yield 1851 kg/ha, fodder yield 2810 kg/ha). The additional income from castor was also realized and gross income of Rs. 39,986/ha was obtained as against farmers' practice (Rs. 34,805/ha).

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

(DEVI DAYAL, M.Y. SAMDUR AND G. D. SATISHKUMAR)

FUNDING AGENCY: NATP (ROPS 12)

The project aims at evaluating groundnut cultivars under moisture and nutrients constraints in the farmer's fields. Twenty-four farmers in three villages of Junagadh district were selected based on soil depth and available phosphorus content. Two habit groups of groundnut cultivars namely; Virginia cv GG20 and Spanish cv. GG2 and GG4 were evaluated.

1 Effect of the treatments

The crop experienced severe moisture stress during the reproductive period. Hence, growth and yields were drastically reduced. The reduction was more pronounced in shallow depth of soil and in Virginia cultivar than in medium soil and Spanish cultivar. The treatment difference could not reach the level of statistically significance mainly due to reduced growth and yield parameters under severe moisture stress prevailed during the crop growth period

Soil moisture conservation: The soil moisture recorded from 0-15 and 15-30 cm depth from each treatment during the crop growth period revealed that the treatment having recommended moisture conservation practice (broad bed and furrows, BBF) maintained slightly higher available soil moisture up to 30 cm depth compared with farmers practice. Even when there was no rain fall and crop experienced severe moisture stress, BBF maintained higher soil moisture at 15-30 cm depth of soil up to 37 standard week. There after, however, no difference in moisture content was observed between two methods of moisture conservation (Fig 1, 2).

1.1 Growth parameters

Growth parameters namely, height of main axis (n), no. of primary branches (n+1) and plant dry weight, were recorded at 60 days after sowing. The results revealed that BBF improved these growth parameters, though differences between the treatments were not significant). Not much difference between the check and improved verities for growth parameters was observed. However, medium soil recorded higher values of these parameters than those in shallow soil.

1.2 Yield and economics

Due to severe moisture stress, the yield level especially in Virginia cultivar under shallow depth of soil was very poor (768-784 kg/ha). It was mainly due to longer crop duration (125-135 days) than Spanish cultivar (110-120 days) and less moisture retention in shallow soil. No difference for pod yield, haulm yields and net returns between the check and improved varieties were observed. Similarly, no significant improvement in these parameters was observed due to different treatments. However, improved soil moisture conservation practice (BBF) and recommended dose of fertilizer (RDF) slightly but consistently improved

pod yield in both the cultivars. Almost similar trend was observed in haulm yield also. Though the net returns was very poor especially in shallow soil due to very poor yield, consistently higher values of net returns were recorded by BBF treatment, though the RDF treatment could not maintain consistency in improving net returns (table 1and 2).

1.3 Quality parameters

Improved method of soil moisture conservation (BBF) consistently improved, though not statistically significant, quality parameters like, 100-pod weight and 100 seed weight irrespective of varieties and soil types and shelling in both the varieties under medium soil. Shallow soil recorded consistently lower values of these quality parameters than medium soil.

Table Nitrogen management in groundnut + pearlmillet intercropping

Treatment	Pod yield (kg/ha)	Grain yield (kg/ha)	pod	grain	Total
B1 S1	636	718	0.524	0.681	1.204
S2	501	838	0.413	0.794	1.207
B2 S1	651	613	0.536	0.581	1.117
S2	582	826	0.479	0.783	1.262
B3 S1	713	573	0.587	0.543	1.130
S2	765	845	0.630	0.801	1.431
B4 S1	645	820	0.531	0.777	1.309
S2	626	807	0.516	0.765	1.281
B5 S1	543	614	0.447	0.582	1.029
S2	536	719	0.442	0.682	1.123
B6 S1	585	611	0.482	0.579	1.061
S2	587	835	0.484	0.791	1.275
	1214	–			1
	–	1055			1

Table Influence of different treatments on pod yield, haulm yield and net returns of Virginia groundnut under medium and shallow depth of soil

Treatments	Pod yield(kg/ha)		Haulm yield (kg/ha)		Net returns (Rs. /ha)	
	Medium	Shallow	Medium	Shallow	Medium	Shallow
T1	980	765	3190	2720	4830	1200
T2	1072	782	3185	3052	6000	1530
T3	1085	805	3470	3160	586	1740
Mean	1112	784	3281	2980	5560	1490
T4	1015	665	3375	2795	5630	100
T5	1047	810	3412	2907	5560	1590
T6	1095	830	3540	3040	6120	1810
Mean	1085	768	3442	2914	5770	1160
S.E. ±	192		172.04		–	
C.D. (0.05)	NS		NS			
C.V (%)	35.82		10.91			

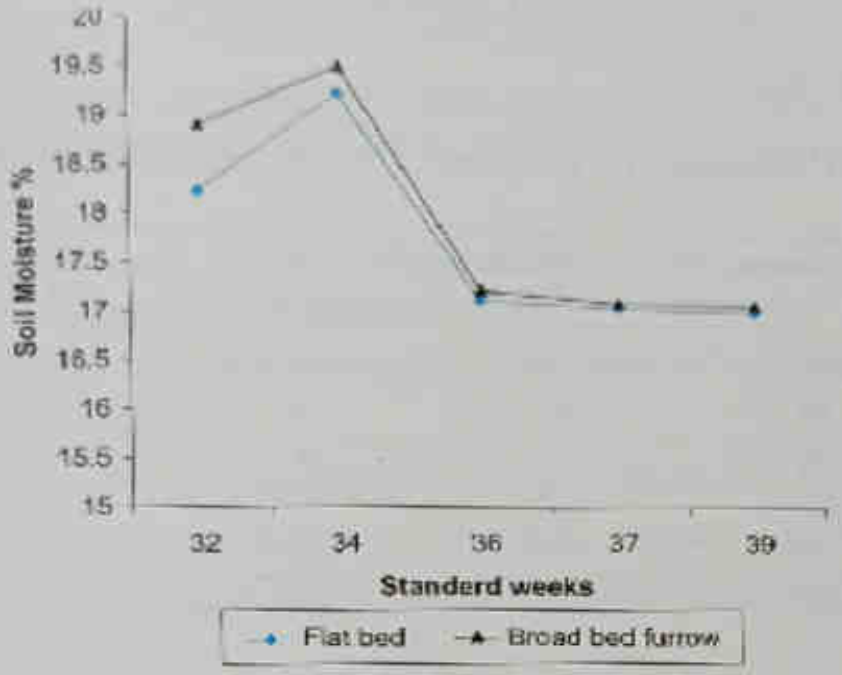


Fig. 1. Soil moisture % at 0-15 cm soil depth under two moisture conservation treatments

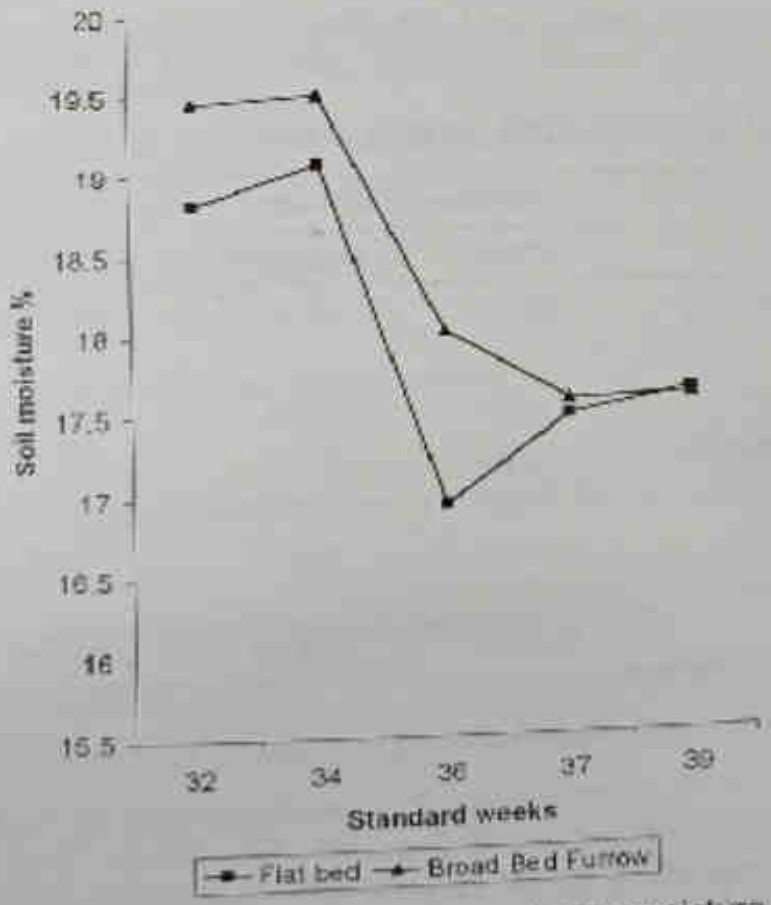


Fig. 2. Soil moisture % at 15-30 cm soil depth under two moisture conservation treatments

Table 2 Influence of different treatments on pod yield, haulm yield and net returns of Spanish groundnut under medium and shallow depth of soil

Treatments	Pod yield (kg/ha)		Haulm yield (kg/ha)		Net returns (Rs./ha)	
	Medium	Shallow	Medium	Shallow	Medium	Shallow
T1	1240	1119	1455	1390	6410	4760
T2	1283	1163	1482	1425	6450	4840
T3	1287	1178	1510	1487	6260	4850
Mean	1270	1153	1482	1434	6370	4810
T4	1291	1155	1507	1438	7140	5300
T5	1316	1208	1554	1497	7140	5300
T6	1315	1227	1600	1521	6790	5530
Mean	1307	1196	1553	1485	6980	5460
S.E. +-	124.09		168.97		-	
C.D.(0.05)	NS		NS			
C.V (%)	29.34		10.72		-	

EXTENSION ACTIVITIES

To fine-tune the core activities, a launch workshop was organized on 22.08.2000 at the NRCG, Junagadh. The workshop was organized to bring together different groups concerned with aflatoxin contamination and develop a sound technical programme to meet demands of a broad spectrum of clienrele by involving the scientists from the collaborating centres and also other stakeholders of the project. The representatives from Agriculture Man Ecology (AME), Bangalore, and Indian Oil Producers and Exporters Association (IOPEA), Mumbai participated actively in the project. In the group discussion held for formulation of a detailed technical programme for survey and sample collection, the participants from NRCG, GAU, ICRISAT, AME and IOPEA actively participated in the discussion.

Different concentrations of aqueous mustard cake extracts inhibited germination of late leafspot and rust spores *in vitro* suggesting its utility as one of he potential components for use in IPM modules.

Aqueous mustard cake extracts tried at 1-5% concentrations also inhibited sclerotial germination in *Sclerotium rolfsii in vitro*.

LIST OF RESEARCH PROJECTS AND SUB-PROJECTS AT THE NRCG AS APPROVED BY RAC HELD IN 1998, JUNAGADH, FOR THE YEARS 1998-2003

Programme I: Low-inputs, low risk efficient sustainable production packages for traditional rain-dependent areas

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

Project Leader: R.K. Mathur

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

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

Project 02: IPM for groundnut based production cropping system

Project Leader: M.P. Ghewande

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

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

Project 03: Management of post harvest problems in Groundnut

Project Leader : P.C. Nautiyal

Sub-project : Seed viability and dormancy

Sub-project : Storage pests

Project 04: Nutrient management in groundnut

Project Leader: K.K. Pal

Sub-project : Development of biofertilizer packages for groundnut

Sub-project : Mineral disorders of groundnut

Project 05: Studies on groundnut based cropping system

Project Leader: Devi Dayal

Sub-project : Studies on input management in intercropping system

Sub-project : Studies on sequential cropping system

ADDITIONAL INFORMATION

Administrative and Financial

A. Total staff in NRCG along with number of SC, ST, and OBC's employees as on 31.02.01

	Posts Sanctioned	Posts Filled up	SC	ST	OBC
Scientific staff	40	24	5		1
Technical staff	46	41	5		1
Administrative staff	19	15	4	3	
Supporting staff	20	20	3	3	7
Total	125	100	17		9

IMC Meeting

Not held during the period.

RAC

A meeting of Research Advisory Committee was held on Sept. 2001 on various research programmes at the centre and recommendarious were made for further improvements. The following members of RAC participated in the meeting.

Expenditure Statement for 2000-2001 (Rs. in lakhs)

Sl. No.	Head	Revised Estimate		Expenditure	
		Plan	Non-plan	Plan	Non-plan
1.	Estt. Charges including LPS & PF	162.67	15.10	141.10	13.45
2.	T.A.	2.00	4.25	2.00	4.25
3.	Other charges including equipment	15.33	61.65	15.33	68.90
4.	Works	50.00	24.00	45.56	19.53
5.	Other Contingencies				
	Total	**230.00**	**105.00**	**203.99**	**106.13**

Departmental promotion committee meetings

1. A DPC for promotion of 11 scientists was held at this centre on 08.05.01.
2. A DPC for promotion of 3 supporting staff under ACP Scheme held on 11.02.02
3. An assessment Committee for grant of promotion/advance increment to 13 Technical Personnel was held on 07.01.02.

Programme V: Cropping system based on groundnut for diversified and value added products

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

Project Leader: J.B. Misra

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

Sub-project : Breeding for HPS and confectionery cultivars

Sub-project : Genetic engineering for enhancement of quality

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

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

Project Leader: S. Desai

Programme II: Cropping system for traditional rabi-summer and spring irrigated situations

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

Project Leader: Y.C. Joshi

Sub-project : Physiological studies on abiotic stresses

Sub-project : Development of cropping system

Programme III: Sustainable cropping systems for non-traditional areas with special emphasis on eastern and north-eastern parts of India.

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

Project Leader: A.L. Singh

Sub-project : Studies on impact of agro-ecology and agr-economy

Sub-project : Development of suitable cropping system

Sub-project : Breeding to develop cultivars tolerant to Al toxicity

Sub-project : Organic farming

Programme IV: Understand and overcome the nature of barriers to enhance the genetic yield potential of cultivars by conventional and modern methods.

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

Project Leader: K. Rajgopal

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

Sub-project : *In vitro* conservation of groundnut germplasm

Sub-project : Enhancing the recombination frequency in groundnut

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

Project Leader: T. Radhakrishnan

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

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

LIST OF PUBLICATIONS

1 Research Articles

Bandyopadhyay, A., Manivel, P., and Mathur, R.K. 2001. PBS29017 - A High Yielding Large Seeded Groundnut (*Arachis Hypogaea* L.) Culture. *Indian Journal of Genetics and Plant Breeding*. 61(2) 197-98.

Bandyopadhyay, A., Manivel, P., Mathur, R.K. and Samdur, M. Y. 2000. A High Yielding Large Seeded Groundnut Culture - PBS29031. *Indian Journal Of Genetics And Plant Breeding*. 64(4) 573-575.

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Chandran, K. and S Pandya, M. 2000. Palynological survey in *Arachis* species of Section *Arachis*. International *Arachis* Newsletter 20 5-7

Desai, S, Thakur, R.P., Rao, V.P., and Anjaiah, V. 2000. Characterization of Isolates of *Trichoderma* for Biocontrol Potential Against Aspergillus Flavus Infection in Groundnut. International Arachis Newsletter 20 57-59.

Dey, R., Pal, K. K., Chauhan, S. M. and Bhatt, D. M. 2000. Field Evaluation of Plant Growth Promoting Rhizobacteria of Groundnut. International *Arachis* Newsletter 20 77-79.

Manivel, P., Mathur, R.K. Samdur, M. Y., Mishra, J.B. and Bandyopadhyay, A. 2000. Evaluation of some confectionery type advanced breeding cultures of groundnut. International *Arachis Newsleter*. No.20 20-22.

Mathur, R.K. and Manivel, P. 2000. Identification Of Male Sterile Mutant In Groundnut. *International Arachis Newsletter*. No.2013-15

Mathur, R.K. and Manivel, P. 2000. Prediction of performance of segregating mutation generation in groundnut, 1999. *Annals of Agricultural Research*. 21(2) 298-300.

Mathur, R.K., Manivel, P., and Gor, H.K. 2000. Genetics of reproductive efficiency in groundnut. *Annals of Agricultural Research*. 21 (1) 65-68.

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Mathur, R.K., Manivel, P., Samdur, M.Y., and Bandyopadhyay, A. 2000. Screening for fresh seed dormancy in spanish bunch groundnut. *Journal of Oilseeds Research*.17 (1) 181-182.

Mathur, R.K., Manivel, P., Samdur, M.Y., and Pariya, P. 2001. Girnar 1 CLM - A new chemically induced curly leaf groundnut mutant. *Indian Journal of Genetics and Plant Breeding*. 61(2) 196.

LIST OF EXTERNALLY FUNDED PROJECTS AND CONTRACT RESEARCHES AT NRCG

Sl. No.	Project Title	Funding Agency	Scientist handling	Duration From To	Nature of Project	Budget (Rs. in lakhs)
1)	Technology Assessment and Refinement through Instt. Village Linkage Programme	ICAR	Dr. M.P.Ghewande Dr.V. Nandagopal Dr. P.K. Ghosh Dr. R.K. Mathur Dr. K.S. Murthy	3 years(likely to be extended)	Research	35.00
2)	Identification and Evaluation of Biopesticides effective against the storage pest of groundnut bruchid beetle (Caryedon serratus) olivies	TMOP	Dr. K.K. Pal Dr. Rinku Dey	3 years(April'98 to March,2000)	Research	20.00
3)	Identification of efficiently nodulating and nitrogen fixing strains of Bradiryizobium and their application	DBT	Dr. K.K. Pal Dr. Rinku Dey Dr. P.K. Ghosh	Nov'98 to Oct. 2001	Research	11.6
4)	Synthesis of sex pher-omone and develop-ment of pheromone trap for groundnut leaf miner	AP Cess IICT collaboration	Dr.V. Nandagopal Dr. J.S. Yadav et.al	March' 99 to Feb' 2002	Research	22.50
5)	Biovillage	DBT through CSIR	Dr. S.Desai Dr. K.K. Pal Dr. Devi Dayal	3 years	Research	0.60
6)	More efficient breeding for high water use efficiency peanut-in India and Australia	ACIAR	Dr. R.K. Mathur	4 years	Research	45.0

Mathur, R.K., Saradu, M.Y., Manivel, P. 2001. Genetics of pod size in groundnut. Research on crops 2(1) 97-98.

Misra, J. B., Ghosh, P.K., Devi Dayal and Mathur, R.S. 2001. Agronomic, nutritional and physical characteristics of some indian groundnut cultivars. Ind. J. Agric. Sci. 70 (10) 741-746

Nautiyal, P.C. Y.C.Joshi, Nageswara Rao Rachaputi, 2001. Moisture-deficit-induced changes in leaf water content, leaf carbon exchange rate and biomass production in groundnut cultivars differing in specific leaf area, Field Crop Research (in press).

Pal, K. K., Dey, R., Bhatt, D. M. And Chauhan, S. M. 2000. Plant growth promoting fluorescent pseudomonads enhanced peanut growth, yield and nutrient uptake. Auburn University Web Site, Available **http//www.ag.auburn.edu/argentina/pdfmanuscript/pal.pdf**

Rajgopal, K. and Chandran, K. 2000. Storability of Groundnut Seeds in Different Packaging Media. International Arachis *Newsletter* 20 11-13

Rajgopal, K. and Chandran, K., J.B. Misra, P.K.Bhalodia and R.S. Mathur, 2000. Evaluation of Bold-seeded Groundnut Accessions for Confectionery Attributes. International *Arachis* Newsletter 20 18-20

Rajgopal, K. and Chandran, K. Influence of Packaging Media on the Storability of Groundnut. Plant Genetic Resources Newsletter, IPGRI, Rome (in press)

Samdur, M.Y. Singh, A.L., Mathur, R.K., Manivel, P., Chikani, B.M., Gor, H.K., and Khan, M.A. 2000. Field evaluation of chlorophyll meter for screening groundnut genotypes (*Arachis hypogaea* L.) tolerant to iron-induced chlorosis. *Current Science*. 79 (2) 211-214.

Samdur, M.Y., Gulati, S.C., Rajni Raman, Manivel, P., and Mathur, R.K., 2000. Evaluation of Indian mustard germplasm for resistance to mustard aphid (*Lipaphis erysimi*). *J of Oilseeds Research*. 17(2) 387-393.

2 SEMINARS /CONFERENCES

Desai, S. and Bandyopadhyay, A. 2001. Cost Effective Tools for Estimation of Aflatoxins and other Mycotoxins in Groundnut. At the Stakeholders' Meet on Aflatoxins, Icrisat, A.P.

Desai, S. and Ghewande, M.P. 2000. Biocontrol Agents as a Component of Integrated Disease Management of Groundnut. *At the Biocontrol Agents and PGPR for Sustainable Agriculture*, University of Hyderabad, Hyderabad, India.

Desai, S., Prasad, R.D. and Ghewande, M.P. 2001. Trichoderma Vis-Â-Vis Ecofriendly Plant Disease Management. At the National Seminar on Ecofriendly Approaches to Plant Disease Management, Centre for Advanced Studies In Botany, University Of Madras, Chennai, India.

Devi Dayal and Malavia, D.D. 2000 Drip fertigation of nitrogen and phosphorous improves nutrient availability, nutrient uptake and yield of summer groundnut in medium black calcareous soils. Proc. GAU, PRII, IPI, National Symposium, Balanced Nutrition of groundnut and other field crops grown in calcareous soils of India, Sept 19-20, 2000, GAU, Junagadh.

Devi Dayal and Singh Y.V. 2000. Response of rain fed groundnut to gypsum, calcium and sulphur in medium black calcareous soil. Proc. GAU, PRII, IPI, National Symposium, Balanced Nutrition of groundnut and other field crops grown in calcareous soils of India, Sept 19-20, 2000, GAU, Junagadh.

Devi Dayal, Bandyopadhyay, A. and Singh, A. L. 2000. Balanced nutrient management for groundnut grown in calcareous soils of India. Lead paper, GAU-PRII IPI National Symp. on Balanced Nutrition of groundnut and other field crops grown in calcareous soils of India, Sept. 19-20, 2000, Gujarat Agricultural University, Junagadh, Gujarat.

Devi Dayal, Ghosh, P.K and Singh Y.V. 2001. Management techniques for sustainable groundnut production in Saurashtra region of Gujarat. Proc. Symposium on Impact of human activities on Thar Desert environment, Feb 15-17, 2001. Arid Zone Research Association of India, CAZRI, Jodhpur.

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Ghewande , M.P., Desai S., Savaliya S.D., Hingrajia H.M., Prem Narayan and N.B.Bagawan , 2000. Evaluation of some Groundnut Genotypes for Resistance to Stem Rot (*Sclerotium Rolfsii*) and Collar Rot (*Aspergillus Niger*) Pathogens of Groundnut, In Thirteenth Zonal Meeting and Conference of Indian Phytopathological Society (W.Z.) on Integrated Diseases Management in Horticultural Crops in New Millennium. SBES College of Science and NARP, Aurangabad, November 24-25, 2000.

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Mathur, R.K.; Chunilal; Manivel, P., Samdur, M.Y. and Gor, H.K. 2000. Combining ability and heterosis for phenological and reproductive efficiency characters in groundnut. Abstract in Diamond Jubilee Symposium on "Hundred Years of Post-Mendelian Genetics and Plant Breeding - Retrospect and Prospects", Feb 20-23, 2001, IARI, New Delhi. (Accepted).

Mathur, R.K.; Manivel, P., Samdur, M.Y. Gor, H.K.; and Chikani, B.M. 2000. Creation of genetic variability through mutation breeding in groundnut. In the proceedings of the DAE-BRNS symposium on the use of nuclear & molecular techniques in crop improvement. Dec. 6-8,2000. Bhabha Atomic Research Centre, Mumbai, pp. 203-213.

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Pal, K. K., Dey, R., Joshi, B. H., and Singh, J. P. 2000. Evaluation of *Bacillus thuringiensis* and *Anisopteromalus calandrae* for controlling groundnut bruchid beetle (Caryedon serratus) Olivier. Presented at the 41st Annual Conference of AMI. 25-27th November, 2000, Jaipur. Abstract and Proceeding, p. 147.

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Singh, A. L., 2000. Potassium, calcium and boron fertilization of bold-seeded groundnut in calcareous soil. Proceedings of the GAU-PRII-IPI National Symposium on Balanced Nutrition of Groundnut and other Field Crops Grown in Calcareous Soils of India., 19-22 Sept. 2000.(B.A. Golakiya, J. D. Gundalia, S. K. Bansal. And Patricia Imas edt) Vol. 2 pp 199-204, Gujarat Agricultural University, Junagadh.

Singh, A. L., Ajay, Vidya Chaudhari and J. B. Misra, 2000. Drip irrigation- an efficient system for micronutrient application in groundnut in Calcareous soils of semi-arid region. In Proceedings of the GAU-PRII-IPI National Symposium on Balanced Nutrition of Groundnut and other Field Crops Grown in Calcareous Soils of India., 19-22 Sept. 2000. (B.A. Golakiya, J. D. Gundalia, S. K. Bansal, and Patricia Imas edt) Vol. 2 pp 194-198, Gujarat Agricultural University, Junagadh.

3 Popular Articles

3.1 In Tamil

Manivel, P. 2000. *Veeriya otru aamanaku vithai urpathy*.(Hybrid castor seed production). *Valarum Velanmai* (Growing Agriculture) Published by Tamil Nadu Agricultural Univestiy, Coimbatore. March, 200024-29.

4 BOOK CHAPTERS / REVIEWS

Bandyopadhyay, A. and Manivel, P. 2000. Groundnut *In* Breeding Field Crops (Ed. V. L. Chopra). Oxford & IBH publishing Co. Pvt. Ltd. New Delhi (In press).

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Singh, A. L. and Y.C. Joshi , 2000. Dynamics of Sulphur, iron and magnesium and their nutrition in groundnut in calcareous soils of India. Proceedings of the GAU-PRII-

IPI National Symposium on Balanced Nutrition of Groundnut and other Field Crops Grown in Calcareous Soils of India, 19-22 Sept. 2000, Gujarat Agricl. University, Junagadh.

Singh, A.L. 2000. Mechanism of Tolerance and Crop Production in acid Soils. In Advances in Plant Physiology Vol III Plant Physiology, Biochemistry and Plant Molecular Biology in 2000 (Ed. A. Hemantranjan). Vol III. pp. 353-394. Scientific Publisher (India), Jodhpur, India.

5 Catalogues/Technical Bulletins

Chuni Lal, Manivel, P. and Bandyopadhyay, A. Guidelines for nucleus and breeder seed production in groundnut. (in press)

Rajgopal, K., Manivel, P., Bandyopadhyay A., Chandran,.. K., Lalwani H.B. Ghetia, N.R. and Bhalodia, P.K., Characterization of Released Groundnut Cultivars - in press

Rajgopal, K. Bandyopadhyay, A., Chandran, K., Lalwani, H.B., Bhalodia, P.K. and Sugad Singh. 2001. Catalogue on groundnut germplasm pp 57

VISITS / PARTICIPATION IN WORKSHOPS/ SEMINARS/ TRAININGS SYMPOSIUM CONFERENCES/MEETINGS ETC

1 Dr. P. Manivel

Visited ARS, Anatapur; ARS, Tirupathi; RRS, Vriddachalam; TNAU, Coimbatore; and ARS, Aliyarnagar during 16.9.2000 to 30.9.2000 and monitored the WUE trial, Breeders seed production plots, and AICRPG trials.

Visited BARC, Trombay from 5.9.2000 to 8.9.2000 and presented a paper on 'creation of genetic variability in groundnut through mutation breeding' in the DAE-BRNS symposium on the use of nuclear & molecular techniques in crop improvement on Dec. 7, 2000.

Visited ORC, NRCG Bhubaneshwar, CRRI, Cuttack from 19.2.2001 to 24.2. 2001 and monitored & roughing in the breeder seed plots of TAG 24.

Visited NEH Region (Manipur, Barapani and Agartala) from 25th August - 12th Sept. 2000 for recording observations on collaborative experiments conducted in that region.

Visited to Jaipur, Mainpuri (UP), Kanpur, Hanumangarh (Raj), and Ludhiana for monitoring breeder seed production plots from 14-9-2000 to 29-9-2000.

Attended Agriculture fair-2000 from 12-10-2000 to 15-10-2000 held at Ahmedabad.

Attended the *Kharif* groundnut workshop from 10-4-2000 to 12-4-2000, at NRCG, Junagadh

Breeding for abiotic stresses in crop plants from 11.12.2000 to 31.12.2000 at Centre of advanced studies for genetics and plant breeding, TNAU, Coimbatore, India.

Techniques on Genetic Engineering and Molecular breeding from 26.2.2001 to 18.3.2001 at NRC for plant Biotechnology, IARI, New Delhi, India

2 Dr. M.V. Samdur

Attended training on, "Analysis of single and multi-environment groundnut varieties trials laid out in alpha design" from 20-12-2000 to 21-12-2000 at ICRISAT, Patancheru, Hyderabad.

3 Dr. M.P. Ghewande

Pre- launch Workshop on Aflatoxin Contamination in Groundnut- Mapping and Management in Gujarat, Andhra Pradesh and adjoining areas (22-08-2000).

Thirteenth Zonal meeting and conference of Indian Phytopathological Society (W.Z.) on Integrated Diseases Management In Horticultural Crops In New Millennium. SBES College of Science and NARP Aurangabad , November 24-25, 2000.

Indian Society of Mycology and Plant Pathology West Zone Meet- 2000 on Integrated Management of Crop Diseases held at B.A. College of Agriculture, G.A.U., Anand , 30-12-2000

Regional Work Shop on Planning and Management of Agricultural Extension Training 2000-2001 held at Western Zone Extension Education Institute, G.A.U., Anand from 9th to 11th November, 2000.

District Co-ordination Committee Meeting of Farmers Training Centre (Training of Farm Women in Agriculture) , Junagadh, 11-01-2001.

Annual Work Shop of IVLP centers in the rain fed Agriculture Echo system held from 19-22, Marc, 2001 at CRIDA, Hyderabad. Actively participated in Interaction and Training in Action Learning Applications for Participatory Technology Development (PTV). Conducted by the experts of department of Natural Resources, Queensland, Australia. Under Action Learning Tools, I led a group of Pest Management and own the first prize by our group. Every one of our group was rewarded with a head cap.

Annual *Kharif* Groundnut Work shop held from 10-12, April,2000 at NRCG, Junagadh.

4 Dr. S. Desai

Biocontrol agents and PGPR for sustainable agriculture, University of Hyderabad, Hyderabad, India April 2-4, 2000.

National Seminar on Ecofriendly approaches to Plant Disease Management, Centre for Advanced Studies in Botany, University of Madras, Chennai, India. February 22-24, 2001

5 Dr. Rinku Dey

41st Annual conference of AMI during November 25-27, 2000 at Jaipur

6 Dr. K.K. Pal

88th Session of Indian Science Congress during January 2-6, 2001 at IARI, New Delhi

Molecular tagging of inoculants strains for ecological studies during August 24-30, 2000 at IARI, New Delhi

7 Dr. V. V. Singh

Attended Annual *Kharif* Groundnut Workshop held at NRCG, Junagadh, from April, 10-12-2000.

Attended Annual Rabi-summer groundnut group meeting held at NRCG, Junagadh from Sept. 29-30, 2000.

Attended National Symp. on Agronomy Challenges and strategies for the new millennium, Nov. 15-18,2000, Gujarat agricultural University, Junagadh, Gujarat

8 Dr. Devi Dayal, Senior Scientist

Attended Annual *Kharif* Groundnut Workshop held at NRCG, Junagadh, from April, 10-12-2000.

Attended GAU-PRII IPI National Symp. on Balanced Nutrition of groundnut and other field crops grown in calcareous soils of India, Sept. 19-20, 2000, Gujarat Agricultural University, Junagadh, Gujarat.

Attended Annual Rabi-summer groundnut group meeting held at NRCG, Junagadh from Sept. 29-30, 2000.

Attended training programme on " Project Management using Microsoft project", Oct. 30 to Nov. 4,2000 at NAARM, Hyderabad.

Attended National Symp. on Agronomy Challenges and strategies for the new millennium, Nov. 15-18,2000, Gujarat agricultural University, Junagadh, Gujarat

Attended a meeting on Minikit programme on pulses and oilseed crops, Govt. of India, on 18-09-2000 at Krishi Bhavan, New Delhi.

9 G.D.Satish Kumar

Attended workshop on "Up gradation of communication skills" at Extension Education Institute, Anand from 24/4/2000 to 1/5/2000.

Attended a training course on "Instructional Aids for Effective Presentations" at National Academy of Agricultural Research Management, Hyderabad from15-07-2000 to04-08-2000.

Undergone Foundation Course for Agricultural Research Service (FOCARS) at NAARM, Hyderabad from 25/8/2000 to 22/12/2000.

Attended the Annual review workshop on TAR-IVLP under rain fed Agro Ecosystem at Central Research Institute for Dry land Agriculture, Hyderabad from 19-22nd march, 2001. As part of workshop attended a two day training programme on Action learning processes by Indo-Australian team (ICAR-ACIAR) of scientists.

Organized the farmers training programme for one day on "Groundnut cultivation-problems & solutions" at zandarda village 19/6/2000. 139 farmers from 7 different villages attended the training. Farmers actively interacted with the Subject matter specialists (Scientists) of the NRCG on Agronomic practices, Weed control, Disease management, Insect pest management, Aflatoxin management, Use of biofertilizers and Use of micronutrients in groundnut cultivation. It was followed by a group discussion in which farmers from 7 different villages shared their experiences on groundnut cultivation.

Participated in "Krishi Expo-2001" organized by the at Pragati maidan, New Delhi from 19/2/2001 to 28/2/2001.

Acted as a member of team for survey work in Kutch- Bhuj region regarding reasons for variation in yield of groundnut, reasons for declining yield of groundnut. A detailed report of the survey work has been submitted.

10 Dr. K. Rajgopal

Sardar Patel University, Vallabh Vidyanagar, to attend Zonal workshop on NATP (Plant Biodiversity) June 20, 2000

11 Dr.K. Chandran

CIAH, Bikaneer. To attend Zonal workshop on NATP (Plant Biodiversity) February 28 2nd March 2001.

Awards

Dr. S. Desai:

Accredited as Faculty of Department of Plant Pathology, ANGRAU, Rajendra Nagar, Hyderabad, India.

Invited to deliver lead paper at the National Seminar on Ecofriendly approaches to plant disease management organized by Indian Phytopathological Society, New Delhi.

Project evaluation panel of Dept. of Science and Technology, Govt. of India.

Member of Board of Examiners for PG studies of Gujarat Agricultural University and University of Hyderabad.

Referee for Indian Journal of Agricultural Sciences; Karnataka Journal of Agricultural Sciences.

STAFF LIST OF NRCG, JUNAGADH

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

Mrs. V. S. Chaudhary	"
Sh. B. M. Chikani	"
Sh. Ranvir Singh	"
Sh. Virendra Singh	"
Sh. H. K. Gor	"
Sh. J. R. Dobaria	"
Sh. S. D. Savalia	"
Sh. M. V. Gedia	Technical Assistant, T-4
Sh. A. D. Makwana	"
Sh. R. D. Padavi	Technical Assistant, T-3
Sh. V. K. Jani	"
Sh. Pitabasdas	"
Sh. Surajpal	"
Sh. H. V. Patel	"
Sh. Sugad Singh	"
Sh. Prabhu Dayal	"
Sh. C. B. Patel	"
Sh. G. J. Solanki	Technical Assistant, T-2
Sh. A. M. Vakharia	Artist-cum-Photographer
Sh. P. B. Garchar	Electrician-cum-Mechinic
Sh. J. G. Kalaria	Tractor Driver
Sh. B. M. Solanki	"
Sh. K. H. Koradia	"
Sh. G. G. Bhalani	"
Sh. N. M. Safi	"
Sh. J. R. Ramani	Assistant Administrative Officer
Ms. Rosamma Joseph	Senior Stenographor
Sh. Balvir Singh	Security Supervisur
Sh. Y. S. Karia	Junior Stenographor
Sh. L.V. Tilwani	"
Sh. J. B. Bhatt	Assistant
Sh. R. T. Thakar	"
Ms. K. A. Vssani	"
Ms. S. Venugopalan	Senior Clerck
Ms. M. N. Vaghasia	"

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

NATIONAL RESEARCH CENTRE FOR GROUNDNUT
IVNAGAR ROAD,
P.O.BOX 5,
JUNAGADH-362 001
GUJARAT, INDIA

Telephone:

Director : +91 - 285 - 2651550(O)
+91 - 285 - 2650382(R)
EPABX : +91 - 285 - 2623041,223461

Fax : +91 - 285 - 26 51550
E-Mail : director@nrcg.guj.nic.in

Telex : 0164 - 220 NRCG IN
Grams : GNUTSEARCH
URL : http://nrcg.guj.nic.in