International *Arachis* Newsletter

No. 14

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International Arachis Newsletter

Co-sponsors

Peanut Collaborative Research Support Program
(Peanut CRSP)

International Crops Research Institute
for the Semi-Arid Tropics (ICRISAT)

Publishing objectives

The *International Arachis Newsletter* (IAN) is published annually by ICRISAT, in cooperation with the Peanut Collaborative Research Support Program, USA. It is intended as a worldwide communication link for all those who are interested in the research and development of groundnut or peanut (*Arachis hypogaea* L.) and its wild relatives. Though the contributions that appear in IAN are peer-reviewed and edited, it is expected that the work reported will be developed further and formally published later in refereed journals. It is assumed that contributions in IAN will not be cited unless no alternative reference is available.

IAN welcomes short contributions (not exceeding 600 words) about matters of interest to its readers.

What to contribute?

Send us the kind of information you would like to see in IAN. An illustrative list is given here.

- Personal news (new appointments, awards, promotions, change of address, etc.)
- Reports of field days, meetings, tours, surveys, network activities, recently launched or concluded projects, etc.
- Short reports on recently held workshops, conferences, symposia, etc.
- Details of recent publications, with full bibliographic information and 'mini reviews' whenever possible.
- Results of recently concluded experiments, newly released varieties, recent additions to germplasm collections, etc.

How to format the contributions?

- Keep the items brief—remember, IAN is a newsletter and not a primary journal. About 600 words is the upper limit (no more than two double-spaced pages).
- If necessary, include one or two small tables (and no more). Supply only the essential information; round off the data-values to just one place of decimal whenever appropriate; choose suitable units to keep the values small (e.g., use tons instead of kg). Every table should fit within the normal type-written area of a standard upright page (not a 'landscape' page).
- Black-and-white photographs and drawings (prepared in dense black ink on a white card or a heavy-duty tracing paper) are welcome—photocopies, color photographs, and 35-mm slides are not. Please send disk-files (with all the data) whenever you submit computer-generated illustrations.
- Keep the list of references short—not more than five references, all of which should have been seen in the original by the author. Provide all the details such as author/s, year, title of the article, full title of the journal, volume, issue, and page numbers (for journal articles), and place of publication and publishers (for books and conference proceedings) for every reference.
- Express all the quantities only in SI units.
- Spell out in full every acronym you use.
- Give the correct Latin name of every crop, pest, or pathogen at the first mention.
- Type the entire text in double spacing. Whenever possible, please send a file, which should match the printout, on a double-sided/high density IBM-compatible disk. WordPerfect 5.1 files are preferred; if that is not possible, send an ASCII file instead.

We will carefully consider all submitted contributions and will include in the Newsletter those that are of acceptable scientific standard and conform to requirements. The language of the Newsletter is English, but we will do our best to translate articles submitted in other languages. Authors should closely follow the style of the reports in this issue. Contributions that deviate markedly from this style will be returned for revision, and could miss the publication date.

If necessary, we will edit communications so as to preserve a uniform style throughout the Newsletter. This may shorten some contributions, but particular care will be taken to ensure that the editing will not change the meaning and scientific content of the article. Wherever we consider that substantial editing is required, we will send a draft copy of the edited version to the contributor for approval before printing.

Contributions should be mailed to:

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SADC/ICRISAT Groundnut Project
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Lilongwe, Malawi

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B R Ntare
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B P 12404
Niamey (via Paris)
Niger

Rest of the world
S N Nigam
Groundnut Coordinator (IAC)
ICRISAT Asia Center
Patancheru 502 324
Andhra Pradesh
India

Requests for inclusion in the mailing list should be addressed to:

The Editor
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India

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Contents

News and Views

Editorial

The *International Arachis Newsletter,* issued twice a year so far, will now be published once a year beginning with this issue. S.N. Nigam, at the ICRISAT Asia Center (IAC), India; P. Subrahmanyam, at the SADC/ICRISAT Groundnut Regional Project, Malawi; and Bonny R. Ntare at the ICRISAT Sahelian Center, Niamey have been appointed Crop Coordinators for groundnut. They will assume regional responsibility for soliciting, collecting, reviewing, and collating information for the Newsletter. Readers are requested to send their contributions to their Regional Coordinators (please see inside front cover for further details). The Newsletter will be published from IAC and S. N. Nigam will serve as the scientific editor for the first year. Number 15 is scheduled for February 1995 and all contributions received before 31 October 1994 will be considered for inclusion in that volume.

We appreciate the assistance of K. Ramana Rao in the preparation of this volume.

L.J. Reddy
G.V. Ranga Rao

About ICRISAT Groundnut Scientists and Research Fellows

- **B.A. Patel,** formerly Research Scientist, Gujarat Agricultural University, joined the Crop Protection Division as Research Fellow in June 1993 to work on nematological problems of legumes.
- **K. Vijayalakshmi** joined the Netherlands' Peanut Bud Necrosis Virus Project as Consultant in June 1993.
- **Suresh Pande,** Scientist (Pathology), has spent the last year as Agriculture Researcher/Production Manager (Seeds) at the Saudi Agricultural Development Company (INMA), Wadi Dawasir, Saudi Arabia.
- **S.B. Sharma,** Scientist (Nematology), is on sabbatical leave for a year at the University of Missouri, USA, where he is a Visiting Scientist and is working on host-plant resistance, from Aug 1993.
- **Fang Xiaping,** Associate Professor, formerly of the Oilseeds Research Institute, Chinese Academy of Agricultural Sciences, joined the Crop Protection Division as Research Fellow in Jul 1993.
- **Hu Wenguang,** Associate Professor, Shandong Peanut Research Institute, Laixi, Shandong Province, People's Republic of China, joined the Genetic Enhancement Division on 31 Jul 1993 for a 3-month stint to study breeding procedures followed at ICRISAT for groundnut improvement.
- **Philippe Delfosse** joined the Crop Protection Division (Virus-Pathology) on 16 Oct 1993 as Visiting Scientist. He is working on *Polymyxa graminis,* the fungal vector of the peanut clump virus, as part of a collaborative project with the Université Catholique de Louvain (UCL), Faculté des Sciences Agronomiques, Unite de Phytopathologie, Louvain-la-Neuve, Belgium. The project, 'Integrated control of *Polymyxa graminis,* vector of peanut clump virus', is funded by the Administration Générale de la Coopération au Développement (AGCD), Belgium, for a period of two and a half years.
- **Himani Bhatnagar** joined the Crop Protection Division as Research Fellow on 8 Oct 1993 to study the influence of agricultural production systems on plant diseases.

Training Activities at ICRISAT

Virology

From 22–27 Nov 1993, a training course was organized on the detection of seedborne groundnut viruses with special emphasis on enzyme-linked immunosorbent assay (ELISA). Ten senior staff from several Indian plant quarantine units attended the course, which was sponsored by the Directorate of Plant Protection, Quarantine and Storage, Government of India. ICRISAT's Human Resource Development Program and Cereals and Legumes Asia Network (CLAN) sponsored scientists from Bangladesh, Nepal, and Sri Lanka, currently involved in research in plant protection. The participants were given hands-on training in:

- mechanical inoculation of groundnut with plant viruses;
- various forms of ELISA [including direct antigen coating (DAC) and double antibody sandwich (DAS) methods] to detect groundnut viruses in plant material including seeds, and
- extraction of γ-globulins and conjugation with penicillinase.

Lectures on seedborne viruses covered:

- methods of virus detection and their comparative advantages and disadvantages; and
- interpretation of results of various tests to detect plant viruses in quarantine.

In addition, techniques of dot immunobinding assay, gel electrophoresis, and Western blots were demonstrated.

Pathology

S. Juntarak (Thailand), A.M. Diallo (Guinea), B.K. Chira (Zambia), and M. Laoubara (Chad) underwent 7 days' training, in Sept 1993, in the diagnosis of several foliar and soilborne fungal diseases of groundnut and in screening for resistance to rust and late leaf spot diseases in the field and greenhouse.

Nematology

Training in basic nematological techniques such as extraction of nematodes from soil and plant tissues, collection of samples from the field, staining of nematodes in infested plant roots, rating scales for different nematodes, and identification of important nematodes was imparted to three trainees from Kenya, Sudan, and Zambia.

Participants in the training course 'Nematodes management in pulse crops' organized by the Central Plant Protection Training Institute (CPPTI), Hyderabad, India, were also introduced to the techniques developed and used by the Nematology Unit of ICRISAT Asia Center.

Reports on Meetings/Tours

Groundnut Virus Diseases Working Groups Meeting, Dundee, Scotland, UK (15–19 Aug 1993)

At a meeting organized by ICRISAT in cooperation with the Peanut Collaborative Research Support Program (Peanut CRSP) and the Virology Department, Scottish Crops Research Institute (SCRI), UK, scientists from 11 countries, representing the three working groups—'Groundnut viruses in Asia-Pacific region', 'Groundnut viruses in Africa', and 'Transformation and regeneration of groundnut, and utilization of viral genes to induce resistance to virus diseases'—reviewed the progress made by the three working groups since their last meetings. Following general discussion, recommendations were made for global cooperative research on groundnut viruses, and specific recommendations for collaborative research were listed for each working group.

The papers presented at the meeting highlighted recent advances in groundnut transformation and regeneration, genome organization of groundnut viruses, and potential for using these data for diagnosis and management of groundnut virus diseases. The recommendations made at the meeting endorsed the importance of the working group approach to finding solutions to problems of virus diseases in developing countries and emphasized technology exchange and research on managing virus diseases through an understanding of epidemiology and exploitation of recent developments in biotechnology.

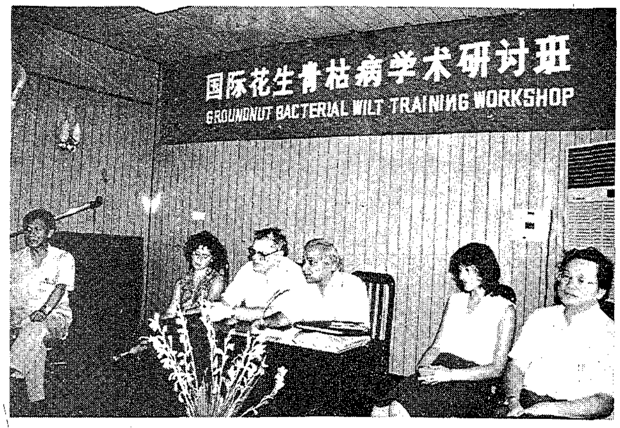
Copies of the proceedings, *Working Together on Groundnut Virus Diseases*, are available from ICRISAT (Order code: CPE 088).

D.V.R. Reddy
ICRISAT Asia Center

Third Groundnut Bacterial Wilt Working Group Meeting, Wuhan, China

The Third Groundnut Bacterial Wilt Working Group Meeting was held at the Oil Crops Research Institute, Wuhan, China, from 4–5 Jul 1994. Forty-four scientists—from Australia, China, Indonesia, Malaysia, Philippines, Thailand, UK, and Vietnam, and from FAO, ICRISAT, and IPGRI—met to review the progress of research in recent years on the diagnosis, biology, and ecology of *Pseudomonas solanacearum*, the bacterium that causes groundnut wilt; to discuss integrated disease

Participants learning an enzyme-linked immunosorbent assay (ELISA) technique for the detection of *Pseudomonas solanacearum*.



V.K. Mehan, Coordinator of the Groundnut Bacterial Wilt Working Group, answers questions from participants during a discussion session. Seated to his right are faculty members Drs A.C. Hayward (Australia), Andrea Robinson-Smith (UK), and Xu Zeyong (China). To his left are Drs Susan Seal (UK) and K.Y. Lum (Malaysia).

control options; and to establish priorities for future research and collaboration. The meeting was co-sponsored by the Chinese Academy of Agricultural Sciences (CAAS) and CLAN/ICRISAT.

The objectives of the meeting were to:

- bring together researchers to exchange the latest information on the bacterial wilt of groundnut,
- evaluate the status of research on the disease in different countries and regions,
- recommend priorities for collaborative research at national and international levels,
- assign, wherever possible, research modules to individuals or groups,
- identify specific training needs as well as institutions that can offer training, and
- determine the resources needed and prepare a research proposal for funding.

The welcome address was given by Dr Liang Keyong, Vice President, CAAS, China. Dr Y.L. Nene, Deputy Director General, ICRISAT, presented the objectives of the meeting, and Dr James G. Ryan, Director General, ICRISAT, gave the inaugural address.

Seventeen papers reviewed the research on host plant resistance to groundnut bacterial wilt, integrated disease management, new serological and molecular methods for the diagnosis of the wilt pathogen, and phenotypic and molecular approaches to strain differentiation.

The Group strongly recommended that an International Groundnut Bacterial Wilt Nursery be established to determine the stability of wilt resistance. ICRISAT should coordinate this nursery, and the exchange of resistant germplasm among the Working Group members. The need to determine the pathotypes/strains of *P. solanacearum* that attack groundnut, and to develop serological and molecular techniques to characterize pathotypes/strains and wilt resistance, was highlighted. Other important recommendations of the meeting include strengthening of national programs through training in advanced techniques and increased cooperation and coordination among scientists of national programs and ICRISAT. The Group suggested that external funds be sought to promote the research activities of the Group.

Full proceedings and recommendations of the meeting will be published by ICRISAT.

Participants learning a polymerase chain reaction (PCR) technique for the diagnosis of *Pseudomonas solanacearum.*

Training Course on the 'Techniques for Diagnosis of *Pseudomonas solanacearum* and for Resistance Screening against Groundnut Bacterial Wilt'

A training course on the 'Techniques for Diagnosis of *Pseudomonas solanacearum* and for Resistance Screening against Groundnut Bacterial Wilt' was held from 6–9 Jul 1994 at the Oil Crops Research Institute of the Chinese Academy of Agricultural sciences (CAAS) in Wuhan, China. The course was co-sponsored by CAAS and ICRISAT. The resource faculty for this course was drawn from Australia, China, Malaysia, and UK, and from ICRISAT. Seventeen participants—from China (13),

Participants visit farmers' fields in the Hong An county, Hubei Province, China, where bacterial wilt is serious. *Left* Wilt-resistant variety Zhonghua 2. *Right* High plant mortality in a local variety Zhonghua 118.

Malaysia (1), Thailand (1), and Vietnam (2), attended the course. The participant from Thailand was sponsored by the Peanut Collaborative Research Support Program (Peanut CRSP), USA.

The participants were given 'hands-on' experience in use of the indirect and direct enzyme-linked immunosorbent assays (ELISAs) for the detection of the wilt pathogen in groundnut plant and seed tissues, in utilizing a polymerase chain reaction (PCR) technique for the diagnosis of *P. solanacearum*, and in the BACTID and Biolog systems for the identification of *P. solanacearum*. In addition, inoculation techniques for resistance screening against groundnut bacterial wilt, techniques for isolation and identification of virulent and avirulent cultures of *P. solanacearum*, and infectivity titration tests were demonstrated. Lectures were given on biovars and pathotypes of the wilt pathogen.

Participants also visited various field trials on host plant resistance to bacterial wilt, and on crop rotation for disease management, in farmers' fields in the Hong An county, Hubei Province, China.

Participants were given a test just before the course; they performed markedly better on the same test, and a supplementary test, immediately after the course. The course was rated highly by all the participants, except that they thought it should have been a little longer. All the participants maintained keen interest throughout the course to learn the various techniques.

V.K. Mehan
(ICRISAT Asia Center)

Sustainable Production of Groundnut in Southern and Eastern Africa: A Workshop, Mbabane, Swaziland

The workshop (5–7 Jul 1994) was sponsored by the SADC/ICRISAT Groundnut Project supplemented by ICRISAT core funds, and hosted by the Ministry of Agriculture and Cooperatives, Royal Kingdom of Swaziland. There were 33 delegates from 11 countries—Botswana, Lesotho, Malawi, Mozambique, Namibia, Republic of South Africa, Swaziland, Tanzania, Uganda, Zambia, and Zimbabwe. The Southern African Centre for Cooperation in Agricultural Research (SACCAR) was also represented, as were all three regional programs of ICRISAT (western and central Africa, southern and eastern Africa, and Asia).

The workshop was a landmark of sorts: the first time South Africa (which is likely to join SADC this August) was participating in a groundnut workshop in the region. Thirty papers were presented, and the proceedings (which will be published by ICRISAT later this year) will form a fairly comprehensive review of groundnut research and extension in the southern and eastern Africa region. There were five papers from South Africa, one of which dealt with an innovative and highly successful system that uses posters and an easy-to-follow disease control manual to improve crop quality (and therefore market price).

The presentations and discussions covered the role of four broad disciplines—genetic enhancement, agronomy, crop protection, and technology transfer—in sustainable groundnut production. The recommendations formalized at the plenary session chart a course for groundnut research for the next few years in southern and eastern

Africa. The suggested priority areas include characterization of drought-prone environments; establishment of drought nurseries every season at selected locations; pest and disease surveys; surveys on aflatoxin contamination, particularly in subsistence farming households; and greater involvement of socioeconomists in demonstrations and on-farm trials. The extension specialists at the workshop suggested that scientists get out of their labs, at least part of the time, and into the villages for extension work—no one disagreed with that.

The workshop was followed immediately by the Fourth Meeting of the SADC/ICRISAT Groundnut Project Steering Committee, which reviewed the status of groundnut research in the region. The project proposal for Phase IV of the Project (for funding by Bundesministerium für Wirtschaftliche und Entwicklung Zusammenarbeit (BMZ)/Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) was also tabled at the Steering Committee meeting.

Ajay Varadachary
ICRISAT Asia Center

Recent ICRISAT Publications

Ahmed, K.M., and **Ravinder Reddy, Ch.** 1993. A pictorial guide to the identification of seedborne fungi of sorghum, pearl millet, finger millet, chickpea, pigeonpea, and groundnut. Information Bulletin no. 34. (In En. Summaries in Fr, Es, and Ar.) Patancheru 502 324, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics. 200 pp. ISBN 92-9066-251-4. Order code: IBE 034.

Seeds of sorghum, pearl millet, finger millet, chickpea, pigeonpea, and groundnut are known to harbor over 62 seedborne fungi belonging to 37 genera. In this bulletin, an attempt has been made to help agricultural scientists and students identify seedborne fungi, usually observed during the seed health tests conducted for phytosanitary certification, of the six ICRISAT mandate crops. This bulletin provides descriptions and illustrations of 45 seedborne fungi, with brief information on the diseases caused by them, methods of seed transmission, detection, symptoms on the seed, morphological characteristics of the fungi, quarantine importance, and control measures to eradicate seedborne inoculum and to prevent inadvertent introductions. Photomicrographs are included to help identify the fungi. A world list of seedborne diseases is also given to help regulatory agencies formulate policies involving seedborne fungi, so that unnecessary restrictions on the movement of disease-free germplasm can be avoided.

Gowda, C.L.L., and **Ramakrishna, A.** (eds.) 1993. Cereals and legumes: an Asian perspective. Summary proceedings of the CLAN Country Coordinators' Consultative Meeting, 29 Sep–1 Oct 1993, ICRISAT Asia Center, India. (In En. Abstracts in En, Fr.) Patancheru 502 324, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics. 160 pp. ISBN 92-9066-280-8. Order code: CPE 087.

This publication is a report of the first Country Coordinators' meeting of the Cereals and Legumes Asia Network (CLAN). Network activities during 1991–93 are reviewed; collaborative research projects in the member countries are described; and future priorities suggested. The role of ICRISAT's research and research-support programs in the network is discussed. Papers from three international research institutes and a major funding agency are also included, outlining their possible contributions to future CLAN activities.

Recommendations are made for future research activities aimed at alleviating major constraints to production of CLAN priority crops: sorghum, millets, chickpea, pigeonpea, and groundnut.

Gowda, C.L.L., van Santen, C.E., Johansen, C., and **Nigam, S.N.** (eds.) 1993. Approaches to on-farm research in Asia: summary proceedings of the Regional Workshop on On-farm Adaptive Research, 18–20 Feb 1993, Ho Chi Minh City, Vietnam. (In En.) Patancheru 502 324, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics. 153 pp. ISBN 92-9066-278-6. Order code: CPE 085.

On-farm adaptive research is an important component of agricultural research that attempts to adapt technology to suit farmers' conditions. A regional workshop in Vietnam brought together representatives of 13 member countries of the UNDP/FAO RAS/89/040 Project, and from regional and international institutions in Asia, to exchange knowledge on on-farm research. Papers presented at the workshop include case studies from the Asian Grain Legumes On-farm Research Project countries, status reports on on-farm research and methodologies followed by different countries, and experiences of regional institutions working in Asia. Recommendations from the participants' discussions include suggestions for methodologies of on-farm research that involve farmer-participatory approaches.

Mehan, V.K., Liao, B.S., Tan, Y.J., Robinson-Smith, A., McDonald, D., and **Hayward, A.C.** 1994. Bacterial wilt of groundnut. Information Bulletin no. 35. (In En. Summaries in En, Fr.) Patancheru 502 324, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics. 28 pp. ISBN 92-9066-284-0. Order code: IBE 035.

Bacterial wilt (*Pseudomonas solanacearum*) is a major constraint to groundnut production in several Asian and African countries. Although the disease is present in many countries, it is particularly important in China, Indonesia, Malaysia, Uganda, and Vietnam. Much progress has been made in understanding the disease epidemiology and the races and biovars of *P. solanacearum* that attack groundnut. Antisera have been produced for several *P. solanacearum* biovars and serological tests to detect the wilt pathogen in plant tissues and soil are available. Effective greenhouse- and field-screening techniques have been developed, resistance sources identified, and resistant cultivars developed. Various options for disease management are discussed, and an integrated approach is advocated.

Reddy, D.V.R., McDonald, D., and **Moss, J.P.** (eds.) 1994. Working together on groundnut virus diseases: summary and recommendations of a meeting of international working groups on groundnut virus diseases, 15–19 Aug 1993, Scottish Crops Research Institute, Dundee, UK. (In En. Summaries in En, Fr.) Patancheru 502 324, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics. 88 pp. ISBN 92-9066-294-8. Order code: CPE 088.

At a meeting organized by ICRISAT in cooperation with Peanut CRSP and the Virology Department, SCRI, UK, scientists from 11 countries, representing the three working groups—'Groundnut viruses in Asia-Pacific region', 'Groundnut viruses in Africa', and 'Transformation and regeneration of groundnut, and utilization of viral genes to induce resistance to virus diseases'—reviewed the progress made by the three working groups since their last meetings. Following general discussion, recommendations were made for global cooperative research on groundnut viruses, and specific recommendations for collaborative research were listed for each working group.

Subrahmanyam, P., Hildebrand, G.L., Taber, R.A., Cole, D.L., Smith, D.H., and **McDonald, D.** 1994. Web blotch disease of groundnut. Information Bulletin no. 43. (In En. Summaries in En, Fr, Pt.) Patancheru 502 324, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics; and Griffin, GA 30223, USA: Peanut Collaborative Research Support Program. 20 pp. ISBN 92-9066-298-0. Order code: IBE 043.

Web blotch disease caused by *Phoma arachidicola* affects groundnut crops in several major groundnut-producing countries, where it can reduce yields by about 40%. In this illustrated bulletin its distribution, economic importance, and symptoms are described. Details of the causal organism are presented, disease cycle and epidemiology explained, and methods of disease management suggested.

Subrahmanyam, P., Wongkaew, S., Reddy, D.V.R., Demski, J.W., McDonald, D., Sharma, S.B., and **Smith, D.H.** 1992. Field diagnosis of groundnut diseases. Information Bulletin no. 36. (In Ch.) Patancheru 502 324, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics. 84 pp. ISBN 92-9066-255-7. Order code: IBE 036.

Diseases are major constraints to groundnut production throughout the world. This handbook is designed to assist agricultural research and extension workers, who may have little formal training in plant pathology, to make tentative diagnosis of diseases of groundnut caused by 31 fungi, 2 bacteria, 9 viruses, a mycoplasma-like organism, 4 nematodes, and a parasitic flowering plant. The most characteristic field symptoms of each disease are illustrated and described. It is emphasized that for confirmation of field diagnosis the assistance of skilled plant pathologists will be required in most cases.

Wightman, J.A., and **Ranga Rao, G.V.** 1993. A groundnut insect identification handbook for India. Information Bulletin no. 39. (In En. Summaries in En, Fr.) Patancheru 502 324, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics. 64 pp. ISBN 92-9066-275-1. Order code: IBE 039.

Groundnut or peanut (*Arachis hypogaea* L.) is an important oilseed crop in India. It is attacked by many insects throughout the country at different stages of plant growth, but only a few of the over 100 insects associated with this crop are economically important. This bulletin provides short descriptions of the most important species, their biology, distribution, and damage symptoms. Color photographs are provided for easy identification of the pests, and appropriate control measures are suggested.

News from Peanut CRSP

Peanut CRSP Annual Meeting, USA

The Annual Meeting of Peanut CRSP was held in conjunction with the American Peanut Research and Education Society (APRES) Annual Meeting in Huntsville, Alabama. The APRES meeting was held from 13 to 16 Jul 1993. Peanut CRSP participants met on 16 July.

In addition to many participants from USA, the following host-country collaborators attended: Dr Remedious Abilay and Dr Eliseo Cadapan, Philippines; Dr Richard Awuah, Ghana; and Dr Amadou Ba and Mr Ousmane Ndoye, Senegal. Visitors to the meeting included Dr Duncan McDonald (also a member of the Board of Directors) and Mr Farid Waliyar, ICRISAT Asia Center and Dr Robert Schilling, CIRAD-France. Along with other CRSP business, Dr Amadou Ba presented an update on peanut research in Senegal, and Dr Eliseo Cadapan reviewed progress in biocontrol of insects in the Philippines.

The Board of Directors met on 16 and 17 July. There was also an organizational meeting of a recently appointed External Evaluation Panel for Peanut CRSP. Its members are Dr Bo Bengtsson, Swedish University of Agricultural Sciences, Uppsala; Dr John P. Cherry, United States Department of Agriculture/Agricultural Research Services (USDA/ARS), Eastern Regional Research Center, Philadelphia; Dr Milton Coughenour, University of Kentucky; Dr David Hsi (retired), New Mexico State University; ~~Dr Robert Schilling, CIRAD-France, Montpellier, France;~~ Dr Joseph Smartt, Southampton University, UK; and Dr Handy Williamson, Jr., University of Tennessee. The Panel will review the activities undertaken by Peanut CRSP during 1993 and 1994, to make recommendations about the proposal to extend the CRSP for 5 years (1995–2000).

Announcement

Semi-Arid Tropical Crops Information Service (SATCRIS)

The Semi-Arid Tropical Crops Information Service (SATCRIS) is a worldwide information service established at ICRISAT to provide access to scientific, technical, and socioeconomic information on the six mandate crops of ICRISAT, namely, sorghum, pearl millet, finger millet, chickpea, pigeonpea, and groundnut. It also provides information on the food and feed quality of these crops, the agroclimatology and farming systems of the semi-arid tropics (SAT), and other aspects of research associated with ICRISAT's mandate.

SATCRIS maintains a bibliographic database using data in machine-readable form from CAB International in the UK and the Food and Agriculture Organization of the United Nations. Locally generated information, i.e., information produced at ICRISAT and that accessed by SATCRIS by virtue of its acquisitions and contacts with research centers in the SAT, is added to the data from the two global sources to build a comprehensive database.

An important component of SATCRIS is its Selective Dissemination of Information (SDI) service, which regularly alerts scientists to current literature that is directly relevant to their interests and ongoing research. The SDI service encompasses delivering documents and has a built-in feedback mechanism to ensure that the SDI outputs keep pace with the researchers' current-awareness needs and interests, which may change with time.

Another component of SATCRIS is information retrieval on demand. This service enables researchers to order a retrospective search of the literature on a specific topic. SATCRIS uses its own database as well as other databases on CD-ROM wherever needed to respond to such search requests.

SATCRIS collaborates with scientists at ICRISAT in developing useful information products that review and consolidate information on specific topics. One example of such a product is a literature review and a database on the groundnut aflatoxin problem that ICRISAT published in 1992. The database is available for use with microcomputers. SATCRIS is now developing prototype expert advisory and diagnostic system for groundnut plant protection. This microcomputer-based system encapsulates the knowledge of researchers and extension staff to cover pests, diseases, nutritional disorders, and weed problems in groundnut.

SATCRIS welcomes researchers working on any of ICRISAT's mandate crops to use its services. For copies of a brochure on SATCRIS, please write to:

The Senior Manager
Library and Documentation Services
Information Management and Exchange Program
ICRISAT
Patancheru 502 324
Andhra Pradesh
India

Reports

Disease Constraints to Groundnut Production in Vietnam–Research and Management Strategies

V.K. Mehan[1] and **N.X. Hong**[2] (1. ICRISAT Asia Center; 2. National Institute of Agricultural Sciences, Hanoi, Vietnam)

Groundnut is the most important food legume crop in Vietnam, and is cultivated over 200 000 ha annually. It is an important cash crop, and a vital export commodity. The major groundnut-growing areas of Vietnam are Nghe An (20 000 ha), Ha Tinh (10 000 ha), Thanh Hoa (15 000 ha), and Ha Bac (10 000 ha) provinces in northern Vietnam, and Tay Ninh (20 000 ha), Song Be (15 000 ha), Long An (10 000 ha), and Dong Nai (10 000 ha) provinces in southern Vietnam. The average pod yield is about 1.0 t ha^{-1}.

Until recently, very little attention was paid to research on disease problems in groundnut. During 1990–1992, systematic surveys were conducted to assess the disease constraints in the major groundnut-growing areas, and to determine research priorities and disease-management strategies.

Disease Problems

Foliar diseases. Rust (*Puccinia arachidis* Speg.) and late leaf spot [*Phaeoisariopsis personata* (Berk. & M.A. Curtis) van Arx] are major fungal foliar diseases in all the groundnut-producing areas. They cause severe damage to the crop regularly in southern Vietnam. In northern Vietnam also, they cause severe problems to maturing crops. The overlapping of the groundnut cropping seasons in southern Vietnam favors the perpetuation of the rust and late leaf spot pathogens and thus contributes to the severity of the diseases. Occurring together, these diseases can cause 30–70% loss in pod yield and reduction in the quality of kernels. The relative importance of each disease varies from place to place and from season to season, depending upon the cropping systems and environmental conditions. Early leaf spot (*Cercospora arachidicola* Hori) can cause economic damage in some parts of northern Vietnam (Ha Bac, Vinh Phu, and Bac Thai provinces) in years when there are frequent early-season rains. This disease alone can cause 35–50% defoliation at peak flowering stage, and yield losses may reach 20–25%.

Other foliar diseases that affect groundnut are pepper leaf spot and leaf scorch caused by *Leptosphaerulina crassiasca* (Sechet) Jackson & Bell, phyllosticta leaf spot (*Phyllosticta arachidis-hypogaea* Vasant Rao), alternaria leaf spot (*Alternaria* spp), leaf blight (*Rhizoctonia solani* Kuhn), and botrytis blight (*Botrytis cinerea* Pers. ex Fries), but these diseases are of low incidence, and are not at present considered to be economically important.

Soilborne diseases. Damping-off and seedling diseases are of common occurrence in many areas in both northern and southern Vietnam and are collectively responsible for the considerably poor plant stands and low yields. Several fungi are involved in seedling diseases but the pathogens most commonly implicated are *Aspergillus niger* van Tieghem, *Sclerotium rolfsii* Saccardo, *Rhizoctonia solani*, *Macrophomina phaseolina* (Tassi) Goidanich, *Pythium* spp, and *Fusarium* spp. *Aspergillus niger* is the most important of these pathogens. Collar rot caused by this fungus is responsible for substantial seedling mortality (15–40%) in Nghe An, Thanh Hoa, and Tay Ninh provinces, particularly in sandy soils. The disease is most severe when there is drought stress early in the season.

Aflaroot disease incited by *Aspergillus flavus* Link ex Fries is of low incidence. Until recently, this disease was locally called 'stunt disease' which was thought to be caused by a virus.

Pod rots. Pod rots are also major constraints to groundnut production in many areas of northern Vietnam. *Pythium* spp, *Fusarium* spp, and *S. rolfsii* appear to be involved in pod rots. The affected pods develop brownish-black to black, water-soaked lesions. Pod rots become severe under waterlogging conditions due to heavy late-season rains. High temperatures and humidity, and excessive vegetative growth favor infection by *S. rolfsii*, which causes stem and pod rots. These pathogens also reduce the quality of groundnuts. Frequent rains towards crop maturity and poor drainage conditions enhance the severity of the problem. This problem is of common occurrence in Thanh Hoa and Nghe An provinces.

Bacterial wilt. Bacterial wilt, caused by *Pseudomonas solanacearum* (Smith) Smith, is becoming increasingly important in both northern and southern Vietnam. The disease is now recognized to be serious in Nghe An, Thanh Hoa, Long An, and Tay Ninh provinces where plant mortality can be 15–45%. But disease incidence varies from place to place. It is severe in the upland areas, particularly in sandy soils. Many of the local groundnut varieties are susceptible to bacterial wilt. The disease incidence is highest at peak flowering and podding stages, although it can also be seen early in the season. Bacterial wilt is considered to be a major threat to groundnut production.

Collar rot and bacterial wilt often occur together in many areas, and cause considerable yield losses. Until 1991, both diseases were locally referred to as 'groundnut wilt' (Mehan et al. 1991).

Other diseases. A new foliar disease characterized by grayish-brown 'eye spots' (caused by a bacterium?) has been found to be serious in some areas of Nghe An province. It causes severe defoliation at flowering stage, especially when there are frequent early-season rains. The popular local groundnut variety Sen Nghe An is susceptible to this disease. Some exotic varieties (e.g., Vienpan and CES 102) were also found to be highly susceptible to it.

Peanut stripe and bud necrosis virus diseases are occasionally found but are low in incidence.

The distribution and severity of major foliar and soil-borne diseases of groundnut in Vietnam are shown in Figures 1 and 2.

Research on Major Diseases of Groundnut

Foliar diseases. Research on foliar fungal diseases in Vietnam has concentrated on host-plant resistance. This research has been conducted at the National Institute of Agricultural Sciences (INSA), Hanoi. All local groundnut varieties are susceptible to rust, late leaf spot, and early leaf spot. During 1990–93, 540 germplasm and breeding lines (obtained from ICRISAT) were screened for resistance to rust and late leaf spot, using the infector-row technique. Fourteen genotypes were found to be resistant to rust, 19 to late leaf spot, and 6 to both. The most resistant genotypes include ICG 4747 (PI 259747), ICG 7884 (PI 341879), ICGV 87302, and ICGV 87305. They consistently showed scores of 2.0–3.5 on a 9-point disease rating scale. The local cultivar Sen Lai showed an average score of 6.5 for rust and 7.5 for late leaf spot. Most of the resistant genotypes are of long duration (150–155 days), have small seeds, and an undesirable testa color. These genotypes are now being used in breeding programs.

Chemical control of foliar diseases has been found to be effective in Vietnam. The fungicides chlorothalonil (Daconil®) and Anvil® have proved most effective in controlling both rust and leaf spots. One or two sprays of either of these fungicides can substantially control the diseases, and have been found to help in increasing pod yield by up to 25%. It may be possible to achieve effective and profitable control of these diseases with one chemical spray at 70 days after sowing (DAS) in early-sown crops in northern Vietnam. Late-sown crops may require two sprays (at around 55 and 70 DAS).

Bacterial wilt. Research on bacterial wilt is conducted mainly by INSA and the Plant Protection Research Institute (PPRI), Hanoi.

Most isolates of the wilt pathogen collected from several disease hot spots in Nghe An, Ha Bac, and Thanh Hoa provinces were found to be highly pathogenic to groundnut at 30–32°C. Several of them were also virulent to tomato, potato, and eggplant, but less virulent to tobacco. All the isolates tested showed good growth on sucrose peptone agar at 30–35°C. Research is now in progress to collect isolates of the wilt pathogen from various cropping systems involving groundnut in different agroecological regions, and to determine which biovars are prevalent, their virulence, and host ranges. Preliminary results indicate that all the collected bacterial isolates belong to race 1.

Several hot spots of this disease have been identified in Ha Bac, Thanh Hoa, and Long An provinces. A hot spot in Ha Bac is now being developed into a wilt sick plot for screening genotypes for wilt resistance. The procedure for developing a sick plot includes continuous growing of a highly susceptible cultivar in the same field season after season, incorporating wilted plants collected from various areas, and using artificially inoculated seeds for sowing. Late sowing is also practised to enhance disease incidence and severity, particularly in spring.

Twenty groundnut genotypes reported to be resistant to bacterial wilt in southeast and east Asian countries have been evaluated for resistance in northern Vietnam. Most of these genotypes (including Indonesian cultivars Gajah, Kidang, and Matjam) have shown resistance to bacterial wilt in Ha Bac and Nghe An provinces. Some accessions of Schwarz 21 (ICG 1609 and ICG 7968) have consistently shown high levels of resistance in disease hot spots, and under artificial inoculation conditions in the greenhouse at INSA. Several rust- and late leaf spot-resistant germplasm lines (e.g., ICG 1703 and ICG 1705) have also shown resistance to wilt. Some breeding lines (ICGV 87165 and ICGV 88252) also possess resistance to wilt. These genotypes are now being tested at several disease hot spots in both northern and southern Vietnam to ascertain the stability of their resistance.

Collar rot. All local cultivars and most of the introduced lines tested have shown susceptibility to collar rot. Several seed protectant fungicides are now being tested to

Province

1. Bac Thai
2. Vinh Phu
3. Thu Do Ha Noi
4. Ha Bac
5. Hai Hung
6. Ha Son Binh
7. Ha Nam Ninh
8. Thanh Hoa
9. Nghe Tinh
10. Song Be
11. Dong Nai
12. Tay Ninh
13. Thanh Pho Ho Chi Minh
14. Long An

	Incidence/severity		
Disease	Low	Moderate	Severe
Rust	△	▲	▲
Late leaf spot	○	●	●
Early leaf spot	□	■	■

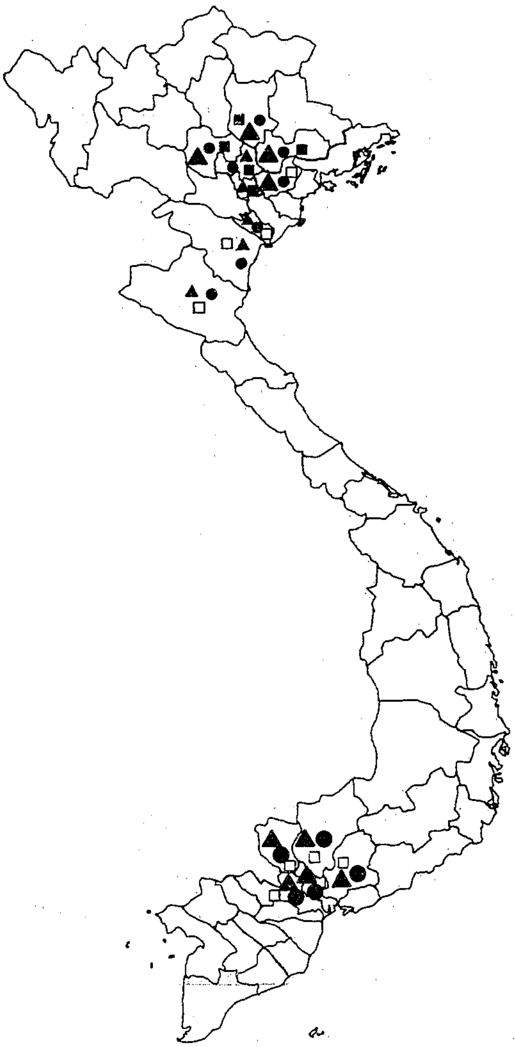


Figure 1. Distribution and severity of major fungal foliar diseases in Vietnam.

	Incidence/severity		
Disease	Low	Moderate	Severe
Bacterial wilt	△	▲	▲
Collar rot	○	●	●
Pod rot	□	■	■

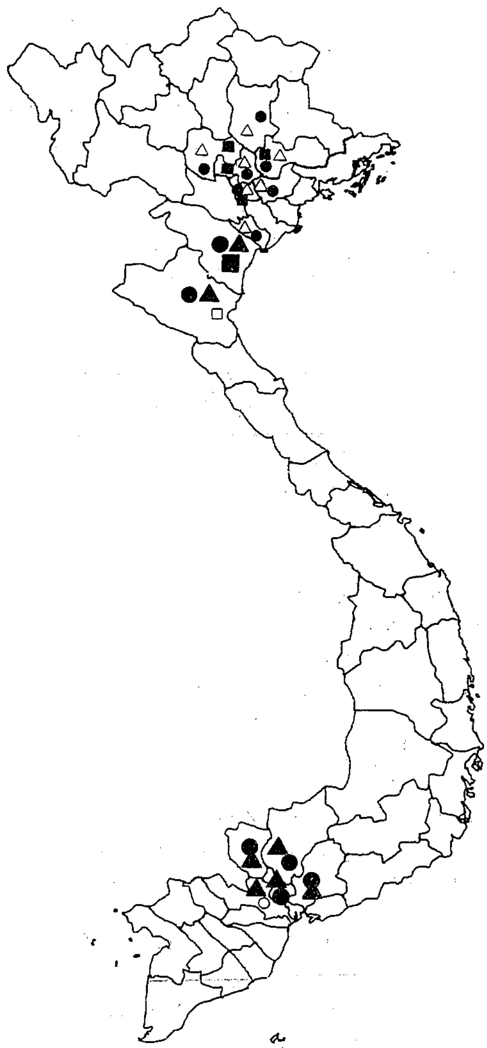


Figure 2. Distribution and severity of major soilborne diseases in Vietnam.

control collar rot and damping-off diseases at various locations in northern and southern Vietnam. Research on these diseases is conducted by INSA, and PPRI in northern Vietnam, and the Oil Plant Research Institute and the Institute for Agricultural Sciences in southern Vietnam.

Pod rots. No research has been conducted on pod rots, although this problem is becoming increasingly important.

Aflatoxin. Frequent rains and high temperatures and humidity at harvest time present drying problems, especially in northern Vietnam, and are likely to contribute to aflatoxin contamination in groundnuts. No systematic research has been done on this problem, but the limited research done at PPRI and INSA has recently shown that a large proportion of seeds were infected by *Aspergillus flavus* during storage (H. M. Trung, personal communication). A few groundnut oil cake samples tested in the late 1980s showed high levels of aflatoxin (Blaha et al. 1990).

Disease Management Strategies

- Developing genetic resistance to rust, late leaf spot, and bacterial wilt should be the thrust of the disease-management strategy.
- Incorporating combined resistance to bacterial wilt, rust, and late leaf spot into high-yielding cultivars adapted to specific environments should get a high priority because foliar diseases are severe in many areas where bacterial wilt is also a constraint to groundnut production.
- Integrated disease management is advocated; this should include use of disease-resistant cultivars, appropriate cultural practices, and crop rotation. Considering the fact that farmers in Vietnam are resource poor, it would be appropriate to use low-cost inputs while using limited need-based chemical control (for foliar diseases and for damping-off).

Future Research Priorities

- Research on bacterial wilt needs to be intensified. More systematic research should be undertaken to understand the influence of different cropping systems and crop-management practices on the incidence/severity of major diseases, particularly bacterial wilt and pod rots.
- Wilt sick plots need to be developed for effective screening for wilt resistance. It is imperative to evaluate new breeding lines that are being considered for release for their reaction to bacterial wilt.
- The possibility of seed transmission of bacterial wilt needs to be investigated. This is important for the safe movement of seed within the country, and for integrated disease management.
- Research on damping-off and collar rot diseases should be intensified, with emphases on the role of major pathogens implicated in the damping-off disease complex, and identification of effective seed protectants.
- Regular surveys are required to assess the importance of major diseases, and to confirm the occurrence of peanut stripe which is prevalent in several southeast and east Asian countries.
- Priority should be given to research on the aflatoxin problem as Vietnam attaches much importance to the export of groundnuts and their products.

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Mutation Breeding in China: Achievements and Prospects in Groundnut

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Mutation breeding in groundnut has been employed in China since the 1960s. This paper reports the major achievements of this effort since then.

New varieties developed through induced mutation. More than 20 new groundnut varieties have been bred and selected in China through irradiation and its combination with hybridization. These include the most popular cultivars such as Yuoyou 22, Yuoyou 551, and Fu 21 in Guangdong Province, Luhua 6 and Luhua 7 in Shandong Province, and Fu 7-28 in Jiangxi Province. Each of these cultivars is being grown profitably over several thousands of hectares by farmers.

New germplasm created through irradiation. More than 280 mutants have been obtained out of which 226 are conserved at the Shandong Peanut Research Institute (SPRI). Some of these possess rarely-seen or novel characters. These include:

- Mutants with multiple leaflets (6–12).
- Mutants with a high content of lysine (1.96%), oil (55.8%), glucose and fructose (2.33%), and Vitamin C (2.03 mg 100 g^{-1}).
- Mutants with resistance to biotic and abiotic stresses: Fiftyone mutants that are less susceptible to late leaf spot, 52 with drought tolerance, and 18 with tolerance to salinity have been developed at SPRI.
- Mutants with short duration: A short-duration mutant which takes only 73–75 days to maturity has been developed at SPRI. This mutant reaches maturity 20 days earlier than the popular early-maturity cultivar Luhua 6, and 7 days earlier than Chico. It is believed to be the earliest-maturing groundnut variety in the world.
- Mutants with varied physiology and anatomy: The program also developed mutants with leaves exhibiting different 'sleep movements' (circadian rhythms), increased or decreased number of stomata, and fewer bundles in their leaf stalks, compared to the original varieties.

Studies on the influential factors in radiation breeding. Including mutations in organisms through radiation is a complex procedure. The research done on this aspect in China is summarized here:

- Materials for treatment: Studies show that sensitivity to radiation as well as the variability spectrum is different for different varieties and for different growth stages of a particular variety. When wet seeds and germinating seeds were treated with 8 kr gamma rays at SPRI, variation for pigmentation and sterility was seen in the former, but not in the latter. When plants in the seedling and pod-filling stages were treated with 3 kr gamma rays, the variation rate for morphological characters was 9.4% in the former and 20% in the latter.
- Mutagenic agents and treatment methods: Mutagenic agents, doses, treatment methods, environmental conditions, and other factors greatly affect mutagenic efficiency. When dry groundnut seeds were treated with 5×10 cm^{-2} fast neutrons, the total variation for morphological characters in the M_2–M_5 generations reached 4.95%. When dry seeds of the same variety were treated with 16 kr x-rays, the total variation observed was only 0.88%. Dry seeds of groundnut variety Fuhuasheng treated with five different doses (7–24 kr) of gamma rays showed that increased dosage led to greater variation in morphological characters, maturity duration, and pigment variation. The variation rate in the M_2 generation was 22.2% in seeds treated once with 3 kr and 14.3% in seeds treated with 0.3 kr day^{-1} for 10 days. The effect of environmental factors (temperature, moisture, etc.) on variation was also great.
- Experiments on storage after irradiation: In order to compare the effects of the storage period after irradiation on variability, seeds treated with 25 kr gamma rays were stored for 22, 52, and 82 days (d). The variation was found to be highest in the case of 52 d, followed by 82 d, and 22 d, in that order.
- Studies on inheritance of mutant characters: A great diversity for various characters was induced with radiation. The rate of occurrence of homozygous dominant mutants with stable inheritance was higher in the M_2 generation than in M_3. However, the number of mutants was greater in M_3 than in M_2.

Prospects

With the knowledge gained about various mutagens and mutagenic rates, mutation breeding in groundnut could be gradually developed and perfected. The thrust of future research should be on:

- strengthening the studies on the mechanism of inducing mutations;
- increasing the number of mutagenic agents and the usage of combined application of various agents;
- application of mutation breeding in conjunction with conventional and biotechnological methods; and
- creation of better mutants possessing multiple resistances, which could be utilized indirectly in breeding programs.

Research Reports

Development of Dormant Bunch Groundnut (*Arachis hypogaea* L. subsp *fastigiata*) Genotypes

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Lack of seed dormancy in the bunch types is one of the major problems limiting groundnut productivity in Argentina, India, Indonesia, and Zimbabwe (Cummins and Jackson 1982). Dormancy can be induced by foliar application of maleic hydrazide (Nagarjun and Reddar 1983). However, the dormancy so induced remains for only a short period, is unstable, and, for the resource-limited farmers of the semi-arid tropics, is an unwelcome expense. Hence evolving bunch groundnut varieties with genetically built-in dormancy is desirable. This paper reports on some dormant bunch types bred at the Regional Research Station, Vriddhachalam, Tamil Nadu, India.

Crosses were made using the high-yielding but nondormant spanish bunch groundnut types as pistillate parents and Robut 33-1 (a virginia bunch type with a dormancy period of 35 days) and TG 19A (a spanish bunch type with 20 days dormancy) as pollen parents. The pedigree method of breeding was adopted. All the stable varieties with the bunch growth habit derived from these crosses were selected for dormancy screening during the 1991 rainy season. Before shelling, fresh pods collected from such varieties were shade-dried for 6–7 days until the moisture content was reduced to 8–10%. Sound, mature kernels were tested for germination. Two sets of 10 seeds of each culture were placed in petri dishes with filter paper, and water was added up to a depth of 2 mm. To one set, 0.05% (v/v) aqueous etherel solution was added to break dormancy so as to act as a check for seed viability (Wadia et al. 1987). The temperature was maintained at 27°±3°C and counts were made 2 days after hydration. The lines which showed more than 70% germination were discarded as they lacked dormancy. Cultures which did not germinate upon hydration but did so upon etherel treatment were inferred to possess dormancy. Regular germination tests were conducted at 5-day intervals to assess the dormancy period.

The experiment was repeated during the 1992 rainy season with 3 sets of 20 seeds each. One sample was treated with etherel and the other two samples served as replicates. From these studies, 16 dormant bunch groundnut types were identified (Table 1). The yield potential of these lines is being assessed.

Table 1. Dormant bunch groundnut varieties identified at Vriddhachalam, Tamil Nadu, India, rainy season 1991–92.

Culture	Parentage	Number of days of dormancy
VG (DB) 9202	BPG 521 × Robut 33-1	15
VG (DB) 9203	BPG 521 × Robut 33-1	25
VG (DB) 9204	BPG 521 × Robut 33-1	30
VG (DB) 9205	Co 2 × Robut 33-1	25
2001-86-1-1	Gangapuri × Robut 33-1	15
2002-110-2-2	BPG 521 × Robut 33-1	30
2002-145-2-1	BPG 521 × Robut 33-1	30
2002-133-1-3	BPG 521 × Robut 33-1	30
2002-126-1-1	BPG 521 × Robut 33-1	30
2003-133-1-4	VRI 2 × Robut 33-1	20
X9-21-1[1]	TG (E)2 × TG 19A	15
X31-2-1[1]	TG 19A × ICGV 86571	30
X36-21-1[1]	(VRI 1 × TG 19A) × TG 19A	30
X38-10-1[1]	(JL 24 × TG 19A) × TG 19A	15
X38-10-1B[1]	(JL 24 × TG 19A) × TG 19A	30
X38-10-2B[1]	(JL 24 × TG 19A) × TG 19A	25

1. Derived from crosses made for the Ph.D. work of the senior author.

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Germplasm Enhancement for Seed-quality Traits in Groundnut

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Groundnuts with large seed mass, uniform seed size and shape, and high oleic/linoleic acid (O/L) ratio are generally preferred for confectionery use. The O/L ratio determines the shelf life of the seed-product; the higher the ratio the longer the shelf life. Large genetic variation for 100-seed mass (17–132 g) has been observed among the 12160 germplasm accessions maintained at ICRISAT, Hyderabad, India. Except for the high O/L ratio lines from Florida (Norden et al. 1987), the genetic variability for O/L ratio in the available germplasm is narrow (1–3).

Germplasm enhancement for seed quality is an important breeding activity at ICRISAT. This paper reports on yield and seed-quality traits of the newly developed confectionery breeding lines in relation to their parental germplasm lines.

Twenty-two F_2 populations derived from various crosses (ICGV 86015 with ICGs 5721, 5983, 7878, and 8325; ICG 6427 with ICGs 5983, 5984, 7878, and 8325; CGC 6 with ICGs 5984, 7878, and 11193; ICGV 87124 with ICGs 5721 and 11193; ICG 7360 with ICGs 2379, 3043, 5984, 6150, and ICGV 86564; ICG 4906 with ICG 2379 and ICGV 86564; and ICGV 86564 with CS 22 and ICG 6150) were advanced to the F_6 generation following the bulk pedigree method. The main selection criteria were high pod yield, and large, uniform pod and seed size. The selected breeding lines were assigned ICGV (ICRISAT Groundnut Variety) numbers. Forty-six phenotypically uniform varieties, derived from these crosses, along with their parental germplasm lines, were compared for yield and seed-quality characteristics during two postrainy seasons (1990/91 and 1991/92) at ICRISAT. The performance of the selected germplasm and varieties are presented in Table 1. Seven varieties (ICGVs 90298, 90301, 90307, 90308, 90310, 90312, and 90324) produced mean pod yields of well over 3 t ha^{-1}, yielding more than their parental germplasm lines by 11 to 110%. They also had greater 100-seed masses, and their O/L ratios were either of a similar level or better than that of the parental lines. The variety ICGV 90307 produced the highest pod yield of 3.89 t ha^{-1}. It is a sequentially branching variety which has a large 100-seed mass (82 g) and a better O/L ratio (1.58). Four other varieties, ICGVs 90295, 90309, 90322, and 90326, showed 23 to 73% greater 100-seed mass and 14 to 83% greater O/L ratio than their parental lines. They also produced mean pod yields ranging from 2.54 to 3.18 t ha^{-1}, ICGV 90326 being the highest-yielding variety in this group.

Our earlier studies had shown significant positive heterotic effects over the better parent for pods plant^{-1} and pod mass plant^{-1} in crosses ICG 7360 × ICG 2379, ICG 7360 × ICG 3043, ICG 7360 × ICGV 86564, and ICG 6150 × ICGV 86564 (Dwivedi et al. 1989). Further studies involving line × tester crosses also revealed significant positive heterotic effects over the better parent for pods plant^{-1} and pod mass plant^{-1} in crosses CGC 6 × ICG 11193, CGC 6 × ICG 5984, ICGV 87124 × ICG 5721, ICG 7360 × ICG 5984, and ICG 6427 × ICG 5984 (S.L. Dwivedi, personal communication). Significant positive as well as negative heterotic effects over the better parent for pod length/breadth, seed length/breadth, and 100-seed mass were observed in several crosses. Pods plant^{-1} and pod mass plant^{-1} in both the studies were controlled by nonadditive genetic variances whereas pod and seed characters, as described above, were predominantly controlled by additive genetic variance (Dwivedi et al. 1989). The superiority of these varieties over their parental lines is probably due to the fixation of these heterotic effects in the later-generation progenies of these crosses. Further studies are planned to understand the physiological basis of yield and seed-quality differences among these varieties vis-a-vis their parental germplasm lines.

These varieties may be used as improved confectionery germplasm in breeding programs or released as cultivars, if found to be suitable after evaluation

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Table 1. Performance of improved groundnut varieties in relation to their parental germplasm lines, ICRISAT Asia Center, postrainy seasons 1990/91–1991/92.

		Pod yield (t ha^{-1})			100-seed mass (g)			O/L ratio		
Genotype	Pedigree	1990/91	1991/92	Mean	1990/91	1991/92	Mean	1990/91	1991/92	Mean
Varieties that showed superiority in pod yield over parental germplasm lines										
ICGV 90298	CGC 6 × ICG 11193	4.59	1.97	3.28	89	67	78	1.61	1.53	1.57
ICGV 90301	CGC 6 × ICG 5984	4.37	2.17	3.27	99	82	91	1.53	1.31	1.42
ICGV 90307	ICGV 87124 × ICG 5721	5.27	2.50	3.89	85	79	82	1.70	1.45	1.58
ICGV 90308	ICG 7360 × ICG 5984	4.34	2.03	3.18	93	79	86	1.49	1.37	1.43
ICGV 90310	ICG 7360 × ICG 3043	4.58	2.21	3.40	93	73	83	1.78	1.68	1.73
ICGV 90312	ICG 7360 × ICGV 86564	3.72	2.77	3.24	100	101	100	1.32	1.38	1.35
ICGV 90324	ICG 6150 × ICGV 86564	4.98	2.19	3.59	114	77	96	1.77	1.74	1.75
Varieties that showed superiority in 100-seed mass and O/L ratio over parental germplasm lines										
ICGV 90295	ICG 6427 × ICG 5984	3.81	1.27	2.54	108	79	93	1.80	1.38	1.59
ICGV 90309	ICG 7360 × ICG 3043	3.80	1.81	2.80	103	75	89	1.44	1.44	1.44
ICGV 90322	ICG 7360 × ICG 6150	4.06	2.07	3.07	111	94	102	1.77	1.72	1.74
ICGV 90326	ICG 7360 × ICG 2379	4.22	2.15	3.18	90	81	85	1.64	1.64	1.64
Control (parents)										
ICG 11193		2.21	0.96	1.56	80	61	71	1.49	1.45	1.47
ICG 5984		3.02	1.64	2.33	78	72	75	1.39	1.35	1.37
ICG 5721		3.12	1.59	2.36	77	71	74	1.45	1.38	1.42
ICG 7360		3.03	1.89	2.46	57	62	59	1.22	1.15	1.18
ICG 3043		3.60	1.48	2.54	84	60	72	1.41	1.28	1.35
ICG 6150		3.65	2.56	3.10	78	68	73	0.94	0.96	0.95
ICG 6427		3.98	2.37	3.17	76	69	73	0.94	0.96	0.95
ICG 2379		4.46	2.15	3.31	81	57	69	1.49	1.38	1.44
ICGV 87124		4.42	2.31	3.36	63	69	66	1.46	1.38	1.42
ICGV 86564		4.00	1.93	2.96	122	88	105	1.66	1.59	1.63
CGC 6		4.10	1.79	2.95	84	66	75	1.72	1.49	1.61
SE		±0.204	±0.245		± 3.76	± 4.37		±0.056	±0.103	
CV (%)		9	21		8	11		7	13	

Performance of Introduced Early- and Late-maturing Groundnut Varieties at Samaru, Nigeria

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Groundnut rosette is the most devastating disease in Nigeria. Therefore, breeding for earliness and resistance to groundnut rosette are important objectives of the Institute for Agricultural Research (IAR), Samaru, Nigeria. A combination of these two traits is most desirable for the Sudan Savannah agroecological zone where the period of rainfall ranges from 75 to 145 days.

In general, parents of diverse origin give better segregants or at least increase the likelihood of producing desirable new recombinants. As a first step towards utilization of exotic varieties as parents, we evaluated three new varieties for their agronomic characters. This paper describes the evaluation of these varieties at Samaru.

To broaden the genetic base of our breeding program, we obtained two early-maturing pure lines [JL 24 and ICG(E)S 56] and one late-maturing rosette-resistant line (RG 1) from ICRISAT (Malawi). These were evaluated along with the IAR-released early-maturing lines SAMNUT 18 and SAMNUT 14, and the late-maturing rosette-resistant line SAMNUT 10 during the rainy seasons of 1989–91 at Samaru. Yield and quality characteristics were determined during the rainy and postrainy seasons.

The early-maturing introductions were comparable to the adapted early-maturing lines in shelling percentage and oil content. However, in terms of pod yield and 100-seed mass, the introductions were superior to the adapted lines (Table 1). Even though there were no significant differences between the varieties in terms of oil content, ICG(E)S 56 performed the best in terms of all characters except protein content, which was significantly lower than in all other varieties. Also of importance was the difference in seed size (100-seed mass). The introductions had larger seeds than the adapted lines.

The late-maturing rosette-resistant introduction RG 1 performed poorly in all yield parameters but in terms of quality it was comparable to the adapted resistant line SAMNUT 10. Its resistance to rosette equals that of SAMNUT 10. Therefore, for this trait it is worth keeping for breeding purposes.

All three introductions have been included in our breeding program: RG 1 as a source of resistance to groundnut rosette; ICG(E)S 56 and JL 24 for their yield and seed-size traits; and, in addition, the former for high oil content and the latter for high protein content. All possible crosses have been made using these parents. The resultant progenies showing resistance to rosette and earliness are now in yield trials.

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Table 1. Performance of six groundnut varieties in an optimum and disease-free environment at IAR, Samaru, Nigeria, 1989–91.

Variety	Maturity type	Pod yield ($t\ ha^{-1}$)		Shelling (%)		100-seed mass (g)		Oil content[1] (%)	Protein content[1] (%)
		1989/90	1990/91	1989/90	1990/91	1989/90	1990/91	1990/91	1990/91
SAMNUT 10	Late	3.37	5.43	71.25	73.00	60.50	50.00	52.01	23.63
RG 1	Late	2.55	4.13	62.00	66.75	55.75	45.25	52.61	24.36
SAMNUT 14	Early	2.43	3.35	67.50	71.00	36.75	32.75	51.49	22.60
SAMNUT 18	Early	2.05	3.46	67.50	69.25	36.75	34.75	51.27	23.02
ICG(E)S 56	Early	2.80	3.94	57.50	64.25	43.75	40.75	53.50	19.66
JL 24	Early	2.21	3.74	67.50	67.00	41.50	38.75	50.49	25.00
Grand mean		2.57	4.01	65.54	68.54	45.83	40.38	51.89	23.04
SE		±0.607[2]		±3.39[2]		±3.82[2]		±1.58	±1.24
CV (%)		18.5[2]		5.0[2]		8.9[2]		3.0	5.4

1. Oil and protein content were not estimated in 1989/90.
2. Pooled analysis of two years' data.

Influence of Different Packages of Practices and Varieties on Groundnut Yields

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To study the influence of different packages of practices and varieties on groundnut yields, three field experiments were conducted during the postrainy seasons [rabi (winter) and summer (hot weather)] of 1988/89 and the rainy seasons of 1989/90 at Parbhani (19° 16′N and 76° 47′E and 409 m above sea level), Maharashtra, India, in a clayey, slightly alkaline soil (pH 7.6–7.9) having a low nitrogen, medium phosphorus, and high potash content. The experiments were laid out in a factorial randomized-block design with 3 replications. The treatments included two packages of practices (P_1 = practices recommended by ICRISAT, India, and P_2 = practices recommended by the Department of Agriculture, Pune, Maharashtra, India) and four varieties of groundnut (ICGS 11, ICGS 21, ICGS 44, and SB XI). The various field operations and inputs used in the two packages are listed in Table 1.

In P_1, groundnuts were raised on a narrow-bed-and-furrow seedbed of 50 cm width. After every bed, a furrow of 30 cm width and 15 cm depth was opened for letting in irrigation water during the postrainy (rabi/summer) season. Two rows of groundnut were sown in each bed at 30×10 cm spacing. In P_2, the crop was raised in a flat check-basin seedbed at 30×10 cm spacing.

It is evident from the data (Table 2) that the dry pod yields and total oil yields were significantly higher under P_1 than under P_2 in all the three seasons. The groundnut cultivars ICGS 11, ICGS 21, and ICGS 44 proved to be equally good and significantly superior to SB XI, a popular cultivar of Maharashtra in terms of dry pod yields and total oil yields in all the three seasons. However, neither the packages of practices nor the genotypes tested significantly influenced dry haulm yield ha^{-1} except in the rainy season when the P_1 package of practices produced a significantly higher haulm yield than the P_2 package.

These experiments clearly suggest that the package of practices recommended for groundnut cultivation by ICRISAT and the groundnut genotypes evolved at ICRISAT, i.e., ICGS 11, ICGS 21, and ICGS 44, are superior in the Parbhani area when compared with the recommended package of practices and standard cv SB XI of the Department of Agriculture, Maharashtra.

Table 1. Field operations and inputs used in the packages of practices recommended by ICRISAT and the Department of Agriculture, Maharashtra, India.

Field operations/inputs	ICRISAT package of practices (P_1)	Department of Agriculture package of practices (P_2)
Preparatory tillage	2 plowings, 2 harrowings, clod crushing and stubble collection	Similar to P_1
Seedbed	2-row narrow-bed-and-furrow system	Flatbed (check-basin)-and-furrow system
Basal dose of manure and fertilizer ha^{-1}		
Farmyard manure	10 t	10 t
Single superphosphate	500 kg	-
Ammonium sulfate	25 kg	-
Zinc sulfate	10 kg	-
Diammonium phosphate	-	100 kg
Top dressing/foliar application		
Ferrous sulfate 2.5 kg + urea 5 kg in 500 L water	Applied twice, 30 and 50 days after emergence	-
Gypsum @ 400 kg ha^{-1} at flowering	Applied	-
Sowing		
Method of sowing and spacing	Hand dibbling at 30×10 cm	Similar to P_1

Continued ....

Table 1. *Continued ....*

Field operations/inputs	ICRISAT package of practices (P_1)	Department of Agriculture package of practices (P_2)
Seed rate	100–105 kg ha^{-1}	125–130 kg ha^{-1}
Seed treatment	Thiram @ 3 g kg^{-1} seed	Thiram @ 5 g kg^{-1} seed
Seed inoculation with *Rhizobium*	-	*Rhizobium* 250 g 10 kg^{-1} seed
Aftercare		
Herbicide pendimethalin (Stomp®) (preemergence)	3.5 L ha^{-1}	
Gap filling	Once	Once
Weeding	Once	Twice
Light earthing-up	-	Once
Uprooting big weeds	Once	Once
Interculture	Deepening of furrows thrice	Hoeing twice
Plant protection		
Dimethoate	660 mL ha^{-1} $spray^{-1}$, twice in rainy season and once in rabi and summer seasons	500 mL ha^{-1} $spray^{-1}$, twice in rainy season and once in rabi and summer seasons
Monocrotophos	1 L ha^{-1}, one spray in rainy, rabi, and summer seasons	0.7 L ha^{-1}, one spray in rainy, rabi, and summer seasons
Mancozeb	1 kg ha^{-1}, two sprays in rainy season	1 kg ha^{-1}, two sprays in rainy season
Carbendazim	250 g ha^{-1}, one spray in rainy and rabi seasons	250 g ha^{-1}, one spray in rainy and rabi seasons
Carbendazim + tridemorph	250 g + 350 mL ha^{-1}, one spray in rainy and rabi seasons	Similar to P_1
Irrigations (no.)	8 in rabi, 13 in summer	8 in rabi, 13 in summer
Harvesting	By pulling the plants	By pulling the plants
Stripping, drying, cleaning the pods, and storing	By manual labor	By manual labor

Table 2. Dry pod yield, dry haulm yield, and total oil yield of groundnuts grown at Parbhani, Maharashtra, India, during rainy, rabi, and summer seasons 1988/89–1989/90.

	Dry pod yield (t ha^{-1})			Dry haulm yield (t ha^{-1})			Total oil yield (t ha^{-1})		
Treatment	Rainy	Rabi	Summer	Rainy	Rabi	Summer	Rainy	Rabi	Summer
Package of practices[1] (P)									
P_1	1.58	3.67	4.60	2.59	4.39	5.48	0.511	1.295	1.628
P_2	1.25	2.76	3.49	2.10	3.96	4.99	0.376	0.917	1.174
SE	±0.072	±0.090	±0.144	±0.078	±0.166	±0.324	±0.211	±0.0439	±0.0555
LSD (P=0.05)	0.218	0.274	0.436	0.238	NS[2]	NS	0.0640	0.0133	0.0168
Variety (V)									
ICGS 11	1.54	3.50	4.64	2.51	4.48	5.74	0.487	1.193	1.595

Continued ....

Table 2. *Continued ....*

Treatment	Dry pod yield (t ha^{-1})			Dry haulm yield (t ha^{-1})			Total oil yield (t ha^{-1})		
	Rainy	Rabi	Summer	Rainy	Rabi	Summer	Rainy	Rabi	Summer
ICGS 21	1.41	3.39	4.15	2.36	4.11	5.26	0.443	1.140	1.405
ICGS 44	1.62	3.76	4.52	2.68	4.51	5.39	0.509	1.306	1.566
SB XI	1.07	2.21	2.87	1.82	3.61	4.56	0.337	0.788	1.037
SE	±0.101	±0.128	±0.203	±0.111	±0.234	±0.459	±0.029	±0.062	±0.078
Trial mean	1.41	3.21	4.04	2.34	4.18	5.24	0.444	1.107	1.401
LSD (P=0.05)	0.308	0.387	0.616	0.337	NS	NS	0.090	0.188	0.238
P × V interaction									
SE	±0.143	±0.181	±0.287	±0.157	±0.331	±0.649	±0.042	±0.088	±0.111
LSD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS

1. P_1 = Practices recommended by ICRISAT; P_2 = Practices recommended by the Department of Agriculture, Maharashtra, India.
2. NS = Nonsignificant.

The study also indicated that groundnut cultivation in the summer season is most beneficial followed by the rabi-season crop (a nontraditional practice). However, its cultivation in the rainy season does not seem to be encouraging, particularly under assured rainfall (>800 mm per annum) with heavy soil conditions.

Oil, Protein, Yield, and Seed Characters of Some Groundnut Cultivars Grown in Rice Fallows in Orissa, India

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Groundnut cultivation in the summer season in rice fallows is gaining popularity in Orissa state of India because the crop requires less water. The average productivity of the summer crop (1787 kg ha^{-1}) is superior to that of the rainy-season crop (1170 kg ha^{-1}) in Orissa. It is grown as a component crop in rice-based cropping systems. Among oilseed crops, groundnut occupies a prime position in terms of acreage and production in India (Paul et al. 1985). Deoiled groundnut cakes are utilized as organic fertilizer and cattle feed. Its high oil and protein content, its ability to withstand water-deficit conditions, and its remunerative price in the market make it an attractive crop to farmers.

There is a need to identify suitable groundnut varieties which can produce a larger amount of oil and protein along with higher pod yields. Therefore, an experiment was conducted at the Central Rice Research Institute, Cuttack, Orissa, in an alluvial (Inceptisol), sandy loam soil (pH 6.5, organic carbon 0.5%, total N 0.06%, available P 14 kg ha^{-1}, and exchangeable K 0.88 meq 100 g^{-1} soil). Fifteen varieties (Table 1) including a local variety AK 12-24 (control) were evaluated in a randomized-block design with three replications. The crop was sown on 25 Jan 1991 in rows spaced at 30 × 10 cm. A fertilizer dose of 20 kg N and 40 kg each of P_2O_5 and K_2O ha^{-1} was applied to the crop. The crop was irrigated six times during its growth period. Interculture, supplemented with hand weeding, was given twice at 15 and 30 days after germination. The crop was adequately protected against insect pests by spraying methyl-parathion (Metacid® 50 EC) @ 0.5 kg a.i. ha^{-1} two times.

Data on pod yield, 100-seed mass, length, breadth, and thickness of seeds (mean of 10 seeds) were recorded. Good and healthy seeds were selected for the estimation of oil and protein content. Oil content was determined by the Soxhlet method and the protein content of the deoiled cake was determined by estimating the N content by the Microkjeldahl method and multiplying it by a factor of 6.25.

All the groundnut varieties tested matured in 102–109 days. Among these, R 8808 was the most promising with a pod yield of 3.12 t ha^{-1} (Table 1) followed by DRG 12

Table 1. Pod yield and quality characters of 15 promising groundnut varieties grown in rice fallows, Cuttack, Orissa, India, 1991.

Variety	Maturity (d)	Pod yield (t ha^{-1})	Shelling (%)	100-seed mass (g)	Seed dimension (mm)[1] Length	Breadth	Thickness	Oil (%)	Protein in deoiled cake (%)
DRG 12	108	2.91	69.4	53.3	11.0	6.8	4.8	52.7	41.7
ICGV 87125	104	2.62	68.0	68.2	15.8	8.0	5.2	49.6	37.8
ICGV 86252	106	2.69	64.5	41.8	11.8	6.5	5.0	51.8	40.0
ICGV 86938	103	2.12	66.5	42.3	13.8	6.5	5.0	51.0	40.9
ICGV 87281	102	2.86	67.0	43.1	10.3	5.9	4.8	47.4	46.3
ICGV 86885	103	2.76	70.4	46.3	13.4	7.2	5.7	51.7	41.7
ICGS 11	104	2.69	68.0	59.5	11.9	7.0	4.9	53.5	43.4
JL 24	108	2.42	68.3	50.9	12.4	6.4	4.5	50.3	41.5
J(E) 2	106	2.46	64.6	49.7	14.7	8.1	5.7	46.2	43.5
R 8808	106	3.12	68.6	60.7	14.8	7.9	5.9	50.4	48.8
R 9021	105	2.80	65.9	49.0	9.7	6.4	4.8	53.3	42.5
RSHY 1	107	2.24	68.5	40.0	11.5	6.5	5.4	52.7	43.4
SLG 8913	105	1.49	65.4	59.8	14.7	8.5	4.9	36.3	42.4
ALG 50	103	2.07	66.7	47.6	13.5	6.8	5.4	52.1	46.5
AK 12-24 (Control)	109	2.12	63.6	48.9	15.4	8.2	6.4	43.6	42.1
LSD ($P = 0.05$)		0.25	NS[2]	1.9	2.3	1.5	0.4	2.4	0.9

1. Mean of 10 seeds.
2. NS = Not significant.

(2.91 t ha^{-1}). R 8808 produced a 47.2% higher pod yield and DRG 12 produced a 37.3% higher yield than the local control, AK 12-24. Shelling percentage was the highest in ICGV 86885 (70.4%) followed by DRG 12 (69.4%) and R 8808 (68.6%). The oil content in 10 of the varieties was more than 50%. The highest oil content was observed in ICGS 11 (53.5%). The protein content of the deoiled cake in six varieties, R 8808, ALG 50, ICGV 87281, J(E) 2, ICGS 11, and RSHY 1 was significantly higher than that of AK 12-24. Protein content was the highest in R 8808 which was also the highest-yielding variety.

Correlation studies indicated significant positive correlation between pod yield and oil content ('r'= 0.577), 100-seed mass and length of seeds ('r' = 0.549), 100-seed mass and breadth of seeds ('r' = 0.636), thickness and breadth of seeds ('r' = 0.535), and significant negative correlation between breadth of seeds and oil content ('r' = -0.653). Shelling percentage was not significantly correlated with any character studied.

This study reveals that the cultivars R 8808 and DRG 12 were promising with higher pod yields and with moderate to good quality characters. As regards ICGS 11, it is a moderate yielder with an excellent oil and protein content. These three varieties are suitable to serve as component crops in rice fallows in rice-based cropping systems.

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Seed-hull Ratio and Shelling Percentage as Indicators of Groundnut Maturity

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The indeterminate flowering nature of groundnut results in the simultaneous presence, on the same plant, of fruits at different stages of maturity at harvest. Decisions regarding when to harvest the crop need to be based on a measure of pod maturity. Several methods to assess maturity in groundnut have been developed, and the literature on the subject has been reviewed by Sanders et al. (1982). The purpose of this paper is to draw attention to shelling percentage as a maturity indicator, and to show how it is related to the more popular seed-hull ratio method.

The seed-hull maturity index (SHMI). The seed-hull ratio as an index of groundnut maturity was first proposed by Pattee et al. (1977), and is obtained by dividing the mass of the seed by the mass of the hull (shells). The ratio may be determined on the basis of fresh as well as dry mass. The dry-mass ratio was found to be less variable and was adopted in later studies under the abbreviated form SHMI (Pattee et al. 1980).

Shelling percentage. Shelling percentage is the proportion of the mass of the seeds in a given mass of pods. It is usually measured on the basis of dry mass. Shelling percentage is an important attribute in the evaluation of varieties and in trade transactions which involve unshelled groundnut.

Troeger et al. (1976) were apparently the first to use the seed-pod ratio as a maturity indicator for individual pods. There are, however, no published studies known to this writer in which shelling percentage was investigated as an aid in judging crop maturity.

Mathematical relations. The following relations hold for various pod and seed parameters:

$$\begin{aligned}\text{Seed-pod ratio (SPR)} &= \text{Seed mass (S)/Pod mass (P)}\\ &= S/P{-}S \times (P/P{-}S)^{-1}\\ &= \text{Seed-hull ratio (SHR)/}\\ &\quad\ \text{Pod-hull ratio (PHR)} \qquad (1)\\ \text{PHR} &= P/P{-}S\\ &= 1 + S/P{-}S\\ &= 1 + \text{SHR} \qquad (2)\end{aligned}$$

Substituting (2) in (1), we get

$$\text{SPR} = \text{SHR}/(1 + \text{SHR}) \qquad (3)$$

Multiplying both sides by 100, equation (3) can be restated as:

Shelling percentage = 100 [seed-hull ratio/(1 + seed-hull ratio)]

Similarly:

$$\text{Hull-pod ratio (HPR)} = 1-\text{SPR} \qquad (4)$$

and,

$$\begin{aligned}\text{SHR} &= S/P{-}S\\ &= S/P \times (P{-}S/P)^{-1}\\ &= \text{SPR/HPR} \qquad (5)\end{aligned}$$

Substituting (4) in (5), we get

$$\text{SHR} = \text{SPR}/(1-\text{SPR}) \qquad (6)$$

Multiplying and dividing the right hand side by 100, equation (6) can be written as:

Seed-hull ratio = shelling percentage/(100−shelling percentage)

Conclusion

It is thus evident that shelling percentage could also be used as an index of maturity in addition to seed-hull ratio. Nonetheless, in the review of maturity methodology by Sanders et al. (1982) there was no mention of shelling percentage or seed-pod ratio as maturity indicators.

Pattee et al. (1977) stated that the seed-hull ratio method is based on the changing seed-hull mass ratio during maturation of the fruit. A similar statement could be made for the seed-pod ratio. Besides, shelling percentage has the appeal of being economically and conceptually meaningful.

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Screening of Spanish Groundnut Cultivars for Germination under Simulated Drought Stress

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Groundnut crops grown in rainfed conditions in India are often affected by drought. The rainfall pattern of the past 26 years at Junagadh, Gujarat, India, indicates that drought occurs mostly during the pod-filling stage (44% of the years) and during the early germination and vegetative phases (40%). The occurrence of drought immediately after sowing may affect plant stand adversely and, consequently, pod yield. It was, therefore, considered necessary to screen groundnut cultivars for tolerance to drought during the germination and early seedling stages.

The postrainy-season produce of 30 spanish cultivars was kept in cotton bags and stored in a GI sheet box in the laboratory under ambient conditions (temperature 29–30°C, RH 82.3–96.4%). Two months after storage, the pods were shelled and the seeds treated with thiram @ 2.5 g kg^{-1} prior to the germination test. Polyethylene glycol (PEG) solutions of concentrations −0.3 MPa (T_2), −0.75 MPa (T_3), and −1.0 MPa (T_4) were prepared according to Slavik (1974) and used for simulating drought conditions. Ten seeds of each cultivar were germinated in petri dishes lined with Whatman® no.1 filter paper in an incubator at 28° ± 2°C. The filter paper was soaked in 10 mL of the PEG solution prior to the placement of the seeds. Double-distilled water was used as control (T_1). To account for any change in the concentration of the PEG solution, the solutions were changed at two-day intervals. The treatments were replicated four times and laid out in a complete RBD inside the incubator.

Observations on germination were taken six days after incubation. Seeds that produced a radicle longer than 2 mm were considered as germinated. The length of the root and hypocotyl were measured to calculate the seedling vigor index (SVI) as per the following equation:

SVI = root length + hypocotyl length × germination percentage

The mean effects of different PEG concentrations on the germination percentage and seedling vigor are given in Table 1. The genotypes which exhibited a germination percentage greater than the average in T_3 were identified as having a moderate ability to germinate under low moisture availability. Genotypes having a germination percentage greater than the average plus least significant difference (LSD) in T_4 were identified as having a high ability to germinate under low moisture availability.

The germination percentage of the groundnut cultivars ranged from 69 to 100 in T_1, 72 to 98 in T_2, 46 to 98 in T_3, and 20 to 92 in T_4 (Table 2). Results indicated that on an average there was no effect of T_2 (−0.3 MPa) on the germination of seeds but it did adversely affect the root + hypocotyl length and thereby lowered the SVI. However, in the case of both T_3 and T_4, the lower SVI values were due to the combined adverse effect of both germination percentage and the root + hypocotyl length. Wide genotypic differences were seen for germination and SVI in the T_4 treatment. Thirteen genotypes, i.e., TG 17, TG 3, DH 3-30, CO 1, S 206, VRI 2, JL 24, GAUG 1, ICGS 11, ICGS 44, TMV 2, Kisan, and ICG 45, were identified as having a moderate ability to germinate while 6 genotypes, i.e., TAG 24, Girnar 1, J 11, RSHY 1, KRG 1, and Jyoti, were identified as having a high ability to germinate under low moisture conditions.

It is concluded that a reduction in the moisture level shows its adverse effect first on the rate of growth of the root and hypocotyl rather than germinability *per se*. Further lowering of the moisture level, however, affects both germinability and root and hypocotyl growth. The wide genotypic variations in germinability and SVI suggest a scope for improvement through conventional breeding. Cultivars TAG 24, J 11, Girnar 1, RSHY 1, KRG 1, and Jyoti could be used profitably in areas where drought occurs during the germination stage of the crop.

Table 1. Effect of different moisture levels (PEG concentrations) on germination and seedling vigor of spanish varieties of groundnut[1].

Treatment[2]	Germination (%)	Root + hypocotyl length (cm)	Seedling vigor index
T_1 (Control)	92.41	10.66	985
T_2	92.11	5.88	544
T_3	86.07	4.43	386
T_4	56.30	1.10	71
SEm	±1.53	±0.27	±25.65
LSD (P=0.05)	2.99	0.54	50.28

1. Based on mean values of 30 spanish groundnut varieties.
2. T_1 = seeds germinated with distilled water (control); T_2 = seeds germinated with −0.3 MPa of PEG solution; T_3 = seeds germinated with −0.75 MPa of PEG solution; and T_4 = seeds germinated with −1.0 MPa of PEG solution.

Table 2. Genotypic variation in germination and seedling vigor of spanish varieties of groundnut in response to drought conditions simulated with different concentrations of polyethylene glycol (PEG).

Variety	Germination (%)				Seedling vigor index			
	T_1[1]	T_2	T_3	T_4	T_1	T_2	T_3	T_4
J 11	89	95	94	80	1156	396	310	125
TG 17	97	94	96	63	840	276	320	70
RSHY 1	98	83	97	76	1029	373	373	125
TG 3	97	92	94	70	746	352	263	59
DH 3-30	98	98	96	37	885	259	390	55
CO 1	95	94	93	58	1104	455	493	87
S 206	82	94	96	56	830	499	520	82
Spanish improved	95	95	81	57	1418	1140	459	43
Pollachi 2	95	98	82	52	1260	728	396	122
Girnar 1	98	82	92	88	667	451	588	171
VRI 2	70	94	96	62	810	305	481	66
TAG 24	100	96	98	92	833	706	414	209
Jawan	93	92	81	52	885	477	229	17
TMV 7	98	96	67	72	1158	834	216	93
Akola selection	96	96	46	20	1295	589	84	28
AK 12-24	98	95	62	70	1118	822	320	75
JL 24	98	93	92	50	905	532	613	36
GAUG 1	96	98	96	65	902	586	530	121
KRG 1	83	96	94	77	1029	590	331	137
ICGS 11	84	82	93	27	938	227	400	29
Jyoti	98	92	92	72	1078	553	502	119
TMV 2	97	98	95	38	976	459	365	14
ICGS 44	98	98	94	37	1486	474	314	17
DH 8	83	96	46	20	987	499	128	4
VRI 3	95	84	80	28	895	544	495	5
Kisan	96	93	94	55	545	903	452	28
GG 2	71	72	79	45	552	180	510	56
MH 1	98	93	82	58	1153	665	491	57
ICG 45	95	81	94	65	1290	616	327	54
SG 84	69	94	79	48	755	826	272	40
SEm		±8.38				±140.50		
LSD (P=0.05)		16.42				275.37		

1. T_1 = seeds germinated with distilled water (control); T_2 = seeds germinated with –0.3 MPa of PEG solution; T_3 = seeds germinated with –0.75 MPa of PEG solution; and T_4 = seeds germinated with –1.0 MPa of PEG solution.

Reference

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Development of a Greenhouse Screening Technique for Stem Rot Resistance in Groundnut

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An experiment was conducted on seven inoculation methods in a greenhouse at ICRISAT Asia Center to identify an effective inoculation technique to screen groundnuts for resistance to stem rot caused by *Sclerotium rolfsii* Sacc.

The inoculum was multiplied on autoclaved sorghum grains (soaked in water for 24 h) in 1 L conical flasks. It was incubated at 25°C for 10 days. Alfisol and sand (3:1) were filled in plastic pots (diameter 15 cm), and eight surface-sterilized seeds of groundnut cultivar Robut 33-1 were sown in each pot. Each method of inoculation was tested in four pots, each representing one replication. The inoculation methods that were evaluated are listed in Table 1.

Ten-day-old groundnut seedlings were inoculated with 10-day-old inoculum according to each inoculation method. Five seedlings were retained in each pot at the time of inoculation. The inoculum (15 g) was spread on the soil surface in the pots in treatments 1 and 2. Five *S. rolfsii*-infested sorghum grains were kept around the collar region of the plant in treatments 3 and 4. In treatments 5 and 6, 25 g of the inoculum was mixed in 1 kg of soil in which five surface-sterilized seeds were sown. Ten grams of dried groundnut leaves were spread on the soil surface after inoculation in treatments 2, 4, and 6. The plants were irrigated twice a day. This experiment was run twice. The minimum and maximum temperatures inside the greenhouse ranged from 16–18°C to 28–31°C and relative humidity ranged from 40–54.5%.

The plants were observed for 30 days after inoculation for stem rot development. Observations on dead plants were recorded and mortality percentage and days to maximum mortality were calculated (Table 1). The maximum mortality (100%) due to stem rot was observed in treatment 2, in which inoculum was spread on the soil surface and covered with organic matter. So, it is concluded that treatment 2 is the most effective method for screening against *S. rolfsii* under greenhouse conditions.

Table 1. Effect of seven inoculation methods on stem rot development in groundnut under greenhouse conditions, ICRISAT Asia Center.

Treatment number	Inoculation method	Run 1 Mortality (%)		Run 1 Days to mortality	Run 2 Mortality (%)		Run 2 Days to mortality
1	Inoculum spread on the soil surface	81	(65)[1]	30	78	(63)	30
2	Inoculum spread on the soil surface and covered with organic matter	100	(90)	10	100	(90)	10
3	Inoculum placed around the collar region of the plant	72	(58)	30	75	(60)	30
4	Inoculum placed around the collar region of the plant and covered with organic matter	78	(63)	30	81	(65)	30
5	Inoculum mixed in the soil	100[2]	(90)	30	100[2]	(90)	3
6	Inoculum mixed in the soil and covered with organic matter	100[2]	(90)	30	100[2]	(90)	30
7	Control (Noninoculated)	0		30	0		30
	SE	± 2.87	(1.98)	±0.11	± 3.41	(2.4)	±0.10
	CV (%)	7.6	(6.1)	0.8	8.9	(7.3)	0.7
	LSD (at P = 1%)	11.68	(8.04)	0.444	13.87	(9.68)	0.384

1. Figures in parentheses refer to angular transformed values.
2. Preemergence rotting.

Parasitism of Groundnut by *Striga* sp in Mozambique

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Striga spp are root parasites of cereals and legumes. More than 60 species of *Striga* have been reported on different plant hosts. *Striga hermonthica* and *S. ges-*

nerioides have been reported on groundnut (*Arachis hypogaea*) in West Africa (Lagoke 1989, Favi 1989, Camara 1989). In March 1991, a *Striga* sp was observed on local groundnut cultivars Bebiano Encarnado and Bebiano Branco growing in a red sandy soil at Maputo, Mozambique. The soil adjacent to the *Striga* and the host plant was carefully removed and the attachment of *Striga* to the roots of the host plant was observed (Fig. 1). The *Striga* sp had a large haustorium connecting it to the groundnut root. Maize plants in adjacent plots were free of *Striga* infestation. The *Striga* sp, which had pink flowers, appeared to be related to *S. gesnerioides*. However, detailed studies are needed to identify the species. We have not been able to find any record of parasitism of groundnut by any species of *Striga* in Mozambique.

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Figure 1. Attachment of *Striga* to the roots of a groundnut host plant.

About ICRISAT

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