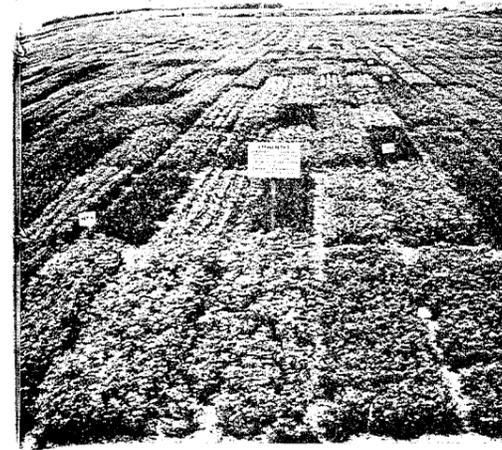


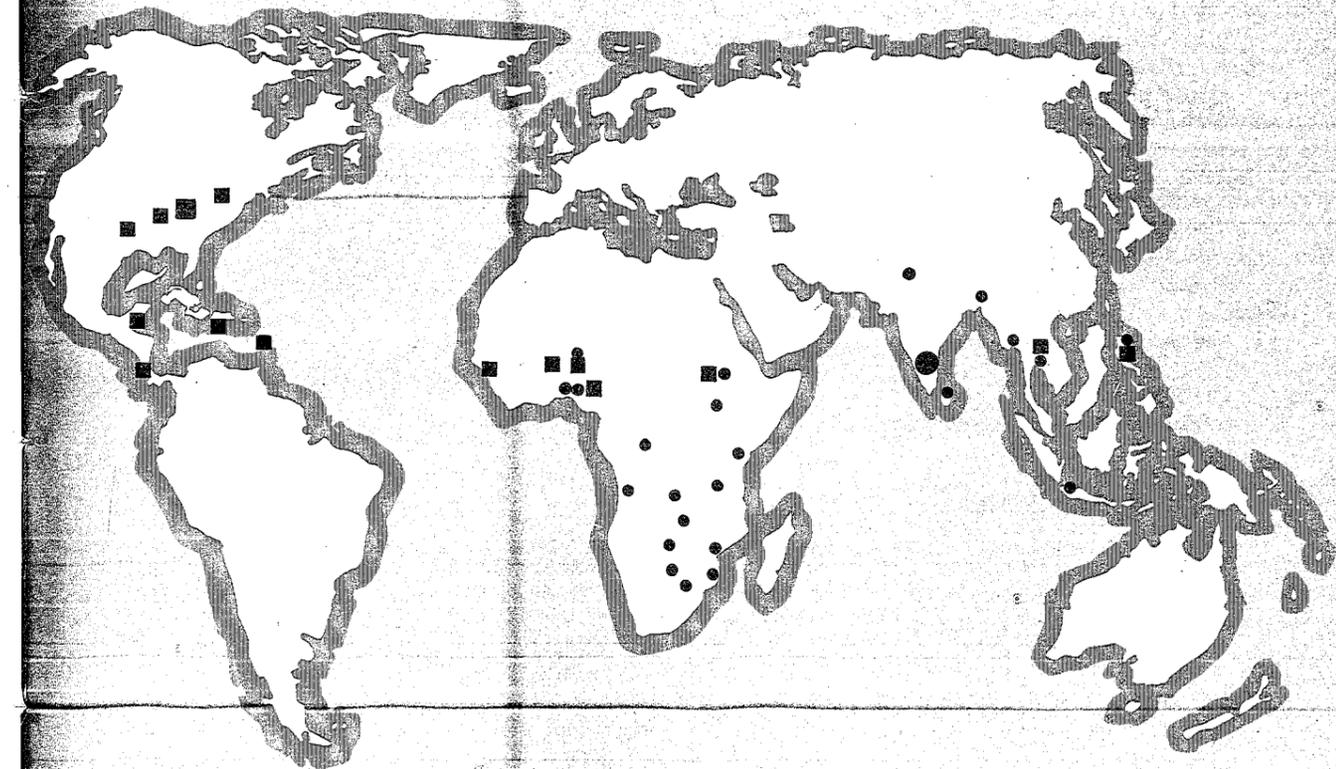
International Arachis Newsletter

Prepared by
LEGUMES PROGRAM, ICRISAT
Patancheru, Andhra Pradesh 502 324, India



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November 88



- ICRISAT Center, Patancheru
- Other ICRISAT Locations
- Peanut CRSP, Georgia
- Other CRSP Locations

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Publishing Objectives

The International Arachis Newsletter is issued twice a year (in May and November) by the Legumes Program, ICRISAT, in cooperation with Peanut Collaborative Research Support Program, USA. It is intended as a communication link for workers throughout the world who are interested in the research and development of groundnut, *Arachis hypogaea*, or peanut, and its wild relatives. The Newsletter is therefore a vehicle for the publication of brief statements of advances in scientific research that have current-awareness value to peer scientists, particularly those working in developing countries. Contributions to the Newsletter are selected for their news interest as well as their scientific content, in the expectation that the work reported may be further developed and formally published later in refereed journals. It is thus assumed that Newsletter contributions will not be cited unless no alternative reference is available.

Style and Form for Contributions

We will carefully consider all submitted contributions and will include in the Newsletter those that are of acceptable scientific standard and conform to the requirements given below.

The language for the Newsletter is English, but we will do our best to translate articles submitted in other languages. Authors should closely follow the style of reports in this issue. Contributions that deviate markedly from this style will be returned for revision. Submission of a contribution that does not meet these requirements can result in missing the publication date. Contributions received by 1 February or 1 August will normally be included in the next issue.

If necessary, we will edit communications so as to preserve a uniform style throughout the Newsletter. This editing 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.

A communication should not exceed 600 words, and may include a maximum of two relevant and well-prepared tables, or figures, or diagrams, or photographs. Tables must not exceed 85 characters in width. All photographs should be good quality black-and-white prints on matt (nonglossy) surface paper in 85 mm or 180 mm width; send with negatives if possible. Color transparencies or color prints will not be accepted. Do not fold the photo or write on it, but identify each photo on the back with author's name and figure number. Type captions or legends on separate sheets, also clearly identified. Electron micrographs or photo micrographs should indicate the magnification in the caption. Each communication should normally be confined to a single subject and should be of primary interest to *Arachis* workers. The references cited should be directly relevant and necessary to supplement the article's content. All contributions should be typed in double spacing and two copies submitted.

SI units should be used. Yield should be reported in kg ha⁻¹. A "Guide for Authors" is available from the Editor.

Address all communications and requests for inclusion in the mailing list, to:

The Editor
International Arachis Newsletter
Legumes Program
ICRISAT, Patancheru
Andhra Pradesh 502 324
INDIA

Cover Illustration: Derivatives of crosses between *Arachis hypogaea* and wild species resisted a heavy infestation of *Phaeoisariopsis personata*, late leaf spot, at ICRISAT Center, rainy season 1988.

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Editorial

In the last few years, there has been a big change in world groundnut production, with the reversal of first and second place between India and the People's Republic of China. China now ranks first, with an annual production of 6.17 million tonnes, followed by India with 4.35 million tonnes. Just 3 years ago, India ranked first in production, with 6.5 million tonnes, followed by China, with 4.81 million tonnes. While the poor groundnut production in India is mainly due to continuous drought for 4 years, China appears to have emerged as the major groundnut-producing country. We wish to congratulate the Chinese groundnut scientists for this remarkable achievement and invite them to contribute articles on their success story to our Newsletter.

During this year, while the USA--the third largest groundnut producer--was reeling under drought, most parts of India, including ICRISAT Center, received bountiful rains. While the excess rains might result in higher production of several crops, they also brought to the fore the problem of leaf spots in groundnut. There was a heavy infestation at ICRISAT Center, but some resistant lines performed very well, especially some of the wild species derivatives (photo on cover).

We welcome the news from Peanut CRSP that David G. Cummins has returned as Program Director, and we look forward to continued cooperation. We wish to record our sincere appreciation and thanks to Tommy Nakayama for his help in launching this Newsletter during his tenure as the Peanut CRSP Director and wish him all success as Head of the Food Science and Technology Department, Georgia Station, Georgia, USA.

This fourth Arachis Newsletter contains reports on an insect pest survey in Andhra Pradesh, India; a nematode survey at Sadoré, West Africa; and a survey on the constraints to groundnut production in Nepal. Please send us reports on similar surveys you might have conducted and that are of general interest to the readers of the Newsletter.

The Newsletter is mailed to many individuals and libraries who receive ICRISAT publications and to all those on the IAN circulation list maintained by the ICRISAT Legumes Program. This circulation list forms a valuable database that has been used to answer a number of queries, such as, "How many scientists are interested in groundnut pathology, and who are they?" or, "What are the names and addresses of all groundnut scientists in Georgia?" The latter was a request from a scientist going on tour. We are now preparing a more comprehensive database of groundnut scientists. If your mailing label has a number in the top line, we ask you to fill in and

return the questionnaire enclosed with this or the previous Newsletter. As the new database will be used to generate the mailing labels, only those who return the questionnaire will receive future issues. If the number on your mailing label is in [] at the lower right corner, you will continue to receive IAN without having to return a questionnaire.

We receive a number of letters of appreciation from our readers. Participants in the Groundnut Scientists Meet held recently in Indonesia expressed their satisfaction with the Newsletter, and the inclusion of Peanut CRSP and its activities. We welcome your suggestions for improving the Newsletter and solicit your contributions. We have covered the work of ICRISAT and other institutions in previous issues, and welcome similar reports on groundnut research centers or on groundnut production in particular countries or regions.

J.P. Moss
L.J. Reddy

Letter to the Editor

Dear Editor:

The mandate of the Oilseeds Research Station, Tindivanam, is to evolve groundnut varieties suitable for dryland cultivation in Tamil Nadu. In pursuance of this mandate, a systematic program has been initiated to breed varieties for drought tolerance. In this context, I would like to have a detailed procedure for screening the varieties for drought tolerance. Besides, I would like to know the type of information to be gathered for developing a database. I hope that you can be of much assistance in this direction, as your international station carries out studies on drought tolerance in a systematic and detailed manner. May I request you to send me the detailed procedure for breeding varieties for drought tolerance and any useful reference on this aspect.

Sincerely yours,
T. Ramanathan
Professor and Head
Oilseeds Research Station
Tindivanam
Tamil Nadu 604 002
India

ICRISAT Physiologists reply:

A detailed screening procedure for drought resistance cannot be provided until we have a better definition of what kind of drought you are concerned with. No single method exists, and we feel that it is best to proceed by creating realistic droughts in standard agronomic circumstances. One requirement is that varieties being tested in this way are tested against lines of the same maturity, otherwise "escape" mechanisms, which are an advantage in the specific drought timing created, confound the results.

Screening varieties for drought resistance is a task that requires intimate knowledge of the environment for which the varieties are destined. This is necessary because: (1) different sets of attributes are needed for different drought situations; (2) realistic drought regions must be created for effective screening. To put all possible mechanisms in a single genotype would be difficult and require a very long-term approach; also, it would probably result in a variety with low yields in those years when rainfall is adequate.

Generally, as a result of our screening and study of genotypes differing in response to drought, we find the following:

1. For end-season droughts, we find that resistances are almost always associated with a low yield potential. This occurs because the roots of resistant varieties continue growing during the drought. Therefore, we feel that earlier maturity to escape these droughts is a better solution, unless the rainy season is so unreliable that "good" years are very rare.
2. For midseason drought situations, we find that requirements of varieties are associated with rapid recovery from droughts. We screen for this attribute by growing groundnut in the post-rainy season and withholding irrigation for 50-60 days from flowering. We then release the drought and irrigate for 4 weeks before harvesting the plants. We then select for yield.
3. Another attribute that may be useful is the ability to utilize surface moisture faster. This attribute, which we located in NC Ac 17090 using line-source irrigation over the whole season, is useful in areas where the majority of rain falls in light showers.

News from ICRISAT Center

ICRISAT/NBPGR (ICAR) Workshop

A workshop on collaborative germplasm exploration and evaluation in India was held by the Genetic Resources Unit of ICRISAT and the National Board on Plant Genetic Resources (NBPGR) of the Indian Council of Agricultural Research (ICAR) in New

Delhi, India, 14-15 Nov 1988. The objective of the workshop was to determine the use and impact of germplasm in national crop improvement programs with respect to the five ICRISAT mandate crops (sorghum, pearl millet, chickpea, pigeonpea, and groundnut) and small (minor) millets.

Eighteen scientists from ICAR organizations, the NBPGR, and agricultural universities and the International Board on Plant Genetic Resources (IBPGR) Coordinator for South and Southeast Asia participated in the 2-day deliberations. The five sessions were: (1) Inauguration; (2) World Germplasm Collections: Status Reports and Potentials; (3) Germplasm Exploration and Collection, Evaluation, Documentation, Exchange and Quarantine, and Conservation; (4) Use and Impact of Germplasm in Crop Improvement in India; and (5) Closing session.

R.S. Paroda, Deputy Director General (Crop Sciences), ICAR, in his keynote address gave a brief account of the achievements of the collaborative efforts of ICRISAT and ICAR. These include: identification of priority areas for exploration, formulation of modalities for operating/planning survey programs, initiation of systematic germplasm evaluation of all the five ICRISAT mandate crops and small millets at selected locations representing different agroclimatic conditions and involving the regional stations of both NBPGR and ICRISAT, and identification of training needs. In the future plans, Dr Paroda indicated that (1) a catalog based on joint evaluation would be produced and disseminated to all concerned scientists in the national system and (2) joint explorations would be further planned to explore untapped areas not only within India but also in other countries with rich variability for the five ICRISAT mandate crops. ICRISAT, NBPGR, and IBPGR should take the lead in imparting regular training in genetic resources to workers from the developing world. He also mentioned the need to establish a Crop Advisory Committee for genetic resources to give proper direction to such efforts.

In session 2, various scientists described the status of the world collections of sorghum, small millets, pearl millet, chickpea, pigeonpea, and groundnut germplasm. B.R. Murty presented the potential of world germplasm collections in crop productivity. J.M.M. Engels presented the IBPGR's objectives and plan of work in South and Southeast Asia. In session 3, five papers were presented on ICRISAT/NBPGR collaborative exploration and evaluation of germplasm in India, conservation of world germplasm collections of ICRISAT mandate crops, computerized documentation and retrieval systems for genetic resources work at ICRISAT, germplasm exchange, and quarantine in India.

Session 4 included five papers on the use of sorghum, pearl millet, groundnut, small millets, chickpea, and pigeonpea germplasm and its impact on the improvement of each of these crops in India. After

this session, a small working group finalized the technical program on the plant exploration missions in India and ICRISAT/NBPGR joint multilocation evaluations of germplasm of all the ICRISAT crops and small millets for 1989/90.

Summaries and recommendations of the various sessions were presented in the closing session. The recommendations of the workshop were as follows:

- more comprehensive, single and effective collaborative programs should be envisaged for germplasm exploration, evaluation, and subsequent utilization in crop improvement;
- crop improvement scientists should be involved in some specific areas of germplasm collection in order to obtain more comprehensive data on biotic and abiotic stresses;
- efforts by ICRISAT, NBPGR, and IBPGR should be increased to train scientists in various aspects of germplasm collection and evaluation;
- collaborative multiorganizational, multidisciplinary, multilocation germplasm evaluation in India should be implemented from the next growing season. The collaborating agencies will be NBPGR (ICAR), crop improvement scientists of All India Coordinated Crop Improvement Units (ICAR), agricultural universities, and the Genetic Resources Unit and Crop Improvement Programs of ICRISAT.

Asian Grain Legumes Network Activities

The aims and objectives of the Asian Grain Legumes Network (AGLN) have been reported earlier (IAN 1:16-17, 2:2-3). Briefly, the AGLN assists and strengthens the national programs in South and Southeast Asia by helping to provide them with technology, including plant material and appropriate agronomy, to increase production of groundnut, chickpea, and pigeonpea.

Apart from general activities that involve all the countries in the region, the AGLN works with individual national programs to prepare an annual work plan for collaborative work between their scientists and those at ICRISAT. (See below for more details about work plans.)

The following is an update of the activities of the AGLN:

1. The memorandum of understanding (MOU) with the Chinese Academy of Agricultural Sciences, China, was signed in April, and that with the Bangladesh Agricultural Research Council (BARC), Bangladesh, was signed in November. The MOU with Indonesia was finalized for signing in December 1988.
2. A Training Workshop on the Identification and Detection of Groundnut Viruses with Special Reference to Peanut Stripe Virus was

held 10-27 Jul 1988, at Malang, Indonesia. It was cosponsored by the Central Research Institute for Food Crops (CRIFC) of Indonesia, the Food and Agriculture Organization of the United Nations (FAO), the International Development Research Centre (IDRC), and ICRISAT. Eleven scientists from China, India, Indonesia, Nepal, the Philippines, South Korea, Sri Lanka, and Thailand, attended the workshop.

3. An In-service Training Course on Analytical Techniques for Evaluating Grain and Food Quality of Legumes was organized 1-14 Aug 1988 at ICRISAT Center. It was cosponsored by FAO, the Asian Development Bank (ADB), and ICRISAT. Eight participants from the region attended.
4. An ICRISAT groundnut scientist participated in the Second National Groundnut Travelling Seminar organized by the National Agricultural Research Council (NARC), Islamabad, Pakistan.
5. An entomologist and a pathologist from ICRISAT joined a groundnut disease and pest survey team in western Nepal. Early and late leaf spot and rust were important in specific areas. These locations would thus be ideal sites for screening for early leaf-spot resistance, which cannot be done regularly at ICRISAT Center. Soil pests, such as termites and white grubs, were found to damage the crop.
6. A training course on Integrated Control of Legume Pests in Asia was held 3-14 Oct 1988. It was sponsored by the FAO, ADB, and ICRISAT. Ten participants from Bangladesh, India, Indonesia, Nepal, Pakistan, the Philippines, Sri Lanka, Thailand, and Vietnam attended the course.
7. A joint Nepal-ICRISAT germplasm expedition to collect local groundnut from the midhill regions of Nepal was undertaken 27 Oct-9 Nov 1988.

Asian Grain Legumes Network--Work Plans

As indicated earlier (IAN 3:2-3), the Asian Grain Legumes Network (AGLN) is involved in transfer of technology in groundnut, chickpea, and pigeonpea to assist the national programs in Asia.

As a part of this activity, we organize Work Plan Meetings to develop a detailed plan of collaborative work for each crop in each country.

These meetings are held every 1 or 2 years, depending on the resources and availability of staff; the results of the experiments conducted in the previous year are reviewed, and plans are made for

the next year's collaborative activities involving the national program scientists and scientists from ICRISAT and collaborating regional and international organizations. The essential steps involved in the work plan meetings are:

- o review the results of work carried out in the country by the national program scientists;
- o provide input by ICRISAT on availability of material, technology, literature, and training programs; and
- o develop a list of collaborative activities that are considered priority areas by the national scientists and mutually agreed upon.

In countries with which ICRISAT has a formal agreement, we request that a scientist be nominated as country coordinator, to coordinate all the AGLN activities and help to organize meetings, workshops, training courses, and monitoring tours.

The work plans cover the following points:

1. Research priorities and thrusts, with details of experiments, meetings, and training.
2. Responsible party: this may be the national program, an institute or ICRISAT, and may indicate the number, and if possible, names of the people involved.
3. Time frames for various activities.
4. Costs involved for various activities.
5. Source of funds to cover these activities.

A typical work plan would go into the following details:

1. Yield trials, which would include material from the national programs and from ICRISAT.
2. Pathology and entomology trials, which include studies on efficacy of fungicides and pesticides, assessment of losses due to various diseases and pests, and screening nurseries.
3. Agronomy trials on: date of sowing, method of sowing, spacing x variety, fertilizer (NPK), weed competition, intercropping, and response to liming on acid soils (to improve pod filling).
4. Surveys and monitoring tours, which are made as needed to assess the pest and disease situation, with a pathologist and entomologist from ICRISAT to participate in the survey and to score entries in trials.
5. Germplasm collection: this is done where no collecting has been done previously, especially of the lines well adapted to local conditions.

6. National program scientists: one or more are to come to ICRISAT for training and to attend special courses, such as the ICRISAT Training Course on Identification of Groundnut Viruses.
7. Workshops and meetings: the participating country nominates scientists to participate in appropriate meetings and workshops organized by ICRISAT, such as the Groundnut Scientists' Meet held at Malang, Indonesia, 14-17 Nov 1988.
8. Review meetings: ICRISAT scientists participate in the country working group meetings to enable advance planning for groundnut, pigeonpea, and chickpea research.

News About ICRISAT Center Groundnut Scientists, Trainees, and Postdoctoral Fellows

F. Waliyar, who served as Assistant Principal Plant Pathologist for about 2 years at ICRISAT Center, will take up a new assignment as Principal Plant Pathologist at the ICRISAT Sahelian Center, Niger, with effect from 1 Jan 1989.

D.G. Faris, Principal Coordinator, Asian Grain Legumes Network (AGLN) of ICRISAT, returned to ICRISAT on 16 Oct 1988, after completing his sabbatical leave in Canada and the Philippines.

Liao Boshou from the Oil Crops Research Institute, Wuhan, China, is working as an in-service fellow in the Groundnut Pathology Laboratory at ICRISAT from 28 Aug to 26 Dec 1988. He has worked on bacterial wilt, rust, and late leaf spot in China and is concentrating on components of resistance to rust during his time at ICRISAT.

F.F. Mwenda, Senior Scientific Officer, Tanzania Agricultural Research Institute, Naliendele, Mtwara, Tanzania, took 3 months' training in groundnut breeding at ICRISAT Center, 15 Jul-15 Oct 1988.

Recent ICRISAT Publication

ICRISAT (International Crops Research Institute for the Semi-Arid Tropics). 1988. Groundnut. Pages 223-277 in *Annual Report 1987*. Patancheru A. P. 502 324. India: ICRISAT. (For offprints, write to Legumes Program, ICRISAT.)

News from the ICRISAT Sahelian Center

First ICRISAT West African Regional Groundnut Meeting

The first ICRISAT West African Regional Groundnut Meeting, held in Niamey, Niger, 13-16 Sep 1988, was officially opened by H.E. Abache Chaibou, the Niger Minister for Higher Education, Research, and Technology. He was accompanied by three other ministers at the opening ceremony: H.E. Malam Boukar Ousmane, Minister for Animal Resources and Hydraulics; H.E. Brigi Rafini, Minister for Trade and Industry; and H.E. Abdoulai Mohamed, Minister Responsible for Parastatal Organizations.

Dr R.W. Gibbons--Executive Director, West African Programs, and Director, ICRISAT Sahelian Center--delivered the welcome address. Twenty-nine papers were presented.

The objectives of the meeting were:

1. To provide an opportunity for participating scientists to share experiences on the status of groundnut production and improvement in various countries in the region and
2. To define the areas in which collaborative research can be developed.

Fifty-six participants attended, representing 12 countries: Benin, Burkina Faso, Cameroon, Gambia, Ghana, Guinea, Mali, Nigeria, Niger, Senegal, Chad, and Togo. Also represented were Peanut CRSP, Institut de recherches pour les huiles et oléagineux (IRHO), Institut français de recherche scientifique pour le développement en coopération (ORSTOM), Centre régional de formation et d'application en agrométéorologie et hydrologie opérationnelle (AGRHY-MET), Overseas Development Administration (ODA), the African Groundnut Council, the Food and Agriculture Organization of the United Nations (FAO), University of Niamey, ICRISAT Center, the Southern African Development Coordination Conference (SADCC)/ICRISAT Regional Groundnut Improvement Program, and ICRISAT Sahelian Center. The participants visited our trials at Bengou and Sadoré and were shown the new facilities at Sadoré by the Executive Director.

The recommendations from the working groups were received and approved at a plenary session. The papers are being edited and the executive summaries and the recommendations will be published by ICRISAT.

News from Peanut CRSP

Peanut breeding and selection efforts in Peanut CRSP projects have resulted in the recent release of seven cultivars: Khon Kaen 60-1 and 60-2 in Thailand, UPL Pn-6 in the Philippines, Payne in Jamaica, along with three in North Carolina.

Collaborators from the Peanut CRSP participated in the Regional Groundnut Meeting for West Africa held at the ICRISAT Sahelian Center, Niamey, 13-16 Sep 1988. U.S. participants were: D.G. Cummins and R.L. Lynch, University of Georgia; R.E. Pettit and O.D. Smith, Texas A&M University, and B. Singh, Alabama A&M University. West African participants were: A.P. Ouedraogo, P. Sankara, S. Some, and A. Traore, Burkina Faso; A. Moukaila, Niger; O. Ansa, S. Misari, and P. Olorunju, Nigeria; J.C. Mortreuil, Senegal.

The Office of Agriculture, Bureau of Science and Technology, United States Agency for International Development (USAID), hosted a Workshop, "Agricultural Development: Today and Tomorrow", in Washington DC, USA, 28-29 Sep 1988. The Peanut CRSP was among over 30 Science and Technology-Agricultural projects represented. The focus of discussion was on issues facing the programs in the 1990s, including research priorities (such as sustainable agriculture, biotechnology, postharvest concerns), networks, funding, and donor cooperation.

The Peanut CRSP collaborators met in Tulsa, Oklahoma, USA, following the Annual Meeting of the American Peanut Research and Education Society. About 30 U.S. and host country participants attended. The CRSP Board of Directors and Technical Committee also met. The discussions centered on research progress, program focus, and initial plans for the Second Triennial Review scheduled for 1989.

APRES Awards

The American Peanut Research and Education Society (APRES) has awarded its prestigious Golden Peanut Research and Education Award for 1988 to Dr Ronald J. Henning for his outstanding contributions to the peanut industry in the USA. Dr Henning served as a county extension agent in Georgia from 1965 to 1973. He then advanced to Extension Agronomist for peanuts and served in this capacity until 1985. Upon leaving the extension service, Dr Henning joined as Vice-President for Technical Services at Farmers Fertilizer and Milling Company. In March of this year, Dr Henning started his own peanut consulting business, Henning Peanut Technical Services.

Dr Frank McGill of Tifton, a Brooks distinguished professor of agronomy (emeritus), was named a Fellow of the APRES. The selection as a Fellow is the highest recognition awarded by the Society.

New Groundnut Varieties Released in India

The Government of India Central Subcommittee on Crop Standards, Notification, and Release of Varieties, at its 10th meeting held on 24 Mar 1988, released and notified two groundnut varieties, ICGV 87128 (ICGS 44) and Girnar-1 (CGC 4018).

The ICRISAT groundnut variety ICGV 87128 is released for postrainy/summer season cultivation in Gujarat state. It is a selection from the natural hybrid population of Robut 33-1. It has consistently outyielded the popular Indian cultivars, including Robut 33-1 (now called Kadiri 3), J 11, GAUG 1, and GG 2. On an average, ICGV 87128 has given 24% higher pod yield than the local variety GG 2 in Gujarat. It also possesses field tolerance to bud necrosis disease. This variety is becoming increasingly popular in other Indian states also: Tamil Nadu, Karnataka, Andhra Pradesh, Orissa, Maharashtra. Recent reports on this variety from Pakistan are also promising.

Girnar-1 is a spanish bunch variety released for rainy-season cultivation in India. It is a selection made by P.S. Reddy, who was the Groundnut Project Coordinator, from the early-generation segregating material supplied by ICRISAT of a cross, Robut 33-1 x TMV 3. Girnar-1 possesses resistance to rust and late leaf spot and is suitable for cultivation during rainy and postrainy seasons in India.

DTCP/UNDP Short Courses in 1989

Development Training and Communication Planning (DTCP), a unit of the United Nations Development Programme (UNDP), offers short courses designed to give participants practical knowledge and skills for application in rural development projects and programs.

The courses are conducted in Manila, the Philippines. Courses for 1989 are:

1. Production Techniques for Instructional Audiovisual Aids 2 to 26 May 1989 (4 weeks)
2. Communication Campaign Planning 5 to 23 Jun 1989 (3 weeks)
3. Field- and Middle-level Management and Supervision 3 to 28 Jul 1989 (4 weeks)

4. Monitoring and Evaluation of Projects and Programmes 7 Aug to 1 Sep 1989 (4 weeks)
5. Planning and Management of Training Programmes 4 to 22 Sep 1989 (3 weeks)
6. Production Techniques for Extension Audiovisual Aids 2 to 27 Oct 1989 (4 weeks)
7. Training Methods 6 to 24 Nov 1989 (3 weeks)

Eligibility. The courses are open to staff of government agencies and nongovernment organizations (NGOs) who perform management, training, extension, and/or communication support functions. A working knowledge of English is essential. Participants should be sponsored by United Nations projects, international organizations, or NGOs which agree to cover training costs.

Costs. Course costs are as follows:

3-week course:	U.S.\$1865	per participant
4-week course:	U.S.\$2295	per participant

Costs do not include airtickets to and from Manila or allowances for accommodation and meals. Living allowances additional to course fees are estimated as follows:

3-week course:	U.S.\$ 920	per participant
4-week course:	U.S.\$1200	per participant.

Inquiries. For additional information on DTCP courses, contact:

Training Coordinator
DTCP/UNDP
5th Floor, Bonifacio Building
University of Life-Campus
Meralco Avenue, Pasig
Metro Manila
PHILIPPINES

Cable: UNDEVCOM MANILA
Telephones: 673-6401 to 673-6405
Telex: 29018 DTCP PH

Reports

Training Course in the Detection of Groundnut Viruses, with Special Emphasis on Peanut Stripe Virus

D.V.R. Reddy (ICRISAT Center)

A training course on the detection of groundnut viruses, with special emphasis on peanut stripe, was held in Malang, Indonesia, 11-26 Jul 1988. The course was organized by the ICRISAT Legumes Program (Pathology Unit and the Asian Grain Legumes Network) and Training Program, and funds were contributed by FAO under the project RAS/82/002-TCDC, and by the International Development Research Centre (IDRC). Twelve participants—one each from India, Malaysia, Nepal, Pakistan, the People's Republic of China, South Korea, Sri Lanka, and Thailand, and two each from Indonesia and the Philippines—attended the course.

The course covered both theoretical and practical aspects of detection and management of groundnut viruses. A.J. Gibbs (Australia) and J.W. Demski and K.F. Harris (USA) delivered lectures. Practical sessions were managed by D.V.R. Reddy, N. Horn, N. Saleh, and Sudarshan Reddy. The participants were introduced to the most commonly used techniques for detecting groundnut viruses. Emphasis was placed on enzyme-linked immunosorbent assay (ELISA), using the penicillinase enzyme. ELISA kits, containing antisera for economically important groundnut viruses occurring in Southeast Asia, chemicals and reagents, including enzyme-conjugates, a micropipette, and ELISA plates, were provided to the participants for use in their home countries. The techniques that the participants learned and practiced included mechanical sap inoculations, local lesion assay, and ELISA (both direct antigen coating and double antibody sandwich forms). Other techniques, such as graft transmission, aphid transmission, Ouchterlony's agar gel double diffusion test, and the precipitin ring interphase test, were demonstrated. Participants were requested to evaluate all aspects of the course and all of them rated the course favorably.

A Survey Report on the Constraints to Groundnut Production in Nepal

M.L. Jayaswal¹, F. Waliyar², D. McDonald², and M.J. Vasudeva Rao² (1. National Oilseed Development Program, Nawalpur, Sarlahi, Nepal; 2. ICRISAT Center)

Introduction. Groundnut is the second most important oilseed crop in Nepal, and the area under

groundnut is increasing every year. In 1987, about 2200 ha, mostly in the *terai* (the plains between Churia range and the Indian border) and inner *terai* (the plains between Churia and Mahabharat ranges), but also in some midhill areas, were sown with groundnut. Although groundnut is not a new crop in Nepal, its commercial cultivation is recent. The Nepal Vegetable Ghee Industry (NVGI) at Hetauda alone requires 20-30 thousand tonnes of groundnut pods every year; hence there is strong local pressure to increase crop area. In both the 1986 and 1987 cropping seasons, the National Oilseed Development Program (NODP) of Nepal and ICRISAT scientists undertook joint surveys to study groundnut production and the problems affecting the crop. The 1986 team comprised M.L. Jayaswal, D. McDonald, and D.G. Faris, and the 1987 team consisted of M.L. Jayaswal, R.B. Sharma, F. Waliyar, M.J. Vasudeva Rao, and B.P. Sharma.

Cropping patterns and varietal constraints.

Groundnut is grown mostly on light sandy soils in the *terai*, the inner *terai*, and the midhill regions (Fig. 1). In some sandy soils on river banks, groundnut is virtually monocropped.

The NODP at Nawalpur has released for general cultivation the variety B 4, a virginia bunch type introduction from Pakistan, which is doing well in farmers' fields. It gives an average pod yield of 1.5 t ha⁻¹ and matures in 130-145 days, but is susceptible to foliar fungal diseases.

Most of the future expansion of groundnut in Nepal is expected to be in the *terai* region. Rapeseed and mustard are the predominant oilseed crops in Nepal and are sown in the postrainy season, soon after the maize crop is harvested. The rainy-season groundnut area could be expanded by increased intercropping of groundnut with maize. This restricts the duration of groundnut cultivars required for the rainy season to 105-110 days; i.e., the same duration as maize. Although B 4 performs well in the *terai*, its duration (135 d) does not allow the fields to be cleared for timely sowing of rapeseed and mustard. Hence the NODP has given priority to identifying shorter duration groundnut cultivars maturing in 105-110 days.

Biotic constraints. In the surveys conducted in 1986 and 1987, three major foliar fungal diseases were observed—early leaf spot (caused by *Cercospora arachidicola* Hori), late leaf spot (caused by *Phaeoisariopsis personata* [Berk. & Curt] v. Arx), and rust (caused by *Puccinia arachidis* Speg.). These three diseases were present in all the groundnut areas surveyed (Fig. 1), but their order of importance differed from place to place. At Rampur, rust and late leaf spot were the more severe, whereas at Nawalpur,

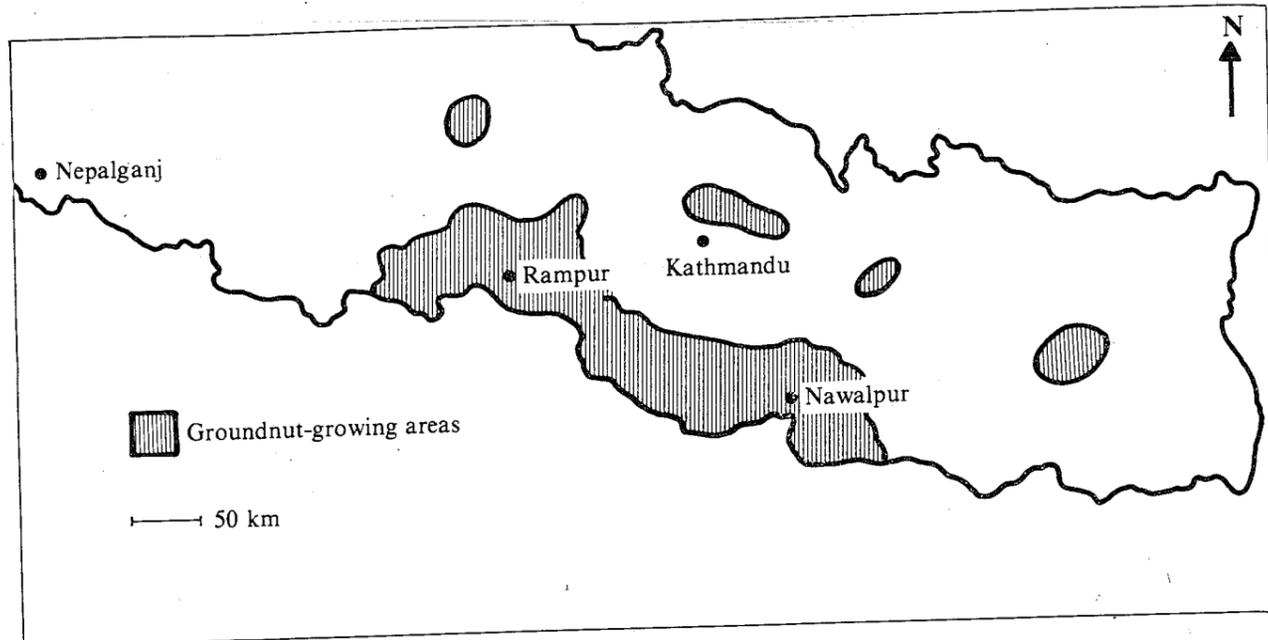


Figure 1. Groundnut-growing areas of Nepal.

early leaf spot was severe, but late leaf spot and rust were present only at low levels. Early leaf spot was the dominant foliar disease at Nawalpur in both seasons, indicating that this center could be a reliable site for screening germplasm for early leaf-spot resistance. Rampur could be a good location to screen for rust and late leaf-spot resistance. Late leaf spot was the dominant foliar disease on groundnut in the midhill region in 1986, causing up to 50% defoliation. Rust was also present in this region.

Sclerotium rolfsii Sacc. appeared to be an important soilborne disease in the terai. Bud necrosis disease (BND), caused by tomato spotted wilt virus and transmitted by thrips, is the most important of the viral diseases of groundnut in Nepal. The high BND levels in farmers' fields were possibly due to the very wide plant spacing practiced in Nepal. Termites and jassids were observed to cause considerable damage in all groundnut crops.

More detailed surveys and associated crop loss assessments are required to provide a reliable evaluation of the comparative importance of the various pests and diseases. However, from these preliminary surveys it appeared that leaf spots and rust cause appreciable losses. BND also causes losses in some areas and has the potential to become a serious problem.

New short-duration (105-110 d) cultivars, resistant to foliar diseases and BND, are required to fit preferred cropping systems.

A Survey of Groundnut Insect Pests in Andhra Pradesh, India, Postrainy Season 1987/88

G.V. Ranga Rao and T.G. Shanower
(ICRISAT Center)

In February and March 1988, the groundnut crop was surveyed in 11 districts of Andhra Pradesh, India, to assess the status of various insect pests and study farmers' pest management practices on irrigated groundnut crops. Figure 1 shows the route followed and the number of fields inspected in each district.

Pest problems. High populations of groundnut leaf miner (GLM), *Protaetia modicella*, were found in Nalgonda district. Two fields had more than 50 GLM larvae plant⁻¹, while other fields had between 10 and 20 larvae plant⁻¹. The GLM larval parasites *Chelonus* spp and *Sympiesis* spp were found, but parasitism was very low. Groundnut crops ranged in age from 25 days after emergence (DAE) to within 2 weeks of maturity. Plant populations were low, and plants seemed drought-stressed from lack of irrigation.

In Khammam district, there was also a wide range of sowing dates, but insect pests were not as abundant as in Nalgonda district. There were 10-15 GLM larvae plant⁻¹, most of them early instars of the first generation. In one field, however, most of the population was adult. In another field, thrips

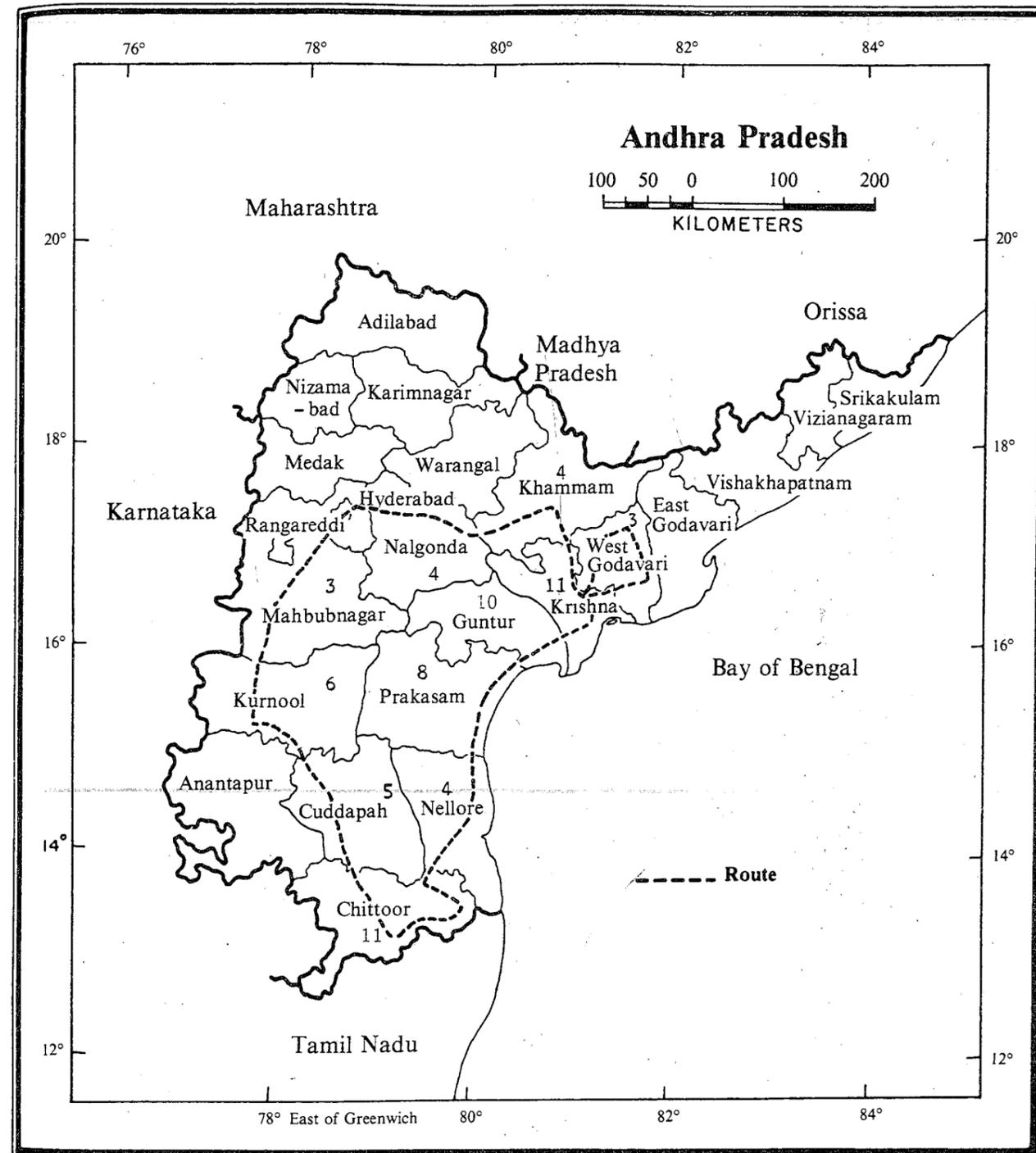


Figure 1. Route map of groundnut insect-pest survey in Andhra Pradesh, India, postrainy season, 1987/88. Numbers indicate total number of fields visited in that district.

(*Scirtothrips dorsalis*) damage was observed in addition to early-instar GLM damage.

In West Godavari district, we observed two

adjacent fields, both about 80 days old, one of which had a heavy attack of GLM but very few defoliators (*Spodoptera litura* and *Heliothis armigera*); the other,

no GLM but a moderate level of defoliators. It is probable that the second farmer applied insecticides to control GLM, and these insecticides killed the natural enemies of *S. litura* and *H. armigera*. Chemical control of GLM is relatively effective, but it may exacerbate the defoliator problem.

GLM was not a problem in Guntur district, though one unsprayed field had a very heavy infestation (> 50 larvae plant⁻¹). Farmers in this area sprayed regularly with a wide variety of chemicals, including synthetic pyrethroids and organophosphates.

In one field (40 DAE) in Cuddapah district, the crop had 15-20 GLM larvae plant⁻¹. These appeared to be from the second generation, as the farmer had sprayed 10 days earlier to control the first generation.

We found some GLM-infested fields in Mahbubnagar district. We noticed 10-15 mines plant⁻¹ in one field (60 DAE). Most of the larvae had been killed by an earlier insecticidal spray, but 1-2 live larvae remained on an average on each plant.

The defoliators (*S. litura* and *H. armigera*) were the most important insects in Krishna district. The crop was around 60-70 days old and had 20-30% leaves eaten by these two pests. Farmers applied large amounts of insecticides (more than 6 sprays), but did not get satisfactory control. Synthetic pyrethroids and combinations of different chemicals are frequently used. Most farmers spray at the first sign of insect damage and seem unaware that groundnut can tolerate some defoliation.

Defoliators were a problem throughout most of Guntur district, and some fields showed 25-30% defoliation. The regular heavy use of a wide variety of insecticides, although it may control GLM and thrips, is probably causing the problem by destroying the natural enemies of defoliators.

This situation has already occurred in cotton in the district, where spraying against whitefly has resulted in a serious *H. armigera* problem. Groundnut farmers face the same risk with the defoliators.

In the coastal areas of Prakasam district, *S. litura* was the major problem. Farmers spray often, but have not been able to control it satisfactorily. We found several fields with 50% defoliation due to *S. litura*.

Near Chirala in Prakasam district, farmers expressed concern about whitefly. Large numbers (50-75) were found on plants and their honeydew excrement led to the development of sooty mold. Aphids were present as a minor pest in Chittoor district. One field (30 DAE) we observed had a severe aphid infestation.

Insecticide use. The fields we visited in Kurnool district had been sprayed and in general looked good; we did not notice any serious insect pest problems. GLM was not present in these fields. However, in Cuddapah district we found farmers applying insecticides inappropriately. Sprayed and unsprayed fields had similar subeconomic pest levels.

In Prakasam district, we met a farmer who had

sprayed a few times, using a mixture of five different chemicals, including fenvalerate and cypermethrin. He agreed with us that pest level and damage in his field were the same as in that of his neighbor, who had not sprayed.

In Chittoor district, we found farmers spraying even when there was no pest problem. One farmer we spoke with said the sprayed fields had more defoliators than unsprayed fields. However, another farmer felt that sprayed and unsprayed fields had similar levels of insect damage. In another part of the district, we found a large area (1500 ha) with only moderate thrips and *S. litura* damage. The farmers in this region used only reasonable amounts of insecticide, mostly a single application.

In Nellore district, we found a farmer who had not worried about defoliation. Not only had he not sprayed his field but he planned to graze a few sheep in it during the last 30 days of the crop. Insect damage in this district was low, though several farmers still sprayed up to four times.

Conclusions. Seventy percent of the farmers we visited used insecticides, mainly to control GLM and defoliators (*S. litura* and *H. armigera*); 20% applied one spray; 25%, two sprays; and 25%, three or more sprays. In many areas, farmers were using insecticides inappropriately (using when not required, combining insecticides, and not considering any damage thresholds). GLM incidence was severe in unsprayed fields, and high populations were found in Nalgonda and Khammam districts.

In heavily sprayed fields, defoliators were more active than in unsprayed ones. This is probably because of the negative effect of insecticides on natural enemies of defoliators.

Plant-Parasitic Nematodes Associated with Groundnut at Sadoré in Niger

S.B. Sharma¹, P. Subrahmanyam², E. Sarr³, and H. Van Riel³ (1. ICRISAT Center; 2. ICRISAT Sahelian Center; 3. Département de formation en protection des végétaux, centre AGRHYMET, Niamey, Niger).

A survey on plant-parasitic nematodes associated with groundnut in different fields at the research farm of ICRISAT Sahelian Center, Sadoré (13°N, 2°E), was conducted during August and September 1988. Soil and root samples were collected from 268 plots in

9 fields. For every 4-m long, 2- to 6-row plot, four to six soil cores up to 20 cm depth were collected, using a steel shovel. Roots and pods were examined for lesions and galls. Above-ground symptoms were also recorded.

Facilities available at the Département de formation en protection des végétaux, centre AGRHYMET, Niamey, for processing the soil and root samples and for nematological investigations were used for this work. A thoroughly mixed 100-cm³ soil sample was processed using a decanting and sieving technique. Approximately 750-1000 mL water was added to the soil sample in a plastic bowl and this slurry was stirred and passed through 725 µm-pore (20 mesh) and 45 µm-pore (325 mesh) sieves. Slurry passing through the 45 µm-pore sieve was collected in a plastic container and passed again through this sieve. Residue collected on the 45 µm-pore sieve was placed on a nematode filter supported on a steel mesh immersed in water in a collecting tray. After 24 to 48 h, water in the collecting tray was examined under a stereomicroscope for plant-parasitic nematodes.

About 5 g of roots were cut into lengths of 1 cm or less, and nematodes were extracted using the same method employed for extracting nematodes from soil. Minimum incubation period was about 36 h at 25°C.

Plant-parasitic nematodes belonging to nine genera were recorded: *Aphelenchoides* sp., *Ditylenchus* sp., *Helicotylenchus* sp., *Hoplolaimus pararobustus* Schuurmans Stekhoven and Tuenissen, *Macroposthonia curvata* Raski, *Scutellonema clathricaudatum* Whitehead, *Siddiqia* sp., *Telotylenchus indicus* Siddiqi, and *Xiphinema attorodorum* Luc. *S. clathricaudatum*, *X. attorodorum*, and *T. indicus* were the predominant nematodes and were present in all the fields. Populations of these three nematode species were also detected in root samples. Samples collected from poor patches showed that there were more than 200 plant-parasitic nematodes in 5 g of roots in some fields, three times more than in roots collected from good patches. The population of *S. clathricaudatum* was usually more than 1 nematode in 1 cm³ soil. Cyst (*Heterodera* spp) and root-knot nematodes (*Meloidogyne* spp) were not encountered in the soil and root samples. Pods were generally free from lesions.

Crop growth was very variable in most of these fields. Every field had some areas where plant growth was apparently normal and other areas where plant growth was very poor and stunted, and leaves were small and often chlorotic. These areas were randomly distributed in different fields (See IAN 3:9-10). Root systems of the poorly growing plants were sparsely developed. In many plants, root tips were swollen. Roots were stubby and profusely proliferated. Factors contributing to the crop growth variability are not fully elucidated, and information on the pathogenicity of the associated nematodes is lacking. However, we suspect that plant-parasitic nematodes are one of the important biotic factors contributing to the crop growth variability of groundnut in Sadoré.

Groundnut Yield Maximization Trials in India, Rainy Season 1987

P.W. Amin (ICRISAT Center)

India is a leading producer of groundnut in the world, with a total production of about 6 million tonnes of groundnut in the shell annually. However, productivity is low, averaging only about 800 kg ha⁻¹ dry pods, and the yields fluctuate tremendously from year to year due to variation in rainfall and pest and disease infestation. When the adverse effects of these factors are removed, yields can be stabilized at a much higher level. At ICRISAT Center and in a few farmers' fields, pod yields in the range of 4000-6000 kg ha⁻¹ have been achieved.

Table 1. Yield of groundnut grown according to ICRISAT, state, and local farmers' methods of cultivation, rainy season 1987.

Method of cultivation	Yield (kg ha ⁻¹)	
	Pods	Fodder
Irrigated		
ICRISAT ¹	3270 (1870-4800) ²	5470 (3000-7800)
State ¹	1970 (885-4300)	4120 (1800-6620)
Local ³	1200 (525-2270)	3300 (1007-5300)
Rainfed ⁴		
ICRISAT	2180 (1850-2500)	5170 (4940-5400)
State	1115 (1050-1180)	3730 (3060-4400)
Local	550 (400-700)	2700 (2400-3000)

1. Average of 11 trials, nonreplicated, plot size 0.4 ha.

2. Figures in parentheses represent the range.

3. Average of nine trials.

4. Average of two trials, plot size 0.4 ha.

At the request of the Ministry of Agriculture, Government of India, ICRISAT set out to demonstrate the high yield potential of groundnut. The demonstrations were laid out in five states of India in the 1987 rainy season. The ICRISAT method of growing groundnut for high yield was modified as necessary for the local soils, climatic conditions, and diseases and pests. The inputs were:

- good quality seed and seed dressing;
- cultivars with high yield potential and/or resistance or tolerance to foliar diseases;
- good land preparation and addition of organic matter;
- modified seedbed (raised beds and furrows);
- sowing by dibbling;
- supplementary irrigation;
- no application of nitrogen or only small amounts applied;
- substantial application of phosphorus (as single superphosphate);
- potash, zinc, and boron where necessary (based on soil analysis);
- application of gypsum;
- application of ferrous sulfate;
- need-based plant protection and weed control; and
- timely harvest.

Where it was possible to provide these inputs, dry pod yields in the range of 1870-4800 kg ha⁻¹, with an average of 3270 kg ha⁻¹, were obtained (Table 1). This was about 2000 kg ha⁻¹ more than yields obtained by the local farmers' method. In two rainfed trials, the yields from ICRISAT's method were 2180 kg ha⁻¹ compared with 550 kg ha⁻¹ from the local farmers' method (Table 1).

When the ICRISAT method was compared with the state-recommended method and variety, yields in the farmers' fields using the ICRISAT method were substantially higher than those obtained using the state-recommended method (Table 2). The state-recommended methods varied from state to state with regard to the variety, plant spacing, fertilizer dose, and plant protection.

The farmers' reaction to this new method of groundnut cultivation--now commonly called "the ICRISAT method"--was very favorable. Farmers commented that the ICRISAT method

- helps maintain good plant stand by reducing seedling mortality;
- increases yields;
- increases pod size, pod filling, and shelling percentage;

Table 2. Yield of groundnut grown using ICRISAT and state methods of cultivation in farmers' fields, Dhule district, Maharashtra, rainy season 1987.

Method of cultivation	Yield (kg ha ⁻¹)		
	Pods	Fodder	Shelling percentage
Irrigated¹			
ICRISAT	1960 (1288-2600) ²	4780 (2100-8700)	70.5 (60-78)
State	1370 (446-2300)	4190 (1900-9000)	68.1 (55-80)
Rainfed³			
ICRISAT	860 (672-1055)	2270 (1300-4000)	64.3 (61-67)
State	630 (570-830)	1930 (750-3850)	61.0 (60-63)

1. Average of 11 trials.
2. Figures in parentheses represent the range.
3. Average of three trials.

- helps reduce pod losses at harvest, because the plants are easy to pull out from the soil.

Farmers cited some drawbacks: the method is labor-intensive, and forming the raised beds and furrows is difficult without the proper tools. Also, furrow irrigation is not as effective as sprinkler irrigation, because the water in the furrows fails to reach the central two rows of the 1.2-m wide bed.

However, the advantages of the new method seem to outweigh these drawbacks, and many farmers have now adopted this method of groundnut cultivation.

Research Reports

Low-Cost Implements to Improve Groundnut Production

N.K. Awadhwal (ICRISAT Center)

Improved cultural practices for groundnut have been developed at ICRISAT, based on the broadbed-and-furrow (BBF) system. A suite of low-cost bullock-drawn implements¹ is now available to enable farmers to form the BBF system easily and to carry out subsequent cultural operations. The design is simple enough for the implements to be fabricated in small workshops with locally available material. The central component common to all of these implements is a "T-Bar" made from either iron or wood. The iron T-bar consists of a square toolbar, formed by joining two angle-iron pieces (40 x 40 x 6 mm, 1.7 m long), and a drawpole made of iron pipe (50 mm diam). The wooden T-bar consists of a wooden plank (70 x 100 mm, 1.7 m long) and two beams. Standard C-clamps are used to attach implements to the iron T-bar, whereas specially designed clamps are used for attaching tools to the wooden T-bar. This allows farmers to carry out a range of operations using the implements described below.

Broadbed former. Two ridgers are attached to the T-bar at a spacing of 1.5 m. The ridgers make two 30-cm-wide parallel furrows on each side of a 1.2-m-wide broadbed. A chain can be attached behind the ridgers to smooth the top of the broadbed (Fig. 1).

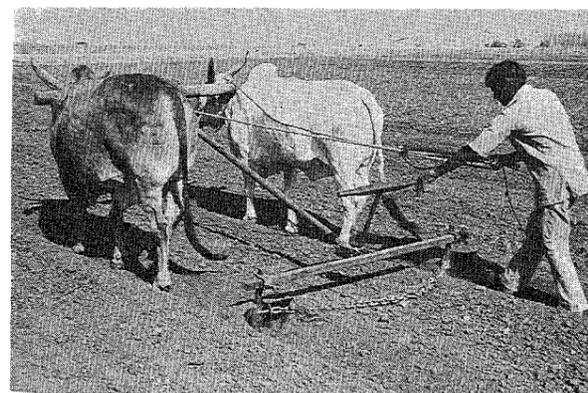


Figure 1. Broadbed former on iron T-bar.

Broadbed former with fertilizer application attachment. Four furrow openers and a wooden

1. Use of the implements on the T-bar is not limited to groundnut; the implements can be used for other dryland crops as well.

divider bowl, for manual metering of fertilizer, are attached to the T-bar of the broadbed former. This enables broadbeds to be formed, rows made, and fertilizer applied simultaneously in one operation. If fertilizer is already mixed into the soil, and seeds are to be dibbled manually, this implement can be used for making broadbeds and marking the rows.

Interrow weeding attachment. Three duckfoot sweeps are attached to the T-bar of the broadbed former and used for interrow weeding. The duckfoot sweeps cultivate the interrow zone in the crop, while the ridgers remove weeds from the furrows and deepen them (Fig. 2).



Figure 2. Interrow weeding attachment on broadbed former.

Groundnut planter. A four-row planter developed for groundnut is mounted on the T-bar, along with a pair of small wheels and four furrow openers. The planter consists of a seed box containing four seed-metering plates, a ground wheel drive, and a frame to support this whole unit on the T-bar. The drive wheel can be held in the lifted position during transport. A chain is attached to the shanks of the wheels to cover the planted rows.

Evaluation. An experiment was conducted to evaluate the performance of these implements. The average (actual) field capacity of each of the implements was about 0.2 ha h⁻¹.

Other useful implements for groundnut production are: a twin spinning-disc knapsack sprayer (IAN 2:14) and a groundnut digger for dry and hard soil conditions (IAN 3:17).

Effect of Water-Soluble and Insoluble Phosphatic Fertilizers on Yield of Groundnut in Acid Lateritic Soils of Orissa, India

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A large area of acid red and lateritic soils of Orissa is under groundnut cultivation. These soils have a high phosphate-fixing capacity due to low pH and high free oxide content. Phosphate management in these soils is a serious problem, particularly when a crop with a high phosphate requirement, such as groundnut, is grown. With this problem in view, field trials were conducted in an acid lateritic soil to evaluate the

efficiency and requirement of a water-soluble phosphate source, such as single superphosphate (SSP), and an insoluble source, such as Udaipur rock phosphate (URP) containing 14.6% total P₂O₅. Both SSP and URP were applied alone and in two different combinations--ratios of 1:1 and 1:3--each applied at 40 and 80 kg P₂O₅ ha⁻¹; a control (no phosphate application) was included.

The trials were conducted with groundnut cv AK 12-24, in both 1986/87 and 1987/88 post-rainy seasons, in a randomized-block design with three replications, at the Regional Research Station, Bhubaneswar. All treatments received 20 kg N ha⁻¹ and 40 kg K₂O ha⁻¹.

The soils of the experimental sites in both 1986/87 and 1987/88 were sandy loam; the first with a pH of 5.1 and available P (Olsen's extract) 10.5 kg ha⁻¹, and the second with a pH of 5.6 and available P

Table 1. Effect of water-soluble and insoluble phosphatic fertilizers on yield of groundnut on acid lateritic soils of Orissa, India, in two post-rainy seasons.

Treatment ^{1/} Source of P ²	1986/87			1987/88		
	Pod yield (t ha ⁻¹)			Pod yield (t ha ⁻¹)		
	P ₂ O ₅ applied (kg ha ⁻¹)			P ₂ O ₅ applied (kg ha ⁻¹)		
	40	80	Mean	40	80	Mean
SSP	1.42	1.71*	1.57a ³	1.62	1.77*	1.70a
URP	1.06	1.22*	1.14c	1.44	1.56*	1.50c
SSP + URP (1:1)	1.38	1.72*	1.55a	1.63	1.84*	1.74a
SSP + URP (1:3)	1.11	1.46*	1.29b	1.55	1.65*	1.60b
Mean	1.24	1.53	-	1.56	1.70	-
Control (no phosphate)	0.93	-	-	1.19	-	-
CD (0.05)				0.06		
P source	0.09			0.01		
P level	0.07			NS		
P source x P level	NS			NS		
Control vs rest	0.13			0.05		

- All treatments were given 20 kg N and 40 kg K₂O ha⁻¹.
 - SSP = single superphosphate; URP = Udaipur rock phosphate.
 - Means followed by the same letters are not significantly different at P = 0.05.
- * Significantly different from 40 kg P₂O₅ level at P = 0.05.

13.5 kg ha⁻¹. URP was applied broadcast, 15 days before sowing, and then thoroughly mixed with the soil; SSP and mixtures of SSP and URP were applied in rows just before sowing.

As Table 1 shows, application of phosphorus significantly increased the pod yield of groundnut. At 80 kg P₂O₅, there was a significant increase in pod yield over 40 kg P₂O₅, which may be due to the high P-fixing capacity and low available P content of the soil. Application of SSP + URP mixture at 1:1 proved as efficient as SSP alone and significantly superior to URP alone and SSP + URP mixture in the ratio of 1:3. Of the three treatments, application of an insoluble phosphate source, such as URP alone, gave the least pod yield.

Weed Management in Groundnut¹

A. Ramakrishna and C.K. Ong (ICRISAT Center)

Weed infestation in groundnut crops can reduce yields by as much as 50% in bunch and 20% in spreading types (Kulkarni et al. 1963). The growth habit of groundnut limits mechanical weed control in this crop. Moreover, the mounting costs and scarcity of labor prove further constraints to the traditional method of hand weeding. Chemical weed control is therefore gaining wide acceptability (Kulandaivelu and Shankaran 1986).

An experiment was conducted during the 1987

Table 1. Dry mass of weeds and pod yield of groundnut as influenced by various herbicide treatments on a medium-deep Alfisol at ICRISAT Center, India.¹

Treatment	Herbicide dose (kg a.i. ha ⁻¹)	Application time ²	Weed mass ³ (g m ⁻²)		Pod yield (kg ha ⁻¹)
			60 DAE	At harvest	
Metolachlor	1.0	Pre	13.0	16.9	1150
Metolachlor	1.5	Pre	11.6	21.8	1350
Metolachlor	2.0	Pre	11.2	13.0	1380
Pendimethalin	1.0	Pre	10.8	16.7	1280
Pendimethalin	1.5	Pre	11.5	15.7	1420
Pendimethalin	2.0	Pre	12.5	16.0	1250
Metolachlor + Pendimethalin	1.0+1.0	Pre	11.1	14.8	1440
Metolachlor/Flauzifop-butyl + Bentazon	1.0/0.2+1.0	Pre/Post	11.1	18.6	1430
Pendimethalin/Flauzifop-butyl + Bentazon	1.0/0.2+1.0	Pre/Post	11.1	15.5	1410
Flauzifop-butyl + Bentazon	0.2+1.0	Post	17.4	18.2	910
Flauzifop-butyl + Bentazon	0.4+1.0	Post	11.6	17.9	1200
Metolachlor/Hand weeding	1.0	Pre/30 DAE	8.0	15.8	1760
Pendimethalin/Hand weeding	1.0	Pre/30 DAE	8.4	15.3	1600
Hand weeding/Flauzifop-butyl + Bentazon	0.2+1.0	21 DAE/Post	10.2	15.6	1440
Hand weeding (1)	-	30 DAE	10.7	14.9	1550
Hand weeding (2)	-	21/42 DAE	3.0	11.0	1830
Control plots					
Weed-free	-	-	0.7	0.7	1860
Weedy	-	-	28.8	23.4	430
CD at 5%	-	-	4.84	4.84	188

- Randomized-block design, with three replications.
- Pre = preemergence; Post = postemergence; DAE = days after emergence.
- Original weed dry matter (x) data were transformed to $\sqrt{x + 0.5}$.

¹ Paper presented at the Biennial Conference of the Indian Society of Weed Science, 8-9 Mar 1988, Assam Agricultural University, Jorhat, Assam, India.

rainy season at ICRISAT Center, Patancheru, to evaluate the effectiveness of pre- and postemergence herbicides at different concentrations, in different combinations, and in combination with hand weeding. These were compared with a weedy control and a weed-free condition. Table 1 shows the 18 treatments tested; they were replicated three times in a randomized-block design.

The soil was a medium-deep Alfisol, sandy clay loam in texture, with a pH of 8.35 and an available soil moisture storage capacity of about 100 mm; it was low in available nitrogen and phosphorus and medium in organic carbon and potassium. A recommended fertilizer dose of 18 kg N and 36 kg P₂O₅ ha⁻¹ was incorporated at the time of land preparation. Weed flora of the experimental field consisted of both annual grasses and broadleaf weeds; these included: *Echinochloa colonum*, *Digitaria ciliaris*, *Dactyloctenium aegyptium*, *Digera arvensis*, *Celosia argentea*, *Portulaca oleracea*, *Euphorbia hirta*, *Amaranthus viridis*, and *Lagascea mollis*. Dry-matter production of weeds and groundnut pod yield are presented in Table 1.

The dry matter of weeds at 60 days after crop emergence (DAE) was least when hand weeding was done at 21 and 42 DAE, which was comparable with the weed-free control. Preemergence application of metolachlor and pendimethalin at 1 kg a.i. ha⁻¹, followed by one hand weeding at 30 DAE resulted in low weed biomass. At 60 DAE, all the herbicide treatments had reduced the density of dominant weeds significantly in comparison with the weedy control plots, although there was a subsequent increase in weed biomass by the end of the season. This may be attributed to the reduced competition among the weed species that were not controlled by the herbicides and the luxuriant vegetative growth, particularly of broadleaf weeds. However, the weedy control treatment recorded less weed biomass at harvest than at 60 DAE, because of the death of annual grasses and the less vigorous growth of broadleaf weeds with increased competition for all the growth factors.

The maximum pod yield of 1860 kg ha⁻¹ was recorded in the weed-free treatment, followed by 1830 kg ha⁻¹ with hand weeding at 21 and 42 DAE, and 1760 kg ha⁻¹ with 1 kg a.i. ha⁻¹ of metolachlor preemergence and one hand weeding at 30 DAE. However, differences in yield among these three treatments were nonsignificant. In plots with poor weed control, particularly at lower rates of herbicides, pod yield of groundnut was significantly lower than in weed-free plots. Comparable yields were obtained with (1) a combination of metolachlor and pendimethalin, (2) sequential application of flauzifop-butyl + bentazon, after preemergence application of pendimethalin and metolachlor, and (3) one hand weeding at 30 DAE followed by postemergence application of flauzifop-butyl + bentazon. All the herbicide treatments were found significantly better than the weedy control, which yielded only 430 kg ha⁻¹.

These results indicate that the integration of

preemergence herbicides, such as metolachlor or pendimethalin, applied at 1 kg a.i. ha⁻¹, with one hand weeding at 30 DAE could considerably reduce the weed infestation by controlling most of the annual grasses and some of the broadleaf weeds, and thereby increase groundnut yields.

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Host Defence Mechanisms Against Groundnut Rust

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Findings on groundnut x rust interactions and the effects of certain chemical and biological agents at cellular and molecular levels on four cultivated groundnut genotypes and three wild *Arachis* species are presented here.

Host reactions at cellular level. Histochemical tests revealed absence of lignin and suberin at all stages, but callose deposition was observed in the cells adjacent to the uredosori at 10 days after inoculation; no genotypic differences were observed.

Reactions at molecular level. Peroxidase activity. Peroxidase activity was highest in PI 259747 and lowest in NC Ac 17090, both genotypes resistant to rust, while it was intermediate in the two susceptible genotypes, Local and RMP 91. Enzymatic activity was

slightly stimulated by rust infection. Electrophoretic study of isoperoxidases showed de novo presence of three cathodic and two anodic bands in infected plant extracts.

Total phenolic and protein content. No correlations were obtained between protein content and host resistance levels. Genotypic differences in total phenolic content did not correlate with host resistance

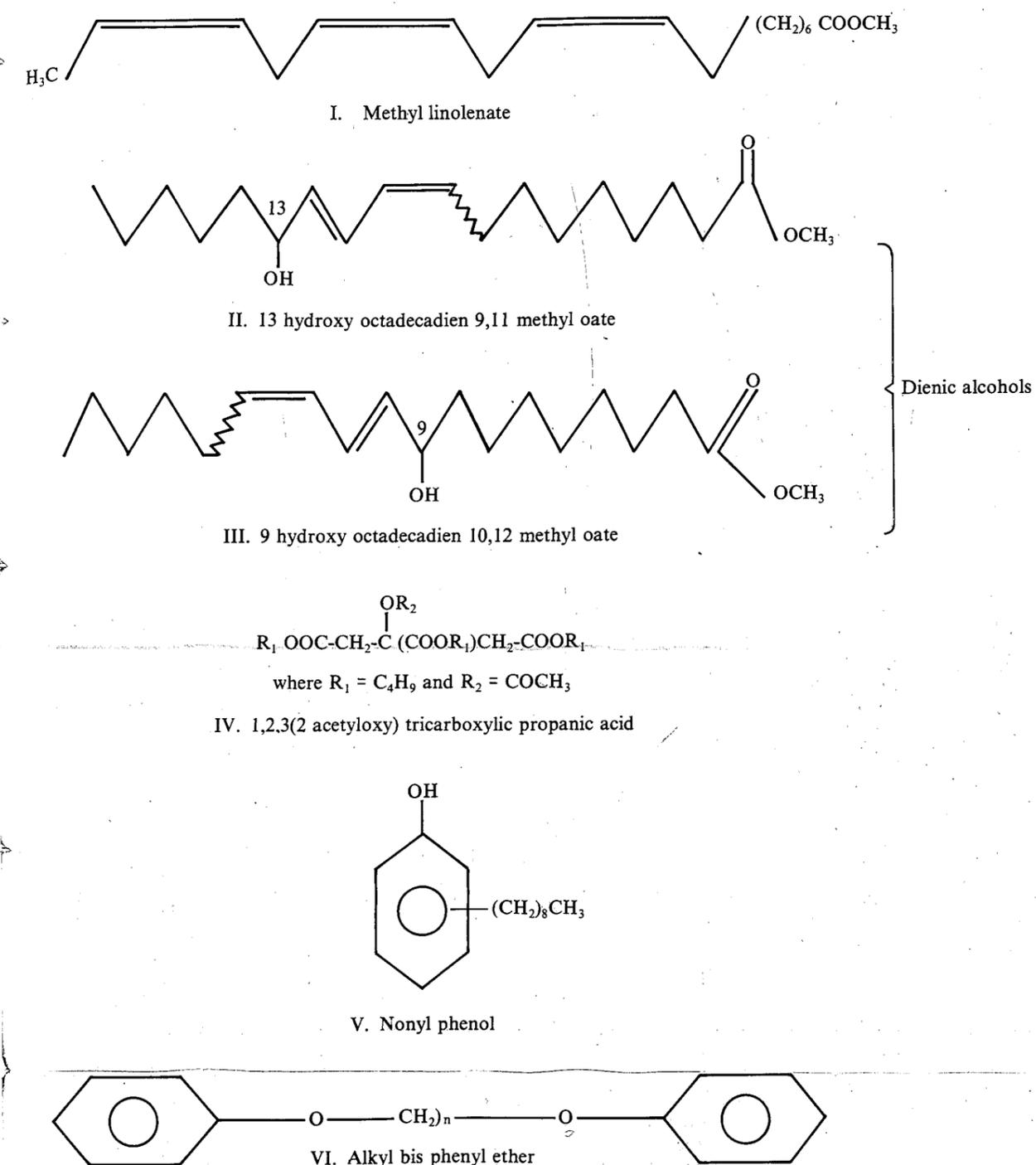


Figure 1. Structures of six new antifungal compounds isolated from rust-infected groundnut leaves.

levels. However, total phenolic contents of three wild *Arachis* species (*Arachis* sp GKP 9893, *A. chacoense*, and *A. glabrata*), which are immune or highly resistant to rust, were at least four times higher than the average of the four cultivated genotypes.

Production of antifungal compounds: Using a *Cladosporium* test, the presence of both preformed and postinfection antifungal compounds was detected; studies were concentrated on the antifungal compounds. Twelve antifungal compounds were isolated and purified, and the chemical structures of eight of them were determined. All compounds listed in Figure 1 are reported for the first time from groundnut, while hydroxystilbenes and medicarpin, also characterized in our studies, were previously reported (Aguamah et al. 1981; Strange et al. 1985), but in interactions with pathogens other than rust. The in vitro antifungal activity of methyl linolenate and dienic alcohols against *Puccinia arachidis* was established (Subba Rao et al. 1988). Time course studies are needed to assess the roles played by these compounds in host resistance.

Modulation of host defences by chemical or biological agents: Treatment with amino-oxy acetic acid (a competitive inhibitor of phenyl alanine ammonia lyase) decreased the strength of host defences, indicating involvement of phenolic compounds in host defence mechanisms. Similarly, fostyl-Al (Tris-o-ethyl aluminum phosphonate), an anti-oomycete compound, enhanced host resistance by stimulating host defence mechanisms.

Cross-protection with a nonpathogen (maize rust) also increased host resistance to *P. arachidis*, and the implication of this for control of rust merits further investigation.

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Improving Field Screening of Groundnut Genotypes for Resistance to Foliar Fungal Diseases

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At ICRISAT Center, Patancheru, India, two foliar fungal diseases commonly cause severe damage to groundnut: rust, caused by *Puccinia arachidis*, and late leaf spot, caused by *Phaeoisariopsis personata*.

When field-screening groundnut germplasm and breeding lines for resistance to these diseases, we have often experienced problems in accurately rating a genotype for resistance to one disease because of the damage caused by the other disease. The problem is not so important when genotypes with resistance to both diseases are tested, but a genotype with resistance to rust may be scored higher or lower for resistance to late leaf spot than another genotype that has actually the same level of resistance to late leaf spot but is susceptible to rust. Also, the defoliation caused by late leaf spot on a susceptible genotype can influence the disease scoring for rust.

To get round this problem of interference, we have tried a modification of our field-screening process, by which each genotype is tested for reaction to rust and to late leaf spot in separate trials.

Two sets of potted plants of cv TMV 2 are raised in isolation from one another; one set is inoculated with rust and the other with late leaf spot. Identical sets of test genotypes are sown in two replicated field trials, preferably in different fields some distance apart. Each test plot consists of two 4-m rows, 60 cm wide, of the test material; one "infecter row" of cv TMV 2, susceptible to both rust and leaf spot, is sown between test plots.

At 30-35 days after sowing (DAS) one potted plant infected with rust is placed in the center of each infecter row in the rust screening trial and one potted plant infected with late leaf spot is placed in the center of each infecter row in the late leaf spot screening trial. A few days later (35-40 DAS), the infecter rows in each trial are sprayed with a spore suspension of the appropriate pathogen to enhance the effects of the potted spreader plants. Five days later, selective fungicides are applied to these trials; bavistin 50% WP (500 g a.i. in 500 L water ha⁻¹) to the rust resistance screening trial to prevent the establishment of leaf spot, and calixin 80% solution (150 mL a.i. in 500 L of water ha⁻¹) to the late leaf spot screening trial to prevent establishment of rust disease. Further sprays are applied at 15-day intervals until 30 days before harvest (the number of sprays may be reduced if weather conditions do not favor disease buildup).

The establishment of separate rust and late leaf spot epidemics enables accurate rating of genotypes for resistance to each disease and satisfactory comparisons of specific disease resistance between genotypes with multiple disease resistances (Table 1). We appreciate that at some stage genotypes must be evaluated under

Table 1. Reaction of eight groundnut genotypes to rust and late leaf spot in field-screening trials, ICRISAT Center, India.¹

Genotype	Disease reaction ²			
	Sprayed with		No spray	
	Calixin (controls rust)	Bavistin (controls leaf spot)	Late leaf spot	Rust
PI 414332	9.0	5.0	8.3	3.0
C.No. 45-23	8.3	6.3	8.0	4.0
PI 298115	8.3	6.3	8.0	3.0
PI 259747	3.6	4.0	4.0	3.3
PI 390595	3.0	4.0	3.0	3.3
PI 393641	7.0	5.3	7.3	3.6
PI 405132	5.0	2.6	3.0	2.6
TMV 2 (susceptible)	9.0	9.0	9.0	5.3
SE	±0.192	±0.272	±0.329	±0.262
CV (%)	5.2	10.4	9.3	12.0

1. For accurate ratings, screening is done separately for each disease; fungicidal sprays control the other disease to prevent interference.

2. Based on a scale of 1-9 where 1 = no symptoms and 9 = 50-100% foliage destroyed.

multiple disease conditions; however, we believe that their reactions to such evaluation can be better understood if there are accurate data on reaction to individual diseases.

Crossopalpus sp (Empididae: Diptera)—an Efficient Predator of Jassids of Groundnut

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Much research and development work is needed before biological control of groundnut pests can

become a practical proposition. The work done at some of the centers under the All India Coordinated Research Project on Biological Control of Insect Pests and Weeds in India tempted us to look for new biocontrol agents.

During a survey in farmers' fields and in our research station fields in Junagadh during the second half of September 1986, a dipteran fly, identified as *Crossopalpus* sp, was observed preying on jassids. These flies, which have a horny piercing proboscis, are popularly called bristly flies. In attacking their prey, they fly swiftly, aiming at the prey and holding it with one foreleg and two of the mid and hind legs opposite. Any part of the jassid prey—thorax, abdomen, ocelli—may be pierced.

Both males and females feed voraciously on the jassids *Empoasca kerri* Pruthi, *Balclutha hortensis* Lindb., and *Exilanus taeniaceps* (Kirchbaum) under laboratory conditions. Preliminary experiments were

Table 1. Feeding and resting time in laboratory studies of the dipteran fly, *Crossopalpus* sp, a predator of jassids of groundnut, Junagadh, India.

Cage	Feeding time (min)	Resting time (min)	CD ($P=0.05$)	Total time taken to consume 10 jassids ¹ (min)
Test tube	6.7	9.9	1.9	165.0b
Glass trough	7.6	13.0	2.0	204.2a
Wooden cage	4.6	17.4	1.8	221.0a

1. Values followed by the same letter in a column do not differ significantly at the 5% probability level.

conducted in the laboratory to assess the predatory potential of *Crossopalpus* sp. Three containers were used for this purpose: a test tube (15 x 1.5 cm), a glass trough (20 x 12.6 x 12.6 cm), and a cage (75 x 60 x 40 cm).

The required population of jassids (*E. kerrii*) and flies were collected from the field with sweepnets. Twenty-five jassids and one fly were released in the test tube. Twenty-five jassids and one fly were released in the glass trough, into which was inserted a glass vial containing a branch of groundnut with five to six leaves, wrapped with cotton dipped in 2% sucrose solution. The top of the trough was covered with a glass plate. Inside the inverted cage, four 75-day-old potted plants of groundnut cv JL 24 were arranged in the middle and 25 jassids were released, followed by 1 fly. Only female predators were used for all the studies.

The time taken for feeding and resting was observed, and highly significant differences in feeding and resting times were noted among the three types of containers. As Table 1 shows, the feeding time was the longest (6.7 min) and the resting time the shortest (9.86 min) in the smallest space--the test tube. Conversely, feeding time was least (4.6 min) and resting time the most (17.4 min) in the largest space--the cage.

The predator took 221 minutes to prey on 10 jassids when the space simulated field conditions, i.e., in the cage, and preyed on an average of 27 jassids in a 10-h period.

Thus *Crossopalpus* sp appears to be a more efficient predator than *Lycosa pseudoannulata*, which consumed an average of three brown plant hoppers (BPH) and six whitebacked plant hoppers (WBPH) a day in a rice ecosystem (Gopalan 1988).

Further investigations are in progress on the predatory potential of both sexes of *Crossopalpus* sp

and the competition for prey between this predator and spiders.

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Screening for Resistance to Groundnut Leaf Miner, *Aproaerema modicella* Deventer

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The groundnut crop in India suffers severe damage from insect pests, particularly leaf miner, *Aproaerema modicella* Deventer, the key pest of groundnut in many parts of India. The areas most affected are Tamil Nadu, western and central Andhra Pradesh, Karnataka, western Maharashtra, and Orissa. Reported yield increases ranged from 49 to 85% when the insect was controlled with chemicals. However, as groundnut is grown mostly as a rainfed crop, control of the leaf miner is aimed at through the development of resistant cultivars. Only a few reports of screening groundnut germplasm against the leaf miner are available (Vikram Singh 1979; Wightman et al. 1987). Vikram Singh (1979) reported that genotypes USA 61 and No. 243 were resistant and EC 76452, EC 76457,

Table 1. Leaf miner incidence and pod yield of four groundnut entries at Vriddhachalam, Tamil Nadu, India, rainy season 1987.¹

Entry	Mean no. larvae plant ⁻¹				Leaflet damage (%)	Pod yield (kg ha ⁻¹)
	Days after sowing			Mean		
	30	60	75			
JL 24	2.7	16.2	4.4	7.8	45.7	2100
Co 2	1.6	8.5	4.4	4.8	31.7	2000
VRI 1	1.4	5.0	4.0	3.5	28.5	2400
ICGS 50	0.5	6.0	2.0	2.8	23.3	3000
Mean	1.6	8.9	3.7	4.7	32.3	2375
SE	±0.5	±2.5	±0.6	±1.1	±4.8	±225

1. Number of plant samples = 10; mean of 3 replications.

EC 106980, EC 106983, EC 106966, Exotic 5, Exotic 5-3, Exotic 5-4, and Ah 7795 were tolerant to leaf miner.

The present study was made to select lines with resistance to the leaf miner at the Regional Research Station, Vriddhachalam, Tamil Nadu. Three hundred entries were screened against leaf miner; these were sown in nonreplicated 3-m rows. One border row of soybean was grown along the field as an infector crop, sown 15 days before groundnut sowing. Leaf miner incidence was visually rated (0-9 scale) on percentage of dry area of leaves.

Sixteen selections were tested under unprotected conditions, with three replications, during the next season. Of the 16 entries, ICGS 50, a cross between wild species, *Arachis cardenasii* Krap et Greg. nom nud., and *A. hypogaea* Linn. recorded the lowest severity index of 0.08 and 1.2 larvae plant⁻¹, as against a 0.18 severity index and 2.8 larvae in the susceptible control TMV 2.

The yield potential of ICGS 50 was assessed during the 1987 rainy season in plots of 5 m x 4 m (Table 1). ICGS 50 not only was less susceptible to the leaf miner than the other genotypes commonly grown in Tamil Nadu but also had the highest pod yield of 3000 kg ha⁻¹.

In the 1988 postrainy season, ICGS 50 was compared with VRI 1 and two runners, ICG 2271 and ICG 156, in plots of 8 m². There was no leaf miner

infestation, but *Spodoptera litura* Bois. and *Heliothis armigera* Hb. were present. Leaf damage by these two pests was estimated to be only 13% in ICGS 50, as against 48% in VRI 1, 20% in ICG 156, and 18% in ICG 2271. When late leaf spot (*Phaeoisariopsis personata*) incidence was scored on a 1-9 scale, ICGS 50 recorded 3, as against VRI 1, which recorded 6. From these data it is evident that ICGS 50 possesses resistance not only to leaf miner but also to other foliar insects and to late leaf spot disease.

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Interaction Between Sex Pheromones of *Spodoptera litura* Fab. and *Heliothis armigera* (Hüb)

C.S. Pawar and C.P. Srivastava (ICRISAT Center)

ICRISAT standard pheromone traps baited with the lures of *Spodoptera litura* Fab. and *Heliothis armigera* (Hüb.), separately and together, were operated in a field of groundnut for 8 weeks during August-October 1982. Traps were used in two replicates at a distance of 30 m from one another. The positions of these traps were changed clockwise twice a week to eliminate positional effect, if any, on trap catches. The lures were replaced with fresh ones after 4 weeks. Records of moth catches are shown in Table 1.

The catches of *H. armigera* males in traps baited with lures of both the insects were far lower than in

traps baited with *Heliothis* pheromone alone. However, the catches of *S. litura* in traps baited with both pheromones were at par with, even slightly higher than, catches in traps baited with the *Spodoptera* pheromone alone.

There was clearly a masking effect of the sex pheromone of *S. litura* on the sex pheromone of *H. armigera*. The marginally higher average catch of *S. litura* in traps with lures of both insects could be due to a complementing effect of some chemical in the composition of the sex pheromone of *H. armigera*. We have occasionally obtained *S. litura* moths in many of our *H. armigera* traps in other experiments, but so far no *H. armigera* moths have been caught in *S. litura* traps.

These observations suggest that the trapping of *H. armigera* and *S. litura* in the same trap using sex pheromones is not advisable.

Table 1. Mean weekly catches of *Heliothis armigera* and *Spodoptera litura* male moths in ICRISAT standard pheromone traps baited with the synthetic pheromones of these insects separately and together in a groundnut field, ICRISAT Center, 1982.

Week	<i>H. armigera</i> + <i>S. litura</i> pheromones		<i>S. litura</i> pheromone	
	<i>H. armigera</i> pheromone	Catches of		
	Catches of <i>H. armigera</i>	<i>H. armigera</i>	<i>S. litura</i>	Catches of <i>S. litura</i>
20-26 Aug	18.0	11.0	45.0	60.5
27-02 Sep	60.5	10.0	54.0	57.0
03-09 Sep	203.0	11.0	166.0	108.0
10-16 Sep	43.0	0.0	46.0	108.0
17-23 Sep	33.0	1.5	86.0	72.5
24-30 Sep	11.0	0.0	122.0	51.0
01-07 Oct	1.0	0.0	67.0	108.5
08-14 Oct	2.0	0.0	195.0	178.5
Mean	46.4	4.2	97.6	93.0
SE (m)		±1.99		±7.33

Evaluation of the Symbiotic Potential of Some Wild *Arachis* Species with Two *Rhizobium* Strains

Jiang Rongwen, Zhou Rong, Jiang Moulan, and Zhang Xuejiang (Oil Crops Research Institute, Chinese Academy of Agricultural Sciences, Wuhan, Hubei, People's Republic of China)

Biological nitrogen fixation (BNF) and the symbiotic relationship between groundnut and *Rhizobium* spp have been extensively studied and well documented by many authors (Nambiar 1985). The host plant (macrosymbiont) also plays an important role in controlling the symbiotic characters, and host selection and breeding to enhance biological nitrogen fixation is an interesting research aspect of BNF.

Although the wild *Arachis* species have been intensively used in interspecific hybridization to improve cultivated groundnut, little work has been done to determine symbiotic characters and nitrogen-fixing potential with *Rhizobium*. Here we report preliminary results on the symbiotic response of two wild species and two *Rhizobium* strains.

A water pot experiment was conducted, using two wild species, *Arachis villosa* and *A. stenosperma*, and

two *Rhizobium* strains—NC 92 (from South America) and M 30 (a domestic strain isolated from the nodules of siratro, *Macropitium atropurpureum*, grown in Wuhan soil, China). Seedlings of the wild *Arachis* species, just transplanted to sterile liquid nutrient pots from sterile germinating tubes (Zhou et al. 1979), were inoculated with liquid suspensions of the *Rhizobium* strains. The species/strain combinations were grown in three pots, with three plants in each; another three pots of each species were used as noninoculated controls. Plants were grown in the greenhouse to prevent possible contamination through rain.

Five plants from each treatment were harvested at 25 days after sowing (DAS) and 4 plants from each treatment at 63 DAS. Nodule number and top dry mass plant⁻¹ were determined (Fig. 1), and total nitrogen content of the shoots was measured by the Kjeldahl method.

There are large differences in nodulating ability between the two wild species tested. *A. villosa* showed higher dry-matter production than *A. stenosperma* when harvested at 63 DAS. These genotypes also have different growth rates, which may be one of the factors contributing to the difference in nitrogen-fixing ability between the two. Total nitrogen content in the shoots

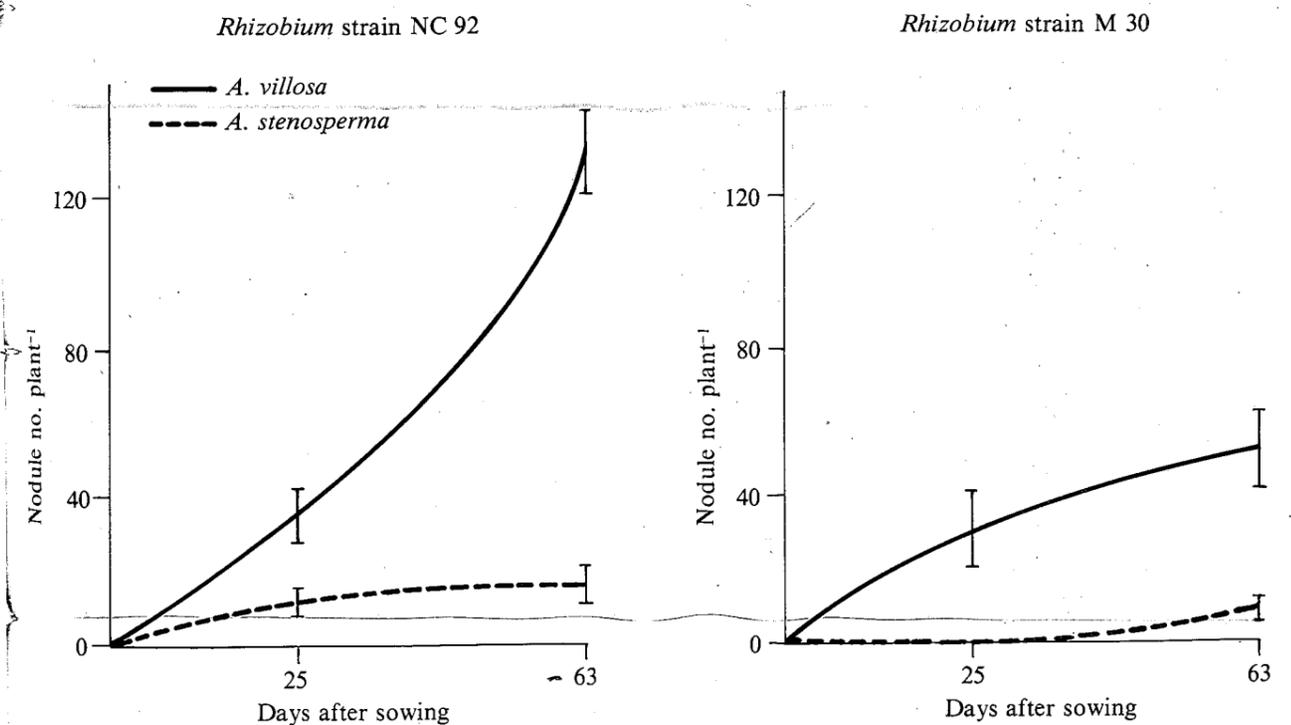


Figure 1. Differences in nodulating ability between two wild *Arachis* species inoculated with two *Rhizobium* strains: exotic strain NC 92 from South America and a local Chinese strain, M 30.

Table 1. Total dry matter and nitrogen content of two wild *Arachis* species inoculated with two *Rhizobium* strains in a water pot experiment, Wuhan, Hubei, People's Republic of China.

Wild <i>Arachis</i> species	Top dry mass ² (g plant ⁻¹)			Total N content of shoot ³ (mg plant ⁻¹)		
	<i>Rhizobium</i> strain		Control	<i>Rhizobium</i> strain		Control
	NC 92	M 30		NC 92	M 30	
25 DAS ¹						
<i>A. villosa</i>	0.43a	0.33a	0.61a			
<i>A. stenosperma</i>	0.35b	0.24b	0.27b			
63 DAS						
<i>A. villosa</i>	1.20a	0.85a	0.66a	20.5	NA ⁴	11.7
<i>A. stenosperma</i>	0.36b	0.41b	0.27b	7.6	6.8	6.5

1. DAS = Days after sowing.
2. Values in the same column at the same growth stage with different letters are significant at the $P=0.05$ level, according to the LSD test.
3. Values are the means of all samples collected at 25 and 63 DAS.
4. NA: not analyzed.

of the *A. villosa*/NC 92 strain combination reached over 20 mg N plant⁻¹ at 63 DAS—about twofold that of its noninoculated control. The total nitrogen content per plant of both the *A. stenosperma*/NC 92 strain combination and the *A. stenosperma*/M 30 strain combination was only slightly higher than that of their noninoculated controls (Table 1).

The *Rhizobium* strain NC 92 was found to be distinctly superior to the M 30 strain, possibly because the NC 92 strain and the wild *Arachis* species have coevolved in South America.

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Root Induction on in vitro Grown Shoots of *Arachis* Species and a Hybrid

J.P. Moss, N.R.G. Dutt, and Aruna Lingamaneni (ICRISAT Center)

Introduction. Plant regeneration is a prerequisite for the success of any genetic engineering experiment. Very often, regeneration is limited to either caulogenesis or rhizogenesis, and complete regeneration may not be realized. In such cases, induction of roots on optimally grown shoots will become an indispensable step to producing plants and to helping establish tissue culture derived shoots.

Several methods have been used to induce roots, such as transferring shoots to either liquid or semisolid rooting medium enriched with auxins, transferring shoots to pots containing sterile sand and soil mixture and feeding them with different nutrients and growth hormones, or grafting the shootlets on to young seedlings of the same species (ICRISAT 1986, 1987).

This paper reports a method used to induce roots with greater efficiency in different *Arachis* spp by using filter paper bridges as supports in liquid medium and manipulating hormonal concentrations and other constituents of the media.

Materials and methods. Shoots regenerated from the callus cultures of *A. hypogaea*, *A. villosulicarpa*, and a hybrid derivative (*A. hypogaea* cv MK 374 x *Arachis* sp PI 276233) were cultured with filter papers folded into bridges to support the shoots (Fig. 1). These were grown in root induction media (MSRIM) based on Murashige and Skoog's (1962) liquid medium, enriched with different concentrations of the auxins naphthalene acetic acid (NAA) and indole butyric acid (IBA) (Table 1) and altered media constituents.

Results.

1. *A. hypogaea* cultures: All shoots formed roots on both media tested, and all rooted shoots established well in soil.

Table 1. Composition of root induction media and rate of root induction in in vitro grown shoots of *Arachis hypogaea*, *A. villosulicarpa*, and a hybrid, at ICRISAT Center, India.

Root induction medium ¹	Concentration of				Proportion of shoots rooting (%)
	NAA (mg L ⁻¹)	IBA (mg L ⁻¹)	Sucrose (g L ⁻¹)	Major salts	
<i>A. hypogaea</i>					
MSRIM 1	2	1	30	100%	100
MSRIM 2	2	1	5	25%	100
<i>A. villosulicarpa</i>					
MSRIM 1	2	1	30	100%	69
MSRIM 3	4	2	30	100%	100
Hybrid cultures: <i>A. hypogaea</i> x <i>Arachis</i> sp PI 276233					
MSRIM 1	2	1	30	100%	20
MSRIM 2	2	1	5	25%	90
MSRIM 4	4	2	5	25%	60

1. MSRIM = root induction medium based on Murashige and Skoog's liquid medium, enriched with various concentrations of auxins; NAA = naphthalene acetic acid; IBA = indole butyric acid.

2. *A. villosulicarpa* cultures: MSRIM 1, with 2 mg L⁻¹ NAA and 1 mg L⁻¹ IBA, which induced 100% rooting in *A. hypogaea*, induced only 69% of shoots of *A. villosulicarpa* to root. However, on MSRIM 3, with 4 mg L⁻¹ NAA and 2 mg L⁻¹ IBA, all shoots formed roots. Although these roots were less vigorous than

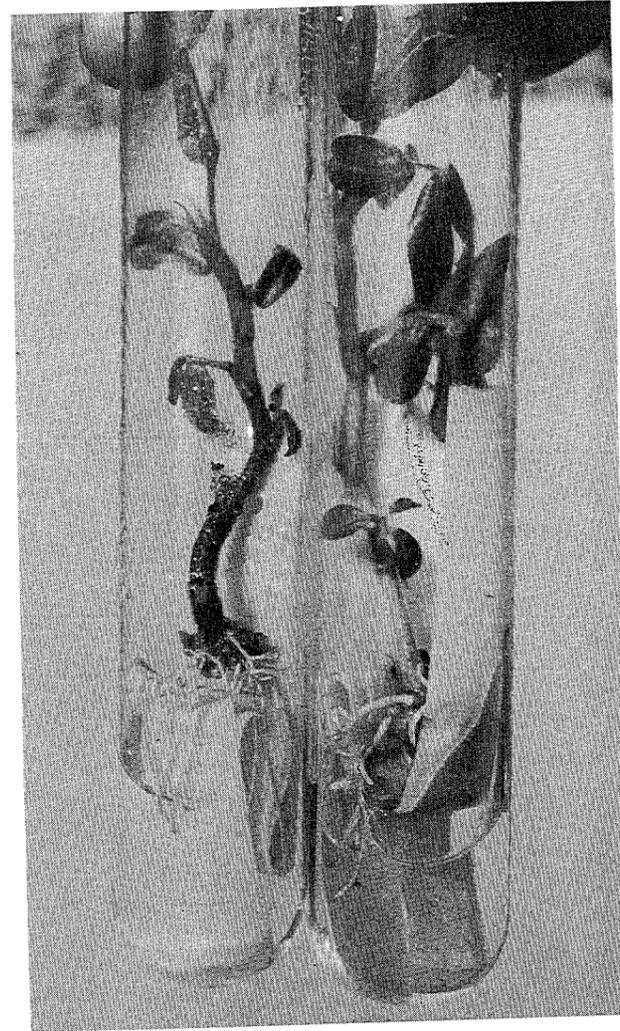


Figure 1. Shoots of *Arachis villosulicarpa* rooting on filter paper bridges.

those induced on MSRIM 1, all rooted *A. villosulicarpa* shoots established well in soil and have grown to maturity in the field.

3. Hybrid cultures: Root formation on MSRIM 1 was poor, but response on MSRIM 2 (also with 2 mg L⁻¹ NAA and 1 mg L⁻¹ IBA, but with reduced sucrose and major salts) was much better. However, increasing the concentration of auxins, which increased rooting in *A. villosulicarpa*, reduced the number of hybrid shoots that rooted.

Discussion. Shoots of both *A. hypogaea* and *A. villosulicarpa* could be induced to form roots on MSRIM 1 and MSRIM 2. Although only 69% of *A. villosulicarpa* shoots rooted on MSRIM 1, this species responded to an increase in the concentration of auxins.

Hybrid shoots have been more difficult to root and establish than those from *A. hypogaea* or wild species. Pittman et al. (1984) obtained better rooting with reduced sucrose and reduced major salts. Our hybrid shoots also responded to such a reduction, MSRIM 2 giving 90% root formation.

The levels of root formation reported are adequate for a practical program using callus formation and shoot and root induction.

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IAEA (International Atomic Energy Agency). 1988. **Improvement of grain legume production using induced mutations.** Proceedings of a workshop, 1-5 Jul 1986, Pullman WA, USA. Joint FAO/IAEA Division of Isotope and Radiation Applications of Atomic Energy for Food and Agricultural Development. Vienna, Austria: IAEA.

An introductory paper gives an overview of needs, achievements, and future possibilities for improving grain legume production through use of induced mutations. It includes a list of groundnut varieties produced following mutagenesis. Factors that have been improved include shell characters, groundnut yield and quality, plant type, stress tolerance, disease resistance, pod number, and oil content. Most cultivars were derived using gamma or X-rays. However, all 17 species of grain legumes together make up only 12% of all mutant cultivars on record, whereas rice contributes 18%. A paper on gamete irradiation points out the advantages of this technique compared with seed treatment.

There are six papers that refer to groundnut. One paper reports the use of gamma rays from 5 to 25 Krad, and mentions that 20 Krad was effective in producing two mutants with increased seed size. In Sri Lanka, kernel size, shelling percentage, early maturity, and yield of groundnut were improved by gamma rays. One derivative was better adapted to both favorable and poor environments. In Uganda, changes in many morphological characters were observed. In the Philippines, mutants were produced with resistance to early and late leaf spot, as they retained leaves when exposed to the disease. In Israel, no agronomically superior lines were produced, but useful genetic marker stocks were identified.

The Proceedings contain useful information on achievements in groundnut improvement through mutagenesis and on the techniques and mutagens used. Although 30 of the papers do not mention groundnut, they are a useful source of information on what is possible in mutation breeding in grain legumes.

--J.P. Moss (ICRISAT Center)

Minks, A.K., and Harrewijn, P. (eds.). 1988. **World Crop Pests: Aphids. Their biology, natural enemies, and control.** Volume 2B. Amsterdam, The Netherlands: Elsevier Science Publishers. ISBN 0-444-42798-8.

Aphids are an important insect pest in agriculture worldwide, destroying crops directly and also indirectly, as vectors of several economically important viral diseases. The literature on aphids is voluminous but scattered. This book gives detailed coverage of different topics on the basic biology and the management of aphids. Thirty-eight scientists from eight countries have contributed to the two volumes. Volume A contained chapters 1-7, on morphology and systematics, anatomy and physiology, reproduction, cytogenetics and developmental biology, aphids and their environment, evolution, and organization of populations and species. Volume B contains chapters 8 and 9; it is a concise and clearly written document and a good source of useful information.

Chapter 8 describes various sampling techniques, population developmental models, rearing, handling and mounting, microscopy, virus transmission, use of isotopes, bioassay, energy budget, electrophysiological and electrophoretic techniques, and application of feeding techniques. Chapter 9 is devoted to sampling, rearing and handling of aphid predators and parasites, the role of aphid pathogens, and insecticidal resistance in natural enemies of aphids.

This book covers 29 parasites, 161 predators, and 15 pathogens of aphids on different crops, which have often been neglected in pest control studies, and also refers to the phenomenon of insecticidal resistance in aphidophagous insects.

The cost of the book, though reasonable for the material and quality, may be high for buyers in developing countries. Order from: Elsevier Science Publishers, B.V. Sara Burgerhartstraat 25, P.O. Box 211, 1000 AE Amsterdam, The Netherlands. Price FL 320. Distributors for the USA and Canada: Elsevier Science Publishing Company, 52 Vanderbilt Avenue, New York NY 10017, USA.

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