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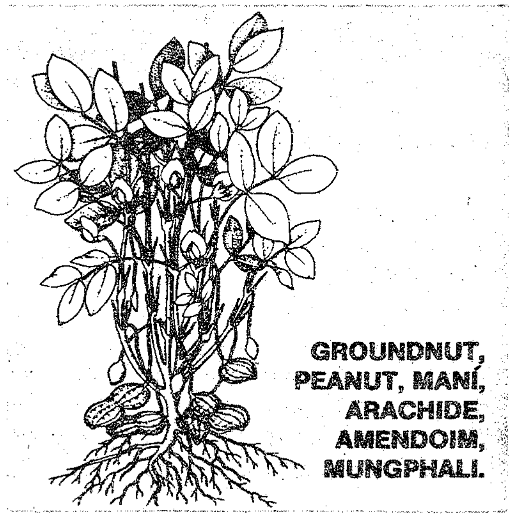
International Arachis Newsletter



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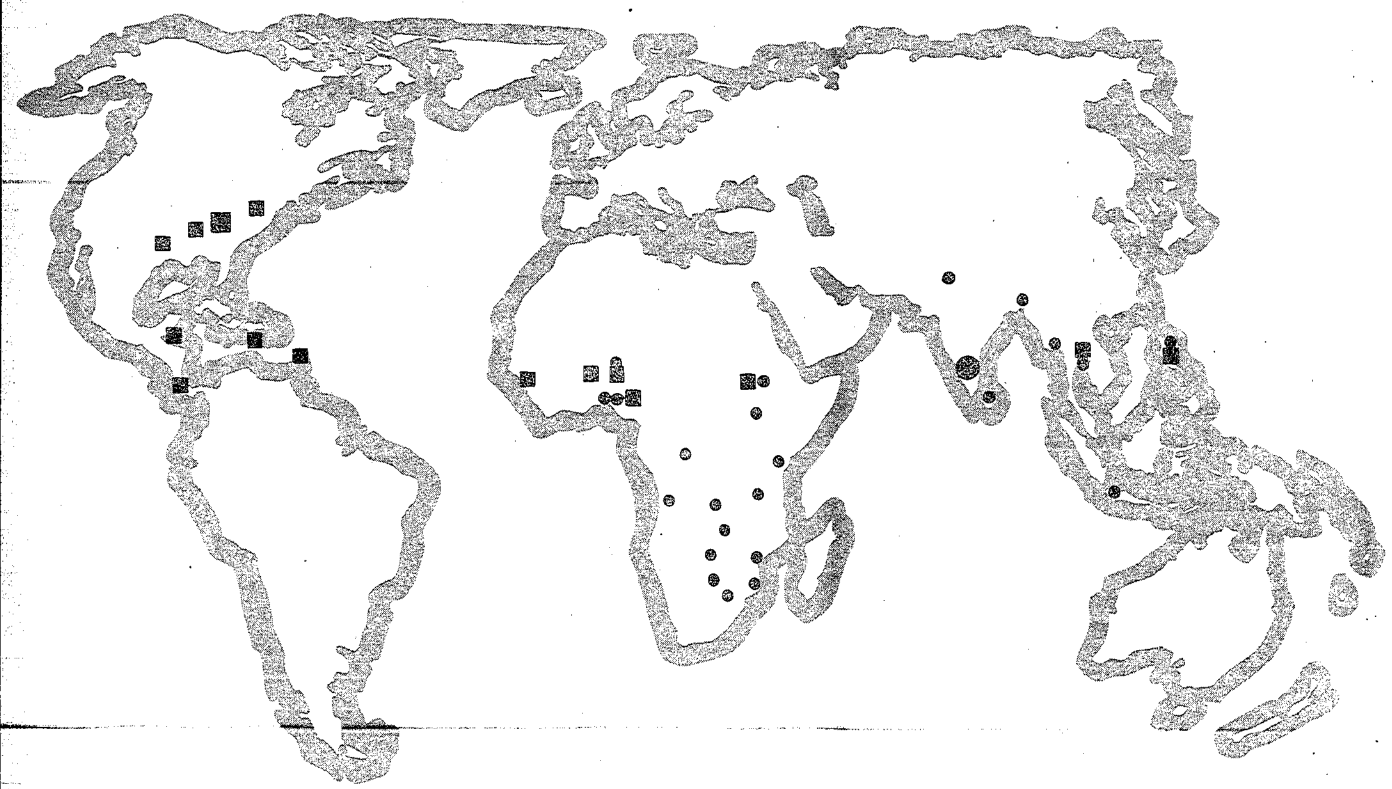

- ICRISAT Center, Patancheru
- Other ICRISAT Locations
- Peanut CRSP, Georgia
- Other CRSP Locations

International Arachis Newsletter

Publishing Objectives

The International Arachis Newsletter is issued twice a year (in May and November) by the Legumes Program, ICRISAT, in cooperation with the Peanut Collaborative Research Support Program, USA (Supported by USAID Grant No. DAN-4048-G-SS-2065-00). 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 (See ICRISAT Style Guide Section of References reproduced at end of this issue.). 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

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INDIA

Cover illustration: *Arachis hypogaea* and some alternative names for groundnut.

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News and Views

Editorial

Drought has long been considered the most important constraint affecting agricultural prosperity throughout the globe in general, and in the semi-arid tropics in particular. Although the extent of efforts that have gone so far into drought research does not appear to be commensurate with its importance and complexity, a vast body of information is accumulating in such related fields as drought mechanisms available in crops and crop varieties, field management techniques, and various agroclimatic and edaphic factors. There is a need to combine all these aspects to develop integrated strategies for various drought situations with the broad objective of stabilizing crop production in the semi-arid regions. In this direction, our legume physiologists have prepared a proposal for a 'Global Grain Legumes Drought Research Network'. The background, objectives, scope and prospects, expected outputs and impacts, and proposed linkages of this network are presented in this issue. We solicit suggestions from our readers including those working with national and international organizations/institutes, universities, etc. Please write to Dr C. Johansen, Legumes Program, ICRISAT, if you are interested in participating in the Drought Research Network and if you have any comments and suggestions.

We appreciate the efforts of Mr K. Ramana Rao, Office Assistant, Legumes Program, who helped in compiling this newsletter, computer entry of the manuscripts, and providing editorial assistance.

L.J. Reddy
Editor

News about ICRISAT Groundnut Scientists and Research Fellows

Donald George Faris retires

Dr D.G. Faris, Coordinator of the Asian Grain Legumes Network (AGLN), ICRISAT took early retirement with effect from 31 Mar 1992. Dr Faris joined ICRISAT as Principal Pigeonpea Breeder in Sep 1980 with his rich experience as a Barley Breeder and Head of the Cereals and Oilseeds Section at the Agriculture Canada Research Station, Beaverlodge, Alberta, Canada (1963 to 1980). Prior to that (1959 to 1963) he served as Research Assistant in the Bean Breeding Program at the University of California, Davis, USA, and as Plant Breeder (1955 to 1959), Department of Agriculture Research Station, Samaru, Northern Nigeria. His major career interest has been the physiological approach to breeding, particularly in breeding to overcome constraints to yield such as diseases and insect pests. He has been responsible for the development and release of one barley variety, one oats variety, and two pigeonpea varieties. He played a key role in the establishment of AGLN, and became its first coordinator.

He was responsible for the initial development and operation of the AGLN, which has a membership of over 800 scientists from 11 Asian countries. This network facilitated collaborative research between ICRISAT and national scientists and among national scientists in Asia on groundnut, chickpea, and pigeonpea and their cropping systems. The network was built on bilateral MOUs between ICRISAT and each country with work plans tailored to each country's needs, and on multilateral activities such as monitoring tours and workshops. Other activities included backstopping national research programs, coordinating working groups that joined together national and international specialists to deal with pressing regional problems, organizing on-farm research to tailor technology to farmers' needs, and supporting human resource development. Dr Faris travelled extensively in Asia to develop contacts, identify needs, and monitor AGLN activities. He also travelled throughout India, Australia, Eastern Africa, the Caribbean, and Cape Verde to observe and advise on pigeonpea research. He carried out two consultancies for FAO on pigeonpea in Cape Verde Islands.

Dr Faris served as an assistant editor for Field Crops Research for 12 years and has published about 198 research articles, book chapters, conference papers, consultancy reports, etc.

Besides his research contributions, Dr Faris will be long remembered for his superb humanitarian and philanthropic activities. We wish him all success and happiness in his future endeavors.

J.A. Wightman, Principal Groundnut Entomologist and Group Leader (Groundnut) went on sabbatical leave on 15 Dec 1991 to Australia. During the first 6 months, he will be working at the Queensland Department of Primary Industries (QDPI), Australia on the relationship between the amount of damage caused by white grub larvae to groundnut roots and the suppression of vegetative and reproductive production. He will be spending the latter 6 months at Oregon State University (OSU), USA updating IPM concepts with special reference to tropical legumes, in addition to undertaking relevant course work at OSU.

D.V.R. Reddy, Principal Groundnut Virologist, left for the USA on sabbatical leave from 7 Apr to 31 Dec 1992 to acquire expertise in the cloning of viral genes and in the development of resistant sources to plant viruses at the University of Kentucky, USA.

R.A. Naidu joined the Legumes Virology Unit as International Associate Scientist on 9 Mar 1992. He will be working on Peanut Clump Virus and on Production of cDNA probes for whitefly-transmitted carlavirus.

Suresh Pande was transferred to the Legumes Pathology Unit from the Cereals Program, ICRISAT, on 26 Mar 1992. He will be working on the project, 'Integrated Disease Management in Groundnut'.

D.E. Padgham, F. Kimmins, and **P. Stevenson** from Natural Resources Institute, UK, spent about 45 days during Feb-Mar 1992 at ICRISAT Center studying the biochemical aspects of pest resistance in groundnut.

W. Reed, erstwhile Legumes Entomologist at ICRISAT Center, served as a consultant to the Legumes Entomology Unit from 9 Feb to 7 Mar 1992. During this period he reviewed various research projects and on-going activities including those on groundnut.

Cereals and Legumes Asia Network (CLAN) Replaces AGLN and CCRN

The ICRISAT Governing Board, at its meeting 25-29 March, ratified the merger of two ICRISAT networks, the Asian Grain Legumes Network (AGLN) and the Cooperative Cereals Research Network (CCRN) to form the Cereals and Legumes Asia Network (CLAN), from 1 April 1992.

The Background. In 1986 ICRISAT assisted in establishing the AGLN to meet the demands of scientists in the National Agricultural Research Systems (NARSs). The CCRN was formed in 1988. The main objectives of both networks was to coordinate regional research on ICRISAT mandate legumes and cereals. The Coordination Units for both networks were provided by ICRISAT at ICRISAT Center. The two networks have helped the Asian NARSs to exchange germplasm, breeding material, information, and technology, and also to train technicians and scientists from Asian countries. Over the years, the NARSs administrators have indicated that they would prefer to work with a single network for all ICRISAT mandate crops. CLAN is the result of this.

It is hoped that the new network, which will also operate from ICRISAT Center, will reduce duplication of effort. The Deputy Director General has direct responsibility for CLAN, and the present members of AGLN and CCRN will automatically become its members.

Report on the Second International Groundnut Workshop

A week-long international workshop involving 165 scientists from over 44 countries and 62 ICRISAT scientists ended 30 Nov at ICRISAT Center, with recommendations to improve groundnut production and productivity worldwide during the current decade.

The major constraints to increased groundnut production and the progress in research since 1980 were reviewed at the workshop. The need to conserve the collection of groundnut germplasm and related wild species for future crop improvement was stressed, as was the importance of facilitating the safe transfer of germplasm between countries.

Reports from donors, special research topics, and concurrent discussion sessions were included in the program, as were field and laboratory visits. Sixty-four posters were exhibited during the workshop. Abstracts of these posters and the workshop papers will be published in the workshop proceedings.

A satellite cooperative meeting of the Indian Council of Agricultural Research (ICAR)/ICRISAT/International Benchmark Sites Network for Agrotechnology Transfer (IBSNAT) on groundnut modeling was held 28-29 Nov with participants from ICRISAT Center, India, Pakistan, the Philippines, and USA. This meeting reviewed the current status of groundnut modeling research.

The groundnut workshop and the modeling meeting were sponsored by USA's Peanut Collaborative Research Support Program (Peanut CRSP), France's Centre de coopération internationale en recherche agronomique pour le développement (CIRAD), Canada's International Development Research Centre (IDRC), IBSNAT, ICAR, and ICRISAT.

Several recommendations, listed below, were made at the workshop.

Socioeconomic Impact of Groundnut Research

- A systematic constraint and systems analysis of groundnut production and utilization should be carried out in each country by multidisciplinary teams using rapid rural assessment (RRA).
- The results of these analyses should be used to prioritize the research and technology needs for each country and region. The analyses should also provide information on site-specific problems and farmers' needs.
- Technologies already available should be reviewed, and research planned only where new answers are required.
- Adequate on-farm research with farmer participation should take place to ensure that any technology developed is appropriate to small-holders, especially in rainfed areas. Impact measurement and mechanisms for feedback from farmers and extension workers must be included.
- Greater emphasis should be given to socioeconomic studies of the factors affecting adoption of groundnut technology and its impact. The socioeconomic implications of the technology to be implemented must be determined.
- Simulation studies could be used to investigate the potential impact of the changing economic and policy environments in the world.
- An integrated economic database on groundnut should be established by ICRISAT in conjunction with Food and Agriculture Organization of the United Nations (FAO) and the Regional Coordination Centre for Research and Development of Coarse Grains, Pulses, Roots, and Tuber Crops in the Humid Tropics of Asia and Pacific (CGPRT).

Working Groups

- The following topics were nominated as the subjects of International Working Groups, as part of the IPM/IRM subnetwork of ICRISAT:
  - Aflatoxin management,
  - Nematodes, and
  - Soilborne diseases.
- The need for an International discussion group meeting on late leaf spot was mentioned.
- Support should be given to a meeting of groundnut genetic resources workers and appropriate groundnut researchers to discuss the need, form, and operation of a groundnut genetic resources network.

Training

- ICRISAT's human resources development efforts on groundnut should continue to be based on the need to improve skills and knowledge in the areas identified by NARSs.
- Efforts to organize in-country specialized courses on groundnut technology by scientists from appropriate centers of excellence should continue.

Biotic Constraints

- International programs of constraint identification are the highest priority prerequisite for the implementation of integrated pest management (IPM).
- Research on the components of IPM should be continued, but their interaction in farmers' fields should be evaluated as the first stage of IPM implementation.
- Data on the factors which contribute to pest epidemics are needed to improve understanding of the pests' epidemiology. Appropriate technologies such as remote satellite imagery and GIS systems will assist in collection of such data, helping the development of management schemes, and forecasting programs.
- The workshop strongly supported continued commitment to taxonomic, biological, and diagnostic studies of biotic constraints, their biotypes, etc. This should include their natural enemies and pathogens. Specific mention was made of foliar diseases, millipedes, white grubs, viruses, nematodes, and thrips.
- Special attention was directed to the need to study pathogen variability on *Arachis* spp in their native habitats. It was not suggested that these studies were the responsibility of ICRISAT.
- ICRISAT and the other groups were asked to develop and provide short-duration material segregating for resistance to groundnut rosette virus to national programs in West Africa, and to strengthen epidemiological studies related to this disease.
- Weed problems and associated factors (labor availability, herbicide effectiveness, mechanization, etc.) require greater attention from national programs and international bodies.
- Models could be used to decide the importance of genetic vs management solutions to biotic constraints.

Developers of crop models should bear this requirement in mind.

Crop Agronomy

- Both the national programs and ICRISAT should make more use of selection traits for water-use efficiency (via carbon isotope discrimination and leaf thickness) in breeding programs to improve groundnut drought and aflatoxin resistance.
- ICRISAT should be requested to conduct research into selectable traits associated with root systems more efficient in water extraction.
- ICRISAT and national programs should collaborate in research into the applications and limitations of the partitioning technology discussed at the workshop.
- Further research is justified to identify the sources of high- and low-temperature tolerance within *Arachis* germplasm. ICRISAT and national programs should collaborate in the quest for high-temperature tolerance, while the concerned national programs should lead the search for low-temperature tolerance.
- A working group of national program scientists should be formed to assist research into shade tolerance.
- Research into the nutritional and/or acid soil problems of specific regions should be conducted by national programs or other institutes with comparative advantage. It should be coordinated through working groups where appropriate. This should include research into identification of *Rhizobium* strains tolerant to acid soil, and with enhanced biological nitrogen fixation ability in acid soils.
- In order to reduce losses due to iron deficiency, national programs and ICRISAT should form collaborative links to assist selection for iron-efficient genotypes at early generations in breeding programs.
- Plastic mulch technology could be investigated by the national programs of relevant countries for adaptation and possible adoption, to extend groundnut production into new areas or to improve the productivity of existing production areas.
- Crop management systems should be developed not only to improve agricultural production but also to ensure sustainability through maintenance of soil fertility, water-use efficiency, activity monitoring, disease and pest control, and protection of the environment.
- An advisory group should be formed to provide guidance on the suitability of different models to the specific needs of the national programs. ICRISAT should be asked to initiate a network on modeling, and then work in collaboration with national programs to ensure models are used to the best advantage of national programs.
- Training opportunities exist for better utilization of techniques of selection for water-use efficiency and partitioning, and the application of physiological models in data analysis. In collaboration with national programs and national scientists, ICRISAT could undertake this responsibility.

Genetic Resources and Germplasm Enhancement

- The ICRISAT international trials and nurseries should continue, and should be extended to newer areas. However, the results from these trials and nurseries should be more widely reported.
- National programs should be encouraged to assume regional responsibility of site-specific constraints.
- The importance of breeding for resistance to foliar diseases was reiterated. It was felt that the emphasis should be placed on the importance of agronomic suitability of resistant cultivars. In addition, the forage value of these cultivars should also be evaluated. It seems desirable to strive for a moderate level of resistance. Collaboration among breeders, pathologists, and physiologists in disease-resistance breeding was stressed. The group felt the need for breaking negative linkages between resistance and quality factors, and for emphasizing moderate levels of multiple resistance and integrated pest and disease management in tackling biotic stresses.
- The transfer of genes conferring resistance to key pests from *Arachis* spp to *A. hypogaea* was considered to be of the highest priority.
- The need for greater emphasis on breeding early-maturing cultivars with limited seed dormancy and increased efficiency of iron-absorption in short-duration lines was stressed.
- As the future of groundnut is seen in the role of food rather than as an oilseed, the confectionery and quality questions were considered to be of importance. Requirements for confectionery and boiling types were discussed in detail. In view of the varying requirements in different countries, it was suggested that these issues be studied in depth to develop suitable guidelines for breeding.
- Poor availability of quality seed was identified as a major constraint to the adoption of improved cultivars. The need for subsidization of seed multiplication by government and/or donor agencies was recognized as an important factor in the sustainability of groundnut production.
- Simple but effective screening procedures, suitable for selecting within segregating material for aflatoxin, drought, cold, and acid-soil tolerance are needed.
- Biotechnology should be restricted only to those areas which cannot be resolved by conventional breeding. This includes the development of molecular markers.
- Delegates felt that ICRISAT should place more emphasis on hybridization, supply of germplasm and segregating material, and training the technical staff of national breeding programs.

Groundnut Utilization

- Efforts should be made to breed groundnuts for more desirable processing, nutritional, and sensory qualities. Oil content and quality, protein content and quality (amino acid profiles), roasting quality, seed size and color, flavor, and texture improvement need to be addressed.
- Development of appropriate drying equipment for small farmers and for use on a village scale should be addressed. Economic rewards to farmers based on quality maintenance during drying and storage should be adopted on an international scale.
- Research to develop groundnut cultivars resistant to invasion by aflatoxigenic molds and subsequent aflatoxin production should continue. Growth and production of mycotoxins by other molds should be investigated. Research is needed on procedures for detoxification. Attention should also be given to antinutritional components, allergenic compounds and flatulence-causing sugars in groundnut.
- The prospect for increased consumption of staple and snack foods containing groundnuts is good. Efforts should be expended to develop and/or improve these products. The promotion and marketing of these products requires further study. Quality parameters that would lead to price discrimination at the buying point would be beneficial, and should be established.
- Research should be conducted to develop additional uses for groundnut shells and skins, thereby enhancing the economic return to the farmer, sheller, and processor.
- Attention should be given by groundnut production and utilization researchers to the role of women at the farm and market level. Drudgery associated with growing, harvesting, drying, processing, preparing, and marketing groundnuts should be addressed in terms of improving the quality of life.

The relative role of ICRISAT, donor agencies, and national programs in these areas of utilization development is unclear, and the issues remain for any group with the capability to address them.

Information Transfer

The need for transfer of information between farmers and scientists by the most appropriate technology was stressed. This workshop recommends support for:

- continuation of SATCRIS,
- centralized dissemination of groundnut information data bases through computer modems, and the training to support it,
- publication of translations of existing literature identified by NARSs as being important to their needs,
- support for NARSs scientists to publish in the international literature,
- a conference of information staff and information end-user scientists from NARSs, and
- publications and media aimed at solving farmers' problems using available information.

Regional Legumes Workshop in Myanmar

A Myanmar-Asian Grain Legumes Network (AGLN)/ICRISAT Workshop on Managing Groundnut, Chickpea, and Pigeonpea in Rice-based Cropping Systems (RBCS) was held in Yangon and Yezin, Myanmar, 17-25 Jan 1992. This was the third regional workshop organized by ICRISAT's AGLN in a member country. Forty-one scientists from Bangladesh, China, India, Indonesia, Myanmar, Nepal, Pakistan, Philippines, Sri Lanka, Thailand, Vietnam, and ICRISAT Center participated. The Minister of Agriculture, Myanmar, gave the inaugural address.

The participants undertook a monitoring tour in two groups to observe crops and identify production problems and constraints. Major recommendations were: to develop varieties suitable for specific situations in the RBCS; to emphasize research on integrated nutrient management and other crop management aspects in RBCS; to consider appropriate management practices to avoid losses due to pests (including insects, diseases, and weeds); and to expand on-farm adaptive testing to extend available technology to farmers.

Work Plan Finalized. A Myanmar-Cereals and Legumes Asia Network (CLAN) Review and Planning Meeting was held from 27-29 Jan, where earlier research was reviewed and plans made for future collaborative research. Plans were also made to sign a Letter of Agreement to cover the First Myanmar-CLAN/ICRISAT Work Plan for 1992/93.

This Work Plan will be the first under CLAN. Eight ICRISAT staff members represented the three main ICRISAT programs at this meeting. Myanmar has a significant semi-arid tropical area, and is one of the few Asian countries where five of the ICRISAT crops are grown.

Short Training Course on Groundnut Production

ICRISAT's Human Resources Development Program, in cooperation with the Legumes Program, conducted a short course on 'Groundnut production and dryland farming' from 17 Feb to 13 Mar. The course was organized at the request of the Arab Organization for Agricultural Development. Fifteen participants (2 from Nepal, 2 from Sri Lanka, 4 from Sudan, and 7 from Yemen) attended the course.

Training Course on Quality Aspects of Food Legumes and Coarse Grains

Twenty-two trainees from 11 Asian countries participated in a Regional Training Course on 'Quality aspects of food legumes and coarse grains with special emphasis on nutrients and antinutritional factors', conducted jointly by ICRISAT and the National Institute of Nutrition (NIN), Hyderabad, from 16 Mar to 4 Apr. During the first week, the course was held at ICRISAT Center, followed by a 2-week training program at NIN. The course was sponsored by the Food and Agriculture Organization of the United Nations (FAO) RAS/89/040 Project based at Bogor, Indonesia.

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

D.V.R. Reddy (ICRISAT Center)

A training course on the 'Detection of Seedborne Viruses in Groundnut with Special Emphasis on Peanut Stripe Virus' was held at ICRISAT Center, 2-6 Mar 1992. This was organized at the request of the Indian Council of Agricultural Research (ICAR) to train scientists/technicians particularly in the detection of peanut stripe virus. The 9 participants came from Gujarat (5), Andhra Pradesh (1), Tamil Nadu (1), West Bengal (1), and Karnataka (1). The course included lectures on groundnut viruses and detection of seedborne viruses. Participants were given hands-on experience in mechanical sap inoculations, various forms of enzyme-linked immunosorbent assay (ELISA), comparison of penicillinase and alkaline phosphatase systems, conjugation of gammaglobulins with penicillinase, detection of peanut mottle virus in seed, and recognition of the field symptoms of bud necrosis virus and peanut mottle virus.

Participants were given a test prior to the course. When the same test was administered after the course, it was noted that participants performed significantly better. This course was rated well by all the participants. The general feeling was that the time allotted to various techniques was rather short.

Recent ICRISAT Publications

ICRISAT (International Crops Research Institute for the Semi-Arid Tropics). 1991. Summary Proceedings of the Second ICRISAT Regional Groundnut Meeting for West Africa, 11-14 Sep 1990, ICRISAT Sahelian Center, Niamey, Niger. (In Eng., Fr.) Patancheru, A.P. 502 324, India: ICRISAT. Eng.:76 pp.; Fr.: 84 pp.

Rupela, O.P., Kumar Rao, J.V.D.K., Sudarshana, M.R., Usha Kiran, M., and **Anjaiah, V.** 1991. *Rhizobium* germplasm resources at ICRISAT Center. Research Bulletin no. 15. Patancheru, A.P. 502 324, India: International Crops Research Institute for the Semi-Arid Tropics.

Faris, D.G., and **Rupela, O.P.** (eds.). 1992. Enhancing grain legumes research in Asia: summary proceedings of the Asian Grain Legumes Network Coordinators' Meeting, 10-12 Dec 1990, ICRISAT Center, India. Patancheru, A.P. 502 324, India: ICRISAT (International Crops Research Institute for the Semi-Arid Tropics). 100 pp. ISBN 92-9066-221-2. Order code: CPE 068.

ICRISAT (International Crops Research Institute for the Semi-Arid Tropics). 1992. Groundnut Variety ICGV 86590. Plant Material Description no.31. (Supplied gratis.)

ICRISAT (International Crops Research Institute for the Semi-Arid Tropics). 1992. Groundnut Elite Germplasm ICGV 86031. Plant Material Description no.32. (Supplied gratis.)

News from Peanut CRSP (Collaborative Research Support Program)

Meetings. The CRSP Council met in Washington, DC, 11-13 Dec 1991 and 17-20 Mar 1992. The CRSP Council consists of the Program Director, the Chairman of the Board of Directors, and the Chairman of the Technical Committee of each of the eight CRSPs supported by the U.S. Agency for International Development. The main objectives of the Council are to promote cooperation among the CRSPs in research and outreach efforts, and educate various groups on accomplishments and impacts of the CRSPs. David Cummins, Program Director; Johnny Wynne, Board of Directors; and Olin Smith, Technical Committee met with the group in December to review progress and plan future cooperative activities of the eight CRSPs. David Cummins met with the other Program Directors in March to review accomplishments and impacts with members of Congress and members of their staff.

Several U.S. and host country investigators and managers in the Peanut CRSP attended and participated in the Second International Groundnut Workshop 25-30 Nov 1991 at ICRISAT Center. CRSP attendees were: Bharat Singh from Alabama A&M University; Larry Beuchat, Manjeet Chinnan, Jim Demski, Bob Lynch, David Cummins, Stan Fletcher (Economist), and Louis Boyd (Board of Directors) from The University of Georgia; Tom Isleib, Tom Stalker, and Art Weissinger from North Carolina State University; Tim Phillips from Texas A&M University; Vichai Harathaithanasan, Sopone Wongkaew, and Sanun Jogloy from Thailand; Marina Natural, Virgilio Garcia, Remedios Abilay, Virginia Ocampo, and Cris Escano from the Philippines; Phindile Olorunju from Nigeria; Philippe Sankara from Burkina Faso; Ousmane Ndoye and Amadou Ba from Senegal; Brian Cooper from Antigua; and Urvan Wilson from Jamaica.

Thailand held the 10th Annual National Groundnut Research Meeting at Hin-Suay-Nam-Sai Resort Hotel in Rayong, Thailand, 16-19 Oct 1991.

Peanut CRSP investigators representing Kasetsart University, University of the Philippines at Los Banos, and The University of Georgia attended the 4th ASEAN Food Conference in Jakarta, Indonesia, 17-21 Feb 1992. Those attending from the respective institutions were Penkwan Chompreeda, Virgilio Garcia, Larry Beuchat, and Anna Resurreccion.

Travel. Larry Beauchat and Anna Resurreccion visited collaborators in the Philippines prior to the 4th Association of Southeast Asian Nations (ASEAN) Food Conference in Indonesia.

Rick Brandenburg of North Carolina State University visited Insect Management Project collaborators in the Philippines and Thailand from 21 Feb-7 Mar 1992.

Manjeet Chinnan, The University of Georgia, and Urvan Wilson, Jamaica visited postharvest handling and storage research project sites in Thailand in Nov 1992 prior to the 2nd International Workshop in India.

Larry Beuchat, The University of Georgia, visited food technology collaborators in Thailand in November following the 2nd International Groundnut Workshop in India. Particularly noteworthy was his visit to the successful village-scale processing technology transfer project near Chiangmai.

Jim Demski, The University of Georgia, participated in a meeting on 'Transformation and Regeneration of Peanut and Utilization of Viral Genes for Inducing Resistance to Viral Diseases' held near Amsterdam, Netherlands, 23-28 Apr 1992.

Publication. A review of Peanut CRSP research programs in aflatoxin management was held at the Peanut CRSP annual meeting in San Antonio, Texas in July 1991. A copy of this review can be obtained from the Peanut CRSP Management Office, The University of Georgia, Georgia Station, Griffin, GA 30223-1797, USA.

The SADCC Regional Groundnut Pathology Training Course

P. Subrahmanyam (SADCC/ICRISAT Groundnut Project)

The First Southern African Development Coordination Conference (SADCC) Regional Groundnut Pathology Training Course was held by the SADCC/ICRISAT Groundnut Project at Chitedze Agricultural Research Station, Lilongwe, Malawi, 16-25 Mar 1992. The training course was organized following recommendations made by groundnut scientists from various national programs in the SADCC region during the Second Regional Groundnut Plant Protection Group Tour in Feb-Mar 1991 and during the First Steering Committee Meeting held in April 1991 at Chitedze, Malawi.

Participants discussing screening methods for resistance to rust and late leaf spot diseases of groundnut, Chitala Agricultural Research Station, Chitala, Malawi.

The course was inaugurated by Dr J.H.A. Maida, Principal Secretary, Ministry of Agriculture, Government of Malawi. Twenty-three participants from seven SADCC countries (Angola 1, Malawi 10, Mozambique 3, Swaziland 2, Tanzania 2, Zambia 2, and Zimbabwe 3) participated in the training course.

The objectives of the training course were to develop and upgrade the skills of research technicians from various national programs in the SADCC region in diagnosis and management of groundnut diseases, and to provide them an opportunity to sustain their professional contacts and exchange ideas with their counterparts in the region.

The course agenda included field diagnosis of groundnut diseases, assessment of yield losses due to foliar diseases, disease survey methods, disease management, screening for resistance to early leaf spot, late leaf spot, rust, and rosette, and serological methods for detecting groundnut viruses.

Proposal for a Global Grain Legumes Drought Research Network

N.P. Saxena[1], C. Johansen[2], and M.C. Saxena[3] (1. ICRISAT/ICARDA; 2. ICRISAT Center; and 3. ICARDA, P.O., 5466, Aleppo, Syria).

Grain legume crops are important sources of high-quality protein in human diets. They are also important components of sustainable agriculture in rainfed areas. Usually drought is the most important constraint limiting crop production in such environments. A substantial body of information on responses of grain legume crops to drought has accumulated in recent years. We suggest this can be better mobilized and exploited through coordinated efforts to achieve significantly better adaptation of grain legumes to drought-prone environments. It is therefore proposed to organize a global grain legumes drought research network. Expected outputs of such a network would include formulation of viable and cost-effective research projects and assistance to national agricultural research systems in focussing problem-solving research on drought-related constraints. We believe that this would contribute to enhancement of sustainable grain legume production, including legume-benefits to the overall cropping system in drought-prone environments.

Background

1. Drought is a major constraint to rainfed production of grain legumes.
2. Grain legume crops are important particularly in developing countries as:
   - sources of protein in human diets, and
   - components of the sustainability equation in rainfed drought-prone agriculture.
3. Increasing knowledge on the adaptation of grain legume crops to drought-prone environments has accumulated in recent years. This has been generated in separate studies with respect to crops, environments, and researchers.
4. We believe that rapid progress in genetic adaptation of grain legumes to drought-prone environments can occur by our coordinating efforts, and we thus propose a network to facilitate this.

Current status

Little quantifiable progress has been made to date in minimizing the yield-reducing effects in grain legumes because of:

- an unrealistic expectation of identifying crop varieties with high levels of resistance to drought;
- an imperfect understanding of the complex nature of drought over time and its interactions with crop growth and yield;
- an emphasis mainly on identifying simple physiological/ biochemical criteria of drought resistance, which often do not relate to field performance;
- lack of efforts to integrate studies across grain legume crops and environments to draw inferences and plan future strategies; and
- reluctance to breed crops for drought resistance because of the unpredictability of drought environments.

Objectives

1. To establish a reference point for integrated global efforts on enhancing and stabilizing grain legume production in drought-affected environments by way of:
   - providing information about active researchers and institutes working on drought and their areas of expertise,
   - maintaining a list and passport information of traits of drought-resistant grain legume crops and varieties,
   - documenting and updating published literature on all aspects of drought relevant to grain legume crops and disseminating specific literature searches, and
   - facilitating regular communication between network members by a means such as an informal newsletter.
2. To characterize and map the types of drought affecting legume production globally, using Geographic Information System (GIS) and models.
3. To quantify yield losses caused by drought by using existing knowledge and data, and through experimentation where such knowledge does not exist.
4. To relate area, production, productivity and yield losses to Item 2, and:
   - identify priority agroecological areas and legume crops for drought research,
   - develop agronomic management/genetic enhancement strategies to alleviate drought effects in the target regions, and
   - set parameters for increasing effectiveness and enhancing impact in the target region.
5. To extend available technologies of genetic enhancement for drought resistance in the target regions.
6. To stimulate basic research including in the area of cell biology that has a well-defined impact on applied or problem-solving research.
7. To organize brainstorming sessions on drought research through workshops, group discussions, and conferences in crucial areas and disseminate the current understanding through publications.
8. To identify and facilitate linkages between organizations with expertise in specific areas of drought research.
9. To solicit funding to support the above activities.

Scope and Prospects

Prospects of mitigating drought effects on grain legume production appear more promising in the 90s because:

1. Good progress has been made towards a better understanding of the realities and complexity of types of drought and their effects on crop growth and yield.
2. Coordinated international efforts seem feasible because drought is an important theme of research at many international centers and institutes.
3. Precise and detailed characterization of atmospheric and soil moisture environments during crop growth is now feasible through computer modeling.
4. Various components of drought can now be mapped on field to global scale using programs such as GIS so that near iso-drought environments can be delineated to enhance transfer of technology.
5. There are some examples of success in the development of grain legume crop varieties resistant to terminal drought.

Expected Output and Impact

1. Development of viable projects in drought research which set realistic goals for achieving success.
2. Increasing awareness of the existing knowledge and experience amongst drought researchers.
3. Evaluation of research projects for most efficient use of resource inputs and possible benefits.
4. Generation of self-reliance and expertise in the conduct of drought research among scientists of participating NARS,
5. Enhancement and stabilization of sustainable grain legume production under rainfed conditions.

Proposed Linkages

Proposed linkages of the network are shown in Figure 1. We also intend to publish an informal newsletter as a means of communication between the network members. We are soliciting suggestions from other related networks, national and international organizations/institutes, universities and individuals on various aspects of the network activities and to determine their interest in joining such efforts. Please indicate to Dr C. Johansen, Legumes Program, ICRISAT if you are interested in participating in such a network and if you have any sug-

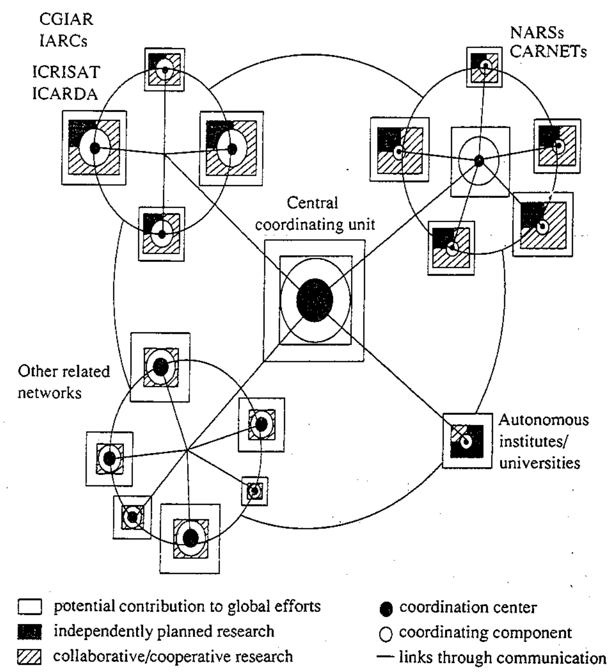

Figure 1: Proposed linkages of the Global Grain Legumes Drought Research Network.

gestions or comments. Our decision to proceed with establishing the network, and the manner in which we proceed, will depend on feedback from prospective members.

Announcements

Information on Groundnut Cultivars in Various Parts of the World

The Groundnut Breeding Unit at ICRISAT Center wishes to compile a current list of all groundnut varieties released in various parts of the world and intends to publish this list in due course as an ICRISAT Information Bulletin. We would be most obliged if readers of this Newsletter could provide the requested information in the proforma enclosed at the end to the following address:

Principal Groundnut Breeder
ICRISAT Center
Patancheru
Andhra Pradesh 502 324
India

Southern Regional Information Exchange Group on Peanut Molecular Biology

A group of scientists has come together to further communication between groundnut breeders and researchers in groundnut molecular biology. To this end, we have established in the U.S. a Southern Regional Information Exchange Group on Peanut Molecular Biology. This group, comprising breeders, geneticists, molecular biologists, and scientists in the pest disciplines, will meet informally this winter to exchange information of mutual interest and to establish networks for scientific cooperation between breeders and molecular biologists.

We welcome interaction from the international scientific community. Our intention is to develop a list of scientists of various disciplines and research interests. We will disseminate this information to all scientists on our list to promote scientific cooperation. We also intend to provide a synopsis of our first meeting to inform other researchers about the current state of research efforts in this area.

Scientists interested in participating in this group in any way may please contact:

Dr David Knauft
Department of Agronomy
University of Florida
304 Newell Hall
Gainesville, FL 32611-0311
USA

Bibliography, Database Diskettes, and Users' Manual on Aflatoxins Available from ICRISAT Center

Mehan, V.K., McDonald, D., Haravu, L.J., and **Jayanthi, S.** 1991.

The Groundnut Aflatoxin Problem - Review and Literature Database. Patancheru, A.P. 502 324, India: International Crops Research Institute for the Semi-Arid Tropics. 388 pp.

This book contains reviews of important aspects of the groundnut aflatoxin problem together with annotated bibliographies. Aspects covered are aflatoxicosis in animals and humans, research on aflatoxin contamination of groundnuts, aflatoxins in groundnuts and groundnut products, limits and regulations on aflatoxins, methods for aflatoxin analysis, and management of aflatoxin contamination. Each aspect is reviewed in a separate section, and each review is followed by an annotated bibliography.

Mehan, V.K., Haravu, L.J., McDonald, D., Jayanthi, S., and **Sinha, P.K.** 1991. Database on the Groundnut Aflatoxin Problem and Users' Manual. Patancheru, A.P. 502 324, India: International Crops Research Institute for the Semi-Arid Tropics.

This manual provides rules and guidelines followed for the bibliographic description of items that have been entered into the computerized Groundnut Aflatoxin Problem Database, and also explains how to make searches for records in the database. The publication includes a folder containing 10 diskettes readable in CDS/ISIS software developed by UNESCO. The period covered by the 1450 references cited is 1960-90.

If you are interested in acquiring the above items, please request a proforma invoice from the Distribution Unit at ICRISAT Center.

Groundnut Thrips and Viral Diseases in South India

G.V. Ranga Rao[1], R.D.V.J. Prasad Rao[2], A. Sudarshan Reddy[1], and Y.L. Chandrasekhar Rao[1]
(1. ICRISAT Center; 2. NBPGR Scientist)

Groundnut crops in parts of three states in India were surveyed during February 1990 to assess the occurrence and species distribution of the potential virus vector thrips and the severity of viral diseases. Thrips samples were collected at 16 locations (7 in Karnataka, 4 in Tamil Nadu, and 5 in Andhra Pradesh). At each location, 100 terminal buds and 100 flowers were collected and stored separately in 70% alcohol. The samples were processed for the presence of *Scirtothrips dorsalis*, *Thrips palmi*, and *Frankliniella schultzei* which are known vectors of tomato spotted wilt virus and peanut yellow spot virus Amin et al. 1981; Palmer et al. 1990) (Table 1). The damage caused by these three species to foliage was also observed on 20 random plants and recorded as percent damaged leaflets. The feeding damage by both *T. palmi* and *F. schultzei* on young foliage is identical and difficult to separate (G.V. Ranga Rao, unpublished information). At Bhavanisagar and Aliyarnagar on a 5-week old crop the injury caused by *T. palmi* and *F. schultzei* was severe.

Table 1. Proportion of different thrips species in three southern states of India in a survey conducted in February 1990.

	Proportion (%)				Proportion (%)			
	Thrips from leaves[1]				Thrips from flowers			
Location/State	S.d	T.p	F.s	Total	S.d	T.p	F.s	Total
Karnataka								
Raichur	75	25	0	(12)[2]	19	19	62	(16)
Nirmanvi	55	45	0	(20)	0	0	100	(4)
Sindhanoor	53	0	47	(94)	2	0	98	(250)
Gajangada	100	0	0	(3)	0	4	96	(26)
Dharwad	55	45	0	(69)	31	38	31	(13)
Ankola	85	15	0	(20)	0	0	100	(8)
Basvanpura	74	13	13	(15)	0	54	46	(13)
Tamil Nadu								
Bhavanisagar	13	0	87	(16)	4	13	83	(24)
Aliyarnagar	55	45	0	(29)	9	74	17	(66)
Kottur	55	45	0	(31)	0	27	73	(63)
Vridhachalam	59	39	2	(41)	2	4	94	(46)
Andhra Pradesh								
Jakkalavaripalli	45	14	41	(29)	0	0	100	(95)
Guttivaripalli	87	0	13	(31)	0	6	94	(18)
Tummuru	0	0	100	(34)	0	2	98	(413)
Kothapatnam	6	35	59	(34)	0	37	63	(167)
Chirala	5	90	5	(129)	0	93	7	(81)
Mean	51	26	23		4	23	73	

1. S.d = *Scirtothrips dorsalis*. T.p. = *Thrips palmi*. F.s = *Frankliniella schultzei*.
2. Figures in the parentheses are the total thrips observed in each field.

Table 2. Distribution of groundnut viral diseases in the southern states of India in a survey conducted in February 1990.

	% plants infected with		
Location/State	TSWV	V.C.	Mottle
Karnataka			
Raichur	6.5;52[1]	3	-
Nirmanvi	-	-	-
Sindhanoor	1.4	-	-
Gajangoda	2	-	-
Dharwad	<1	<1	-
Ankola	<1	-	-
Basvanpura	-	-	-
Tamil Nadu			
Bhavanisagar	4.7%	-	-
Aliyarnagar	1	<1	-
Kottur	<1	<1	-
Vridhachalam	-	-	Present[2]
Andhra Pradesh			
Jakkalavaripalli	<1	-	-
Guttivaripalli	<1	<1	-
Tummuru	-	-	-
Kothapatnam	-	-	-
Chirala	-	-	-

TSWV = Tomato spotted wilt virus. VC = Veinal chlorosis.
1. December-sown and wider-spaced (45 x 25 cm) crop.
2. Two suspected plant samples with mottle symptoms confirmed peanut mottle virus through ELISA test.

The observations in different ICRISAT collaborative trials indicated a wide range of thrips injury (1.5% to 55%). The data in Table 1 indicate that thrips damage on the Bhavanisagar crop was due to *Frankliniella*, while the damage at Aliyarnagar was caused by *Thrips palmi*. The incidence of bud necrosis disease caused by tomato spotted wilt virus in general was very low across the locations (<1%) except in late-sown (2nd week of December) and widely spaced (45 × 25 cm) trials at Raichur (52%) while the normal-sown crop (3rd week of November, 30 × 10 cm) had 6.5% disease incidence (Table 2). Veinal chlorosis was noticed in 5 out of 16 locations. However, the incidence was very low (Naidu et al. 1989). Veinal chlorosis was maximum with 3% plants infected at Raichur, while the incidence at the other four locations was <1% (Table 2). The crop was inspected for peanut stripe and mottle symptoms. In some locations plants with stripe and mottle-like symptoms were noticed and brought to the ICRISAT virology unit for further confirmation. The serological tests (ELISA) showed negative reaction for peanut stripe in all the samples, while one sample from Vridhachalam gave a positive reaction for peanut mottle virus only, indicating the absence of peanut stripe disease in these areas.

It was also apparent from the observations that *Scirtothrips* populations were present mostly on leaflets and *Frankliniella* was mostly present in flowers. *Thrips palmi* was present on leaflets as well as flowers in approximately equal proportion.

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Status and Significance of Root-knot Disease of Groundnut in China

Song Xie Song[1], S.B. Sharma[2], S.N. Nigam[2], and **Hu Jiapeng[3]** (1. Peanut Research Institute, Laixi City, Shandong Province, People's Republic of China; 2. ICRISAT Center; 3. Institute of Crop Germplasm Resources, Bai Shi Qiao Road, Beijing, People's Republic of China)

China is the second largest groundnut producer in the world. The area under groundnut has increased from 2 m ha to 3 m ha in the last 10 years. Many abiotic and biotic stresses affect groundnut production in China. The root-knot disease caused by *Meloidogyne* species is considered to be one of the important biotic constraints to groundnut production (Table 1). At present, approximately 400,000 ha of the groundnut-producing area,

Table 1. Distribution of the root-knot nematodes in major groundnut-producing provinces in China.

Province	Total area ('000 ha)	Infested ('000 ha)	Predominant species[1]
Shandong	820	130	*Meloidogyne hapla*
Henan	400	40	*M. hapla*
Guangdong	390	20	*M. arenaria*
Hebei	320	70	*M. hapla*
Guangxi	170	10	*M. arenaria*
Sichnan	180	10	*Meloidogyne* spp
Liaoning	150	30	*M. hapla*
Anhei	140	20	*M. hapla*
Hubei	60	1	*Meloidogyne* spp

1. Based on plant-parasitic nematode surveys of the groundnut-producing regions in China in 1970s.

spanning 10 provinces under different agroecological zones, is considered to be infested with the root-knot nematodes (*M. arenaria* and *M. hapla*). *M. hapla* attacks 80 field crops and 50 weed species in China, and groundnut is one of the most susceptible crops.

Distribution of Root-knot Nematodes

Work on root-knot disease of groundnut in China started in 1958. Surveys conducted by Chinese scientists between 1958 and 1975 revealed that the population of *M. arenaria* in southern China and *M. hapla* in northern China are very widely distributed. *M. hapla*-caused root-knot disease is more severe on sandy soils than on clayey soils. The disease is very important in regions where groundnut is cultivated continuously year after year.

Management of Root-knot Disease of Groundnut

Work on the management of root-knot disease of groundnut in China can be grouped broadly under 5 periods:

1. *1958-64.* During this period, various agronomic practices were evaluated. Rotation of groundnut with grasses and watermelon for 2-3 years increased groundnut pod yields by 15% and significantly reduced root-knot nematode populations in the fields. Deep ploughing and addition of high dosages of organic manures increased the pod yield by 10-15%.
2. *1965-70.* More than 100 chemicals were screened for their efficacy in controlling root-knot disease. Dibromochloropropane (DBCP) was found to be the best in controlling the nematode populations. Application of DBCP at the rate of 24 kg ha^{-1} with irrigation water significantly reduced population densities of *M. hapla* and increased the pod yield by more than 100%.
3. *1971-80.* DBCP was used in all the groundnut-producing provinces. Improved techniques were evolved for application of DBCP in large areas.
4. *1981-85.* The use of DBCP was banned in all the provinces due to health hazards and environmental pollution and the search for another effective nematicide began. More than 50 biocides were screened. Aldicarb (2-3 kg a.i. ha^{-1}), Carbofuran (2-3 kg a.i. ha^{-1}), Phenamiphos (3-6 kg a.i. ha^{-1}), and Mocap (3-4 kg a.i. ha^{-1}) were found to be useful but none of these was as good as DBCP. Application of these biocides in the nematode-infested fields increased the crop yield by 30-80%.
5. *1986-91.* The use of nematicides was restricted because of their high costs and high toxicity. During this period work on host-plant resistance was started. More than 4000 accessions of groundnut were screened for resistance to *M. hapla* at Shandong. Only 2 accessions, N 001 and N 002, were resistant. Eighteen other accessions showed a moderately resistant reaction to the disease.

Deep ploughing to a depth of 50 cm and use of organic manure, rotation of groundnut with grasses, watermelon, or sweet potato for 3 years resulted in a 20% increase in pod yield. Three species of nematode-trapping fungi were identified and work on biological control of *M. hapla* was initiated.

Future Plans

It is proposed to conduct surveys of groundnut-growing regions in all the provinces to identify other important nematode-caused problems. Groundnut germplasm will be screened for resistance to the root-knot nematodes, and management options developed in terms of crop rotation and biocontrol.

Research Reports

Use of Categorized Information in Crop Loss Analysis and Multi-pest Management in Groundnut: an Outline of the West Africa Context

S. Savary[1] and **J.C. Zadoks**[2] (1. ORSTOM, Institut Française de Recherche Scientifique pour le Développement en Coopération. Present address: IRRI, Division of Plant Pathology, PO Box 933, Manila, Philippines; 2. Department of Phytopathology, Agricultural University of Wageningen, PO Box 8025, 6700EE, The Netherlands)

One way to address a multi-pest system is to conduct surveys in farmers' fields. This approach has been followed at Institut Française de Recherche Scientifique pour le Développement en Coopération (ORSTOM) to study the multiple pathosystem of groundnut in West Africa (Savary 1987; Savary et al. 1988). The datasets describe: (1) the crop itself and the production situation, (2) the pests (diseases, insects, and weeds), and (3) yields. A crop loss survey can be seen as part of a systems approach, where: (1) a series of pests is considered, (2) the emphasis is primarily on variation in yield rather than on dynamics of processes, and (3) one level of integration only — that of the field — is considered. Surveys can provide descriptions of the relationships between yield variation, production situation (De Wit and Penning de Vries 1982), and pests. The corresponding datasets may, however, be of limited value for extrapolation since they only account for a given diversity of environmental conditions — those encountered during the survey period, and within the surveyed area. In order to enlarge the target population of production situations and pest levels, one may consider the establishment of a database in

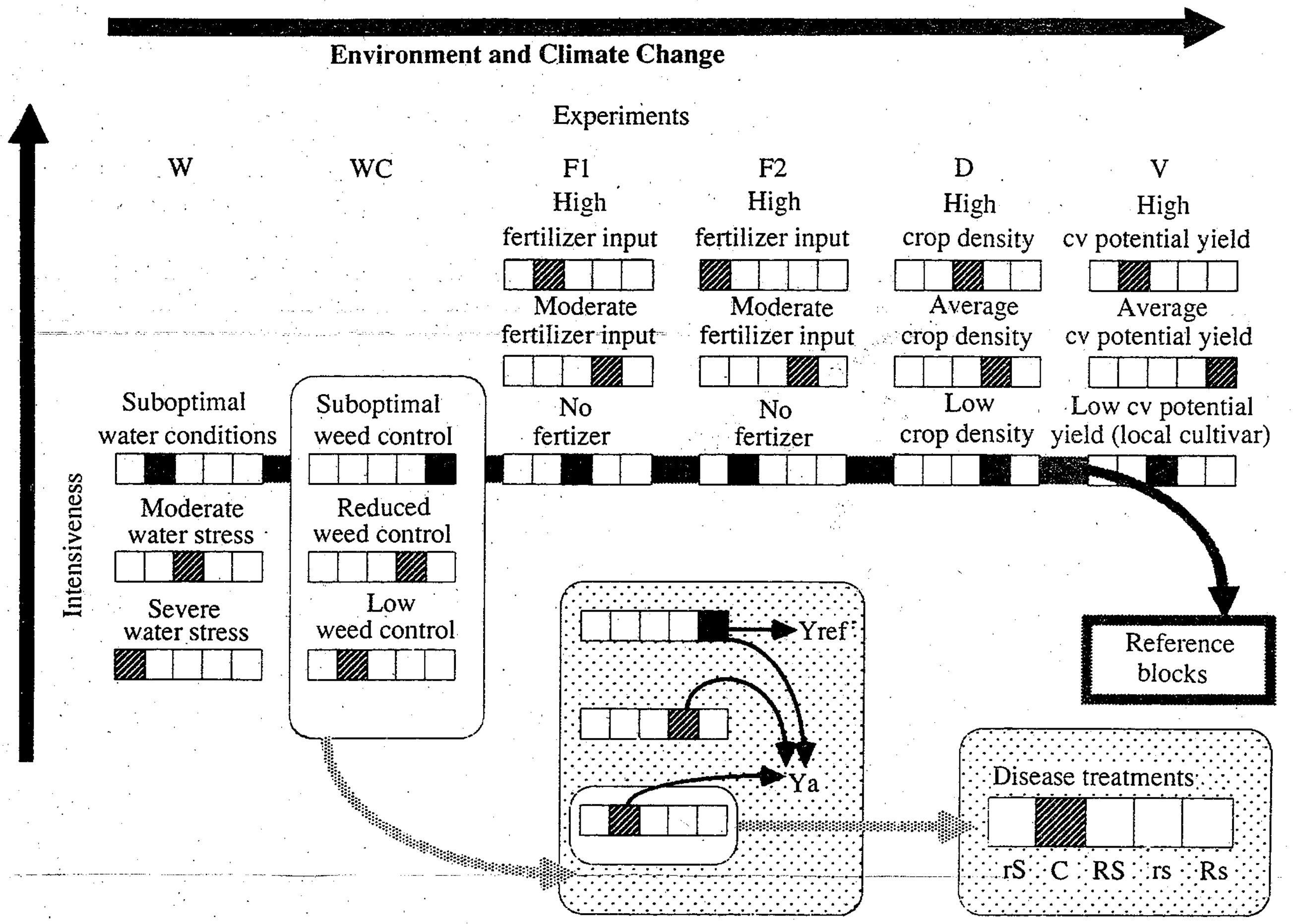

Figure 1. The layout of a database for the dual pathosystem of groundnut in West Africa.

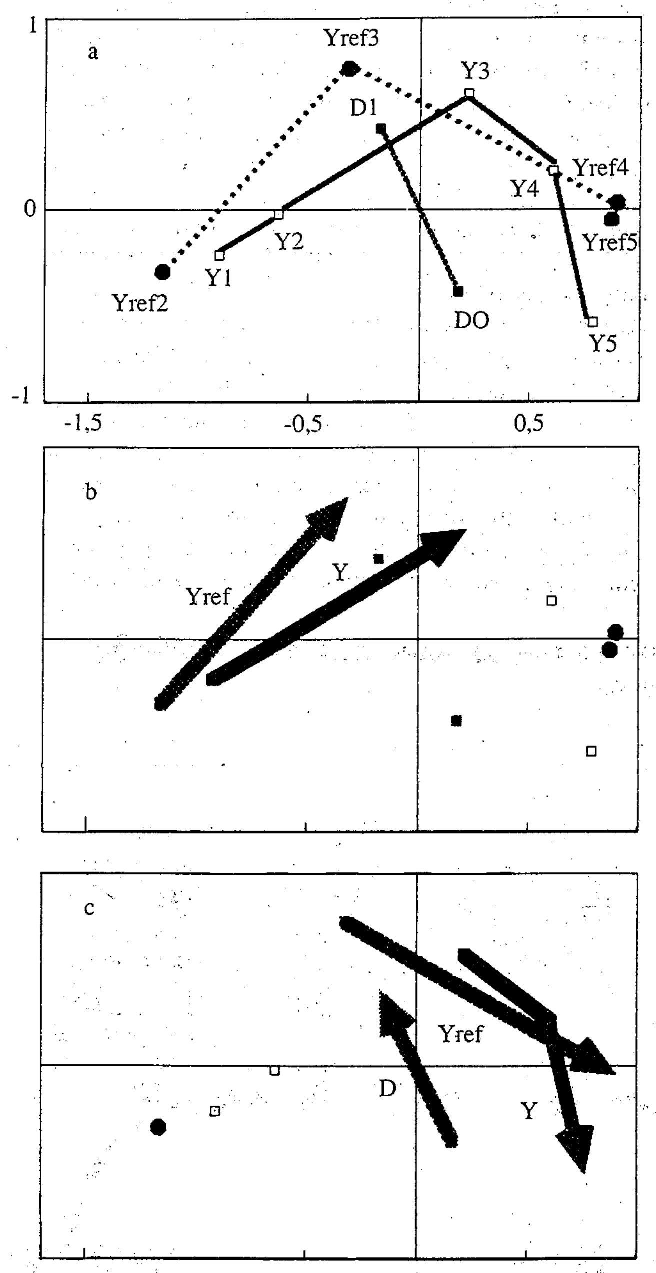

Figure 2. An example of correspondence analysis, where three categorized variables are involved: actual yield (Y), the reference yield (Yref), and presence (D1)/absence (D0) of rust and leaf spot diseases.

which the production situations and the pest levels would be manipulated.

Pest-yield interaction can be described by a damage function (Zadoks 1985) linking the increasing injury of a pest and the increasing damage to the crop (yield loss). Damage functions allow one to identify thresholds, which are the bases of pest management. These thresholds are site-dependent: they vary with the production situation. Interactions between pests and yield variation are likely to occur, making the threshold concept more difficult to handle (Zadoks 1985). The use of categorized information may help to grasp such complex patterns of relationships.

A West Africa groundnut crop may be considered as a dual pathosystem: the very large set of insect pests and diseases may be reduced to two major constraints: leaf spot (early and/or late) and rust (Savary et al. 1988). Figure 1 shows the layout of a database for the dual pathosystem of groundnut, established from a series of six simple, independent experiments. Each experiment (from W to V) involves three blocks representing a given input factor with three levels. The treatments within each block are combinations of manipulated levels of rust (r, R; low, high) and leaf spot (s, S; low, high), with one control plot (C; no disease). The two diseases were independently manipulated, primarily by means of inoculations, and in some instances, sprays with specific fungicides. The experiments produce three yield variables: Y, the actual yield of any plot, Ya, the attainable yield representing a block (treatment C), Yref, the reference yield of one experiment, which corresponds to the protected plot (C) of the block where input factors are set to default levels (reference block).

The variables to be handled are either qualitative (e.g. input levels) or quantitative (e.g. yields or disease intensities). One way of manipulating them simultaneously is to encode the quantitative variables, build contingency tables, and conduct correspondence analyses (Benzécri 1973; Hill 1974; Savary et al. 1988). A contingency table shows the distribution of a population (here, plots) according to two categorized criteria (e.g. actual yield and leaf spot injury), and allows to test the association between the two criteria, using a chi-square test. In practice, one may expect a large number of plots with either low leaf spot injury and high yield, or high leaf spot injury and low yield: this association would be shown by a significant chi-square test. Correspondence analysis is a multivariate statistical technique that allows one to analyze a series of contingency tables, using a chi-square distance. The computation process involves the identification of a series of axes, each accounting for a fraction of the total variance represented in the dataset. Figure 2 shows an example of a correspondence analysis, where three categorized variables are involved: the actual yield (Y), the reference yield (Yref), and presence (D1) / absence (D0) of groundnut diseases, whatever the disease or its intensity. In other words, in this overall analysis, the four disease treatments represented in Figure 1 (RS, Rs, rS, and rs) are merged into one group: presence of diseases.

The two axes shown in Figure 2 account for 62.6% (horizontal axis) and 21.8% (vertical axis) of total variance. The sequences of classes for each variable can be delineated (e.g. from Y1 to Y5), and the resulting paths analyzed. This analysis indicates two phases in actual yield (Y) progress: (1) a first phase of parallel increase of the actual yield, along with the reference yield, independent of disease levels (the vector D0-D1 is orthogonal to this direction; Fig. 2b), and (2) a second phase where the increase of actual yield, still depending on that of reference yield, is opposed to the occurrence of diseases (Fig. 2c). The graph indicates a threshold in reference yield, above which the increase of actual yield does not only depend on the improvement of the production situation through input factors, but also on the protection of the crop against the dual pathosystem. In other words, this graph indicates a threshold in the improvement of the production situation, in terms of the hazard incurred by pest constraints. The threshold is represented by a class of yields ranging from 1400 to 2300 kg ha^{-1}. It is worth noting that this represents the uppermost range of groundnut yields in farmers' fields in most of West Africa. Further experiments and analyses should narrow the range. The analysis indicates that progress in yield beyond this threshold cannot be foreseen without strict control of rust and leaf spot diseases.

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Efficacy of Fungicides for the Control of Leaf Spots of Groundnut in Meghalaya, India

S. Chandra and **R.N. Verma** (ICAR Research Complex for NEH Region, Barapani, Meghalaya 793 103, India)

Early leaf spot (*Cercospora arachidicola* Hori) and late leaf spot [*Phaeoisariopsis personata* (Berk and Curt.)] are the most important foliar diseases of groundnut (McDonald et al. 1985). Although groundnut is not a traditional crop in the Northeastern Hill region (NEH) of India, occurrence of these diseases in experimental as well as isolated farmers' plots has been reported (Gupta 1987). Also several workers have reported the efficacy of different fungicides for the control of this disease (Vidhyasekaran 1981; Gupta et al. 1987). However, to identify the most effective and economic fungicide in this high rainfall area, six fungicides including two experimental ones i.e., propiconazole (Tilt(R) 250 EC) and triforine (Saprol(R) 18 EC) were tested and their performance is reported here.

A field experiment was conducted in a randomized block design with three replications at the ICAR Research Farm, Barapani (Altitude: 950 m; latitude and longitude 26°N and 92°E), during the rainy season of 1987 and 1989 with groundnut cv JL 24. The crop was line sown at 30 × 10 cm spacing in 2.1 × 3 m plots. The sowing and harvesting was done on 22 May and 17 Sep in 1987 and 23 May and 19 Sep in 1989. A basal fertilizer dose of 20 kg N, 60 kg P_2O_5, and 40 kg K_2O ha^{-1} was applied. Six fungicides i.e., propiconazole (Tilt® 250 EC), carbendazim (Bavistin® 50 WP), thiophanate methyl (Topsin M® 70 WP), triforine (Saprol® 18 EC), (Mancozeb® 75 WP), and dithianon (Delan® 75 WP) were included in the experiment besides an unsprayed control. Both early and late leaf spot diseases appeared 30-35 days after sowing (DAS) in all the plots. Each fungicide was sprayed three times at 45, 65, and 85 DAS using a knapsack sprayer. Intensity of the disease was recorded on a 0-5 scale (where 0 = no infection, 5 = 50% leaf area affected) on the top three leaves of 10 plants

Table 1. Effect of fungicides on disease control, defoliation, and yield of groundnut cv JL 24, Barapani, Meghalaya, India.

		Disease index (%)		Defoliation (%)		Pod yield (kg ha^{-1})	
Fungicide	Dose ha^{-1}	1987	1989	1987	1989	1987	1989
Propiconazole 250 EC	1.0 L	8.39	13.76	14.56	46.4	4471	2540
Carbendazim 50 WP	1.0 kg	9.4	14.51	11.38	55.8	4405	2672
Thiophanate methyl 70 WP	1.0 kg	10.98	13.34	29.76	54.1	3916	2460
Mancozeb 75 WP	2.5 kg	18.37	31.63	44.81	63.5	3162	1042
Triforine 18 EC	1.8 L	16.53	25.74	47.64	61.3	3095	1614
Dithianon 75 WP	1.5 kg	21.11	36.46	45.84	62.1	2328	1508
Unsprayed check	-	23.52	39.74	46.09	69.4	1878	1084
SE		±3.07	±1.88	±3.25	±3.62	±264.1	±133.8
CV (%)		32	12	15	10	13	11

plot^{-1}. Percent disease index (PDI) was calculated as:

$$PDI = \frac{\text{Sum of numerical rating} \times 100}{\text{Number of leaves scored} \times \text{Maximum score}}$$

Defoliation was expressed as a percentage by counting the total number of nodes and defoliated nodes on 15 stems plot^{-1}. Pods were sun dried for about a week and dry pod yield was recorded. All the fungicides gave significantly higher yield over control, except dithianon. However, only propiconazole, carbendazim, and thiophanate methyl reduced the disease severity.

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Identification of Groundnut Genotypes Less Susceptible to Early Leaf Spot in Zambia

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Early leaf spot (ELS) caused by *Cercospora arachidicola Hori* is a major disease of groundnut in all the three agroecological zones in Zambia (Kannaiyan et al. 1989; Haciwa and Kannaiyan 1990). Haciwa and Kannaiyan (1990) reported that infection by leaf spots (mostly ELS) only caused between 32 and 68% loss in seed yield in the Eastern Province, where most of the groundnut is produced in the country.

Since groundnut is largely cultivated by small farmers, the development of disease-resistant varieties is a cheap, economical, and long-term solution to this major problem. Systematic field screening of groundnut genotypes for resistance to leaf spots, especially ELS, was undertaken from the 1983-84 crop season onwards in Zambia (Kannaiyan et al. 1989). This paper reports on the recent progress made in identifying groundnut genotypes that are less susceptible to ELS. Information on susceptibility to insect pests and seed yield potential of these genotypes is also presented.

In 1989-90, 30 alternatively branching and 40 sequentially branching groundnut genotypes including susceptible and local controls were planted both at Msekera and Masumba Research Stations in a randomized block design with three replications with a plot size of one 4-m

Table 1. Performance of some promising selections less susceptible to early leaf spot (ELS) at Msekera (MSK) and Masumba (MAS), Eastern Province, Zambia, 1989-91.

	ELS severity (1-9 score)				thrips damage (1 score)	Leafhopper damage (1-9 score)	100-seed mass (g)	Seed yield (kg ha^{-1})
	1989-90		1990-91	Mean	1990-91	1990-91	1990-91	1990-91
Genotype	MAS	MSK	MSK	Severity	MSK	MSK	MSK	MSK
C 177/5/1	2.3	4.3	4.0	3.5	2.5	6.0	57	1214
48/5/25	3.7	5.0	5.0	4.6	4.0	5.5	72	777
93/5/23	4.0	5.0	5.0	4.7	3.0	4.5	68	1350
ICG 5351	4.3	5.0	5.0	4.8	4.0	3.5	63	816
ICG 7237	3.7	6.0	5.0	4.9	4.0	4.5	50	1119
ICG 7884	5.0	5.0	5.0	5.0	4.5	4.0	54	1610
SAC 58	4.7	5.3	5.0	5.0	5.5	6.5	68	1378
CH 83/74	4.3	5.7	5.0	5.0	6.0	4.5	78	983
Gambia Bunch D	4.3	6.0	5.0	5.1	5.5	6.5	56	1262
Red Mwitunda	5.3	5.7	5.0	5.3	4.5	5.5	46	1646
ICG 5778	4.7	5.7	5.5	5.3	6.5	2.5	63	1185
ICGS 54	4.7	6.0	5.5	5.4	3.5	7.0	53	1240
ICG 5728	5.0	6.0	5.5	5.5	6.5	2.5	73	888
ICG 2271	5.0	6.0	5.5	5.5	2.5	3.0	65	1744
ICG 9116	5.3	6.0	5.5	5.6	6.5	6.0	54	1245
ICG 7888	6.0	6.0	-	6.0	-	-	-	-
Comet (susceptible check)	9.0	9.0	9.0	9.0	3.6	3.0	31	1109
MGS 2 (local check)	6.3	8.7	6.5	7.2	3.0	3.5	73	1888
SEm	±0.4	±0.3	±0.3	-	±0.7	±0.6	±4.0	±144.5
mean[1]	6.5	6.3	5.9	6.2	4.4	4.8	53	1282
CV (%)	12	9	7	-	21	19	11	16

1. Total of 40 genotypes for 1990-91 (MSK) and 70 for 1989-90 (MSK and MAS).

long ridge. In 1990-91, 40 promising selections from both alternatively and sequentially branching types were planted in the same design with two replications in plots having two 4-m long ridges at Msekera alone. ELS- susceptible spreader rows (JL 24 or Malimba) were planted after every two test rows and all round the trial about 2 weeks prior to planting of test genotypes. Fertilizer 'D' compound (LON 20P 10K) was applied prior to planting at @ 200 kg ha^{-1}; but no pesticide/fungicide was applied. Hand weeding and reridging were done twice.

The severity of ELS was scored on a plot basis using a 1 to 9 field rating scale at about 90 and 110 days after planting and mean ratings were used to compare genotypes. Foliar damage by two sucking insect pests, thrips (*Frankliniella* spp) and leafhoppers (*Empoasca dolichi*) was also visually scored on a 1-9 field rating scale. The seed yield of each plot was recorded and estimated per hectare only for the 1990-91 nursery.

The disease-spreader rows provided uniform severity of ELS to all test entries as indicated by high disease scores (9.0) in the susceptible control, Comet, both at Msekera and Masumba. Among the several groundnut genotypes screened, C117/5/1, 48/5/25, 93/5/23, ICG 7273, CH 83/74, SAC 58, Gambia Bunch D, ICG 5778, ICGMS 54, ICG 5728, ICG 2271, ICG 9116 (alternatively branching), ICG 5351, ICG 7884, Red Mwitunda, and ICG 7888 (sequentially branching) showed significantly less susceptibility to ELS severity (6.0 and lower scores) in comparison to the susceptible control score of 9.0 (Table 1). Of these less susceptible types C177/5/1, 48/5/25 and 93/5/23 are derived from crosses made locally, for incorporating ELS resistance. Among these, C177/5/1 and ICG 2271 appeared to be distinctly less susceptible to thrips damage, while ICG 5728 and ICG 5778 seemed distinctly less damaged by leaf hoppers. While MGS 2 recorded the highest kernel yield, ICG 2271, Red Mwitunda, and ICG 7884 showed distinctly higher yields than the susceptible control, Comet.

Red Mwitunda, which also showed good level of ELS resistance, is a popular cultivar in Tanzania. Two genotypes (ICG 2271 and ICG 5351) showed combined tolerance to both thrips and leaf hopper damage. Some of these promising low ELS selections are being utilized in the Zambia national groundnut hybridization program.

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Evaluation of ICRISAT Groundnut Lines for Resistance to Foliar Diseases in Vietnam

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Rust (*Puccinia arachidis* Speg.), early (*Cercospora arachidicola* Hori) and late (*Phaeoisariopsis personata* (Berk and Curt) v.Arx) leaf spots are the three most important diseases of groundnut in Vietnam. Rust and leaf spots normally occur together causing severe defoliation and pod yield losses up to 70% (Hong et al. 1990). In recent years the severity of rust and leaf spots has increased. Groundnut varieties popularly grown in Vietnam have been found highly susceptible to these diseases.

Use of resistant cultivars should be the most practical way to control these diseases. However, in Vietnam, information on sources of resistance to rust and leaf spots is lacking. This paper briefly reports screening of 140 promising ICRISAT groundnut lines included mainly in the International Trials (IFDRGVT, IPRGVT, ICGVT, IEGVT, IMLGVT) against rust and leaf spots under natural epiphytotic conditions at the National Institute of Agricultural Science (INSA). To obtain reliable results, all the entries of the different trials were tested for three seasons (1989 spring and autumn seasons and 1990 spring season). The infector-row method and the 9-point scale developed at ICRISAT were used in this study. During the testing period weather conditions at INSA favored the build up of all the three diseases and high inoculum pressure was ensured.

Of the 140 lines tested, none was found free from infection. However the varieties ICGVs 86013, 86548, and 86550 showed stable resistance to rust (disease score <4). The varieties ICGVs 86112, 87134, 87142, 87147, 87170, 87171, and 87173 showed resistant reaction to early leaf spot. The varieties ICGVs 86063, 86015, and 86066 were resistant to late leaf spot.

There is an obvious need to identify lines having resistance to more than one disease. We have identified several varieties with combined resistance to foliar diseases (Table 1).

The present studies indicate that INSA is an extremely suitable location for screening groundnut germplasm for resistance to the three major foliar diseases. The identified lines would be tested in various ecological regions of Vietnam for the stability of their resistance. The groundnut varieties ICGV 86550 (resistant to rust) and ICGV 86015 (resistant to late leaf spot) have been found also to be high yielding; hence these promising lines will be included in the hybridization programs for further improvement.

Table 1. ICRISAT groundnut varieties with combined resistance to the major foliar diseases in Vietnam.

Disease	Groundnut varieties (ICGV No.)
Rust and late leaf spot	86548, 86549, 87149,
Rust and early leaf spot	87157 86024, 86162,
Early and late leaf spot	87168, 87061 86016,
Rust, early, and late leaf spot	87063 87165

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Characterization of a Necrosis Strain of Peanut Stripe Virus Infecting Beggerweed and Groundnut in Georgia, USA

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Beggerweed (*Desmodium canum*) is a leguminous weed common in southeastern USA. Edwardson et al. (1970) isolated a virus from this plant in Florida and designated it as desmodium mosaic virus (DMV). The virus has the properties of the potyvirus group. We isolated a virus from beggerweed with mosaic symptoms that was growing in a groundnut field in Tift county, Georgia, in 1985. Initial isolation was made to groundnut (*Arachis hypogaea* cv. Florunner) in the greenhouse by sap inoculation. The foliar symptoms of sap-inoculated groundnut mimicked the symptoms incited by the necrotic strain of peanut mottle virus (PMV-N) (Paguio and Kuhn 1973) and tomato spotted wilt virus (TSWV) (Halliwell and Philley 1974) at certain stages of disease development. In 1990 we isolated a virus from groundnut in Decatur county, Georgia with foliar necrosis that was indistinguishable from the beggerweed isolate based on serology, host range, and symptoms in groundnut.

The virus cultures were maintained in groundnut and white lupine (*Lupinus albus*). We made sap inoculations using the juice from infected leaves triturated in 0.05 M potassium phosphate buffer, pH 7.0, containing 0.1% 2-mercaptoethanol (PBM). The host range was determined by sap-inoculating 6 to 10 plants of each test species. The dilution end point (DEP), thermal inactivation point (TIP) and the longevity *in vitro* of the virus in sap extracted from groundnut with PBM were determined by using *Chenopodium amaranticolor* as a local lesion assay host. Aphid transmission was determined using populations of *Aphis craccivora* maintained on cowpea (*Vigna unguiculata Subsp.* unguiculata cv California Blackeye) and *Myzus persicae* maintained on pepper (*Capsicum annuum*) in a growth chamber. The aphids were starved overnight, given a 1-min acquisition-access period on virus-infected detached groundnut leaves, and then transferred to healthy groundnut plants (1 aphid/plant) and given a 1-2 h inoculation-access period. Florunner groundnut seeds were planted on an experimental farm in Sphalding county, Georgia and the seedlings in the center of five rows were mechanically inoculated at the fourth leaf stage to determine the effect on seed yield and seed transmission. The virus was purified from white lupine leaves and an antiserum produced essentially as described by Demski et al. (1984). Virus coat protein molecular weight was determined by the procedure of Laemmli (1970) and of virus nucleic acid by the procedure described by Vance and Beachy (1984). Viral inclusion bodies were examined in infected groundnut and white lupine epidermal tissues under a light microscope using tissue preparation and staining techniques of Christie and Edwardson (1986). Serological relationships with other potyviruses were determined using the indirect enzyme-linked immunosorbent assay (ELISA) as previously described by Hobbs et al. (1987). Symptoms induced in beggerweed take the form of a general mosaic of light and darker green areas characteristic of those induced by many potyviruses. In groundnut, the first few newly developed leaves showed chlorotic spots and necrotic patches, followed by drooping of whole leaves with downward rolling of leaf margins. Newly developed leaves were small and the whole plant appeared stunted when infected early.

The virus produced necrotic local lesions on *C. amaranticolor*; systemic symptoms on *Nicotiana benthamiana*, *N. clevelandii*, *Sesamum indicum*; and both local and systemic symptoms on *Canavalia ensiformis*, *Glycine max* cv Bragg, *Lupinus albus* and cowpea (cv California blackeye). *Gomphrena globosa* and *Petunia hybrida* were infected locally without visual symptoms. The following plant species neither showed symptoms nor was the virus recovered from them: *Capsicum annuum*, *Cucurbita pepo* cv melopepo, *Cucumis melo*, *Datura stramonium*, *G. max* cv Davis, *Lycopersicon esculentum*, *Medicago sativa*, *N. glutinosa*, *N. tabacum* cv Burley 21, *Phaseolus vulgaris* cvs Pinto and Topcrop, *Pisum sativum* cvs Little Marvel and Alaska, *Vinca rosea*, and cowpea cv Clay.

The DEP of the virus was between 10^{-4} to 10^{-5}, and the TIP between 50° to 55°C. The virus retained infectivity for 8 days but not for 10 days at 25°C.

Aphis craccivora transmitted the virus to 8 of 49 plants and *M. persicae* to 4 of 50 groundnut plants, in a nonpersistent manner.

Table 1. Reciprocal reaction of seven potyviruses with beggerweed isolate and peanut stripe virus (PStV) antisera in indirect enzyme-linked immunosorbent assay.

		Antisera[3]	
Antigens[1]	Antigen dilutions[2]	Beggerweed isolate	PStV
BICMV	10^{-1}	1.10[4]	1.03
	10^{-2}	1.46	1.41
	10^{-3}	1.00	0.97
PGMV	10^{-1}	0.43	0.40
	10^{-2}	0.70	0.72
	10^{-3}	0.98	0.87
PMV	10^{-1}	0.02	0.00
	10^{-2}	0.07	0.03
	10^{-3}	0.09	0.01
SMV	10^{-1}	1.08	0.78
	10^{-2}	1.16	0.96
	10^{-3}	0.75	0.51
TEV	10^{-1}	0.23	0.19
	10^{-2}	0.29	0.26
	10^{-3}	0.38	0.35
WMV 2	10^{-1}	0.44	0.36
	10^{-2}	0.48	0.51
	10^{-3}	0.77	0.76
Sesame isolate	10^{-1}	0.59	0.57
	10^{-2}	0.59	0.50
	10^{-3}	0.51	0.48
Virus control	10^{-1}	>2.00	1.61
	10^{-3}	>2.00	>2.00
	10^{-3}	>2.00	>2.00
Healthy control			
white lupine	10^{-1}	0.01	0.00
pea	10^{-1}	0.00	0.00
tobacco	10^{-1}	0.00	0.00
soybean	10^{-1}	0.01	0.00
cowpea	10^{-1}	0.01	0.00

1. BICMV = blackeye cowpea mosaic, PGMV = peanut green mosaic, PMV = peanut mottle, SMV = soybean mosaic, TEV = tobacco etch, WMV 2 = watermelon mosaic viruses, and a virus isolated from sesame.
2. Antigen leaf tissues extracted at 1 g tissue per 9 mL 0.05 M carbonate buffer + 0.01 M sodium diethyldithiocarbamate (antigen buffer) = 10^{-1} dilution.
3. Crude antisera used at 1:1000 dilution.
4. Values (A_{410}) represent average of two replications read over antigen buffer controls.

The yield of six groups of 10 consecutive infected plants were 331, 382, 363, 329, 339, and 308 g compared to six groups of 10 consecutive healthy plants of 384, 356, 387, 396, 389 and 380 g with an average of 342 g for infected plants and 382 g for healthy plants.

From the 467 germinated seeds from infected parents, one seedling showed visible virus symptoms. This symptomatic plant, tested by ELISA, was positive for virus.

Purified virus was infective on groundnut and *C. amaranticolor*. The ultraviolet absorption spectrum of purified virus had a shoulder at 290 nm and the A_{260}/A_{280} ratio was 1.27 to 1.29. The A_{260}/A_{245} ratio was 1.10 to 1.18. In indirect PTA-ELISA tests the antiserum produced against the purified virus had a titer of 1:60,000 and did not react with crude healthy leaf extracts. Serological reactions of some potyviruses against the antiserum of the beggerweed isolate and peanut stripe virus are given in Table 1.

The virus-protein preparations contained a major polypeptide of 34.5×10^3 and a minor polypeptide of 31×10^3 daltons. The virus nucleic acid, assumed to be RNA, migrated as a single band with an estimated molecular weight of 3×10^6 daltons.

Cytoplasmic cylindrical inclusions were observed in epidermal peelings of groundnut and white lupine leaves under the light microscope.

The DMV from beggerweed in Florida is not available and thus could not be directly compared to our isolates from beggerweed and necrotic peanut. However the literature on host range and other characteristics indicate that DMV is a distinctly separate virus.

Comparisons of our beggerweed and necrotic peanut virus isolates with peanut stripe virus (PStV) shows that these viruses are closely related in nearly all aspects and we conclude that our isolates are symptom variants of PStV.

Isolates of PStV that induce necrosis in groundnut have been reported from Thailand (Wongkaew and Dollet 1990) and Taiwan (Chang et al. 1990). We now report a necrosis isolate of PStV naturally infecting groundnut and weeds in the USA.

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Identification of Additional Groundnut Sources Resistant to Bacterial Wilt Under Field Conditions in East Java, Indonesia

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In Indonesia, occurrence of bacterial wilt of groundnut (*Pseudomonas solanacearum*) is widespread in Sumatra, Java, Bali, Lombok, and Sulawesi. In the past, estimated crop losses amounted to 25% to 90% (Machmud 1986). Release of the resistant variety Schwartz 21 in 1925 and its derivatives, including Gajah, since 1951 have markedly reduced crop losses due to bacterial wilt and at present the incidence in farmers' fields ranges from 0.8 to 10.1% with an average of 3.5% (Machmud 1986). However, the introduced exotic germplasm is often highly susceptible under field conditions. We introduced germplasm sources resistant to late leaf spot [*Phaeosariopsis personata* (Berk. & H.A. Curtis) Arx] and rust (*Puccinia arachidis* Speg.) from ICRISAT. The promising introduced lines were evaluated for bacterial wilt resistance under field conditions. The paper reports the results, which indicate the possibility of establishing additional sources of resistance to bacterial wilt and multiple resistance to late leaf spot, rust, and bacterial wilt.

A highly uniform naturally wilt-sick field was chosen at the Jambegede Experimental Station of Malang Research Institute for Food Crops (MARIF) in East Java. Three sets of groundnut genotypes introduced from ICRISAT were evaluated in the field during September-December 1988, April-July 1989, and September-January 1990-91. The first set consisted of 14 introduced genotypes and the local cultivar, Gajah. The second set included 50 introduced genotypes and surviving single plant progenies of the introduced genotypes and Gajah from the previous season. The third set consisted of 31 introduced genotypes and single plant progeny family bulks of promising entries from the previous two seasons. Initially test entries were planted in 2-m, 2- to 4-row plots at 40 × 10 cm spacing. The following year single-plant progenies or progeny bulks were planted in 3, 2, and 1 row nonreplicated plots depending on availability of seed. During 1990-91, a replicated trial of 39 entries consisting of 21 Gajah progeny bulks, 16 selected introduced genotypes, and Gajah and J 11, a susceptible cultivar, as the checks were planted in RBD with two replications in 3-row, 2-m length plots. Test entries were planted perpendicular to the susceptible cultivar, chico at the top and J 11 at the bottom of each 2-m broad block. Indicator rows of Gajah (resistant) and J 11 (susceptible) flanked the entries after every 8 or 12 rows. Initial germination was recorded at 15 days after planting. Percent survival at harvest is reported though observations were recorded every 2-3 weeks.

Nonreplicated Plot Observations

Uniformly low survival of the susceptible checks, chico and J 11 (Table 1) indicated uniformly high bacterial wilt incidence in the three seasons. Survival of the resistant

Table 1. Percent survival of selected groundnut lines in wilt-sick field in comparison with resistant and susceptible controls.

Accession	% Survival 1988	1989	1990-91
Set I			
ICGV 87165-BWR-BWR-B	23.6	66.6	-
ICGV 87170-BWR-BWR-B	8.0	71.42	73.6
ICGV 87176-BWR-BWR-B	22.9	68.90	69.33
ICGV 87182-BWR-BWR-B	14.9	65.00	73.70
ICGV 87183-BWR-BWR-B	12.9	60.00	64.23
ICGV 87184-BWR-BWR-B	40.9	73.70	58.80
Ah 1 x NC Ac 17090-1-BWR-B	9.0	74.10	68.80
Ah 3 x NC Ac 17090-BWR-BWR-B	13.3	57.89	75.80
Set II			
ICGV 86021-BWR-B	-	18.2	78.3
ICGV 86187-BWR-B	-	22.8	41.7
ICGV 86352-BWR-B	-	30.3	57.0
IGCV 86621-BWR-B	-	30.5	75.1
ICGV 86623-BWR-B	-	30.3	72.2
ICGV 86663-BWR-B	-	38.2	58.6
ICGV 86973-BWR-B	-	21.8	42.3
ICGV 86977-BWR-B	-	66.6	80.8
ICGV 87160-BWR-1B	-	100.0	83.3
IGCV 87160-BWR-2B	-	100.0	72.2
ICGV 87161-BWR-B	-	44.4	47.0
ICGV 87255-BWR-B	-	32.4	*
ICGV 88245-BWR-B	-	20.5	80.0
ICGV 88252-BWR-B	-	45.0	54.4
ICGV 88255-BWR-B	-	46.6	*
ICGV 88259-BWR-B	-	56.0	50.0
ICGV 88260-BWR-B	-	63.0	*
ICGV 88271-BWR-B	-	65.0	52.3
ICGV 88274-BWR-B	-	47.3	65.6
ICGV 88275-BWR-B	-	35.3	82.6
ICGV 88277-BWR-B	-	41.6	30.4
ICGV 88278-BWR-B	-	68.0	72.0
Kidang x ICG(FDRS)-1-10-BWR-6-B	-	71.4	69.2
Altika-BWR-2B	-	100.0	80.0
ICG(E)127-BWR-B	-	8.5	76.9
Ah 1 X NC Ac 17090-4-BWR-2	-	50.0	75.0
Ah 1 x ICG(FDRS)10-3-BWR-2	-	64.0	70.0
Ah 1 x ICG(FDRS)10-5-BWR-2	-	50.0	72.7
Ah 3 x NC Ac 17090-BWR-2	-	100.0	83.3
Ah 3 x NC Ac 17090-BWR-4	-	71.4	68.4
Kidang x ICG 17-1-BWR-1	-	38.5	75.0
Kidang x NC Ac 17090-BWR-1	-	100.0	68.4
Set III			
ICGV 86594	-	-	63.4
ICGV 86606	-	-	38.8
ICGV 86023	-	-	39.4
Controls			
Gajah (resistant)	70.5	84.22	40.42
Chico (susceptible)	0.0	0.0	0.97
J 11 (susceptible)	-	3.2	1.58

* Seed did not germinate.

check, Gajah varied from 40.42 to 84.22% depending on the seed source. In set I (Table 1), eight of the entries had 8.0 to 40.9% survival in 1988. However, 87% single plant progenies from them had high plant survival in the subsequent years. In set II, of 50 new accessions, 34 had 8.5 to 100% survival in 1989, and 41.7 to 83.3% in 1990-91. In set III, of 31 only 3 new accessions had more than 30% survival with a range of 38.8 to 63.4%.

Replicated Trial

Actual and transformed percent survival values for selected entries from the trial are given in Table 2. As analysis of variance on the actual percent survival and on arcsin-transformed values was not different and there was hardly any change in the ranking of the entries, data on actual percent survival only is discussed. Of the 21 selected Gajah progenies, 17 were significantly superior in percent survival ranging from 73.55 to 92.00. Only four of them were not significantly different from the Gajah unselected bulk seed, which had 45.85% survival against 1.9% for the susceptible cultivar J 11.

Among the 16 genotypes selected for resistance to bacterial wilt 10 were significantly superior in percent survival than Gajah bulk and were similar to the selected Gajah entry number 21, which had 92% survival. The other six selected resistant introduced lines ranged in their survival from 55.50 to 72.60%, which was not significantly different from Gajah bulk but was much higher than the 1.90% survival of the susceptible cultivar J 11.

Observations on sets I and II given in Table 1 show that a number of introduced lines from ICRISAT carried resistance to bacterial wilt in varying frequency, which could be considerably increased by selection for resistance in a wilt-sick field.

High recovery of resistant plant progenies of family bulks from the surviving plants of the entries in set I and II and their consistent high survival in the subsequent two seasons for set I and for one season for set II indicated high heritability for the observed resistance. High heritability values of 88.0 to 93.3% for resistance to bacterial wilt of groundnut have been reported from China (Liao et al. 1986).

The data in Table 2 show that the resistance of selected progenies of Gajah is of a much higher order than that of the Gajah unselected bulk. This indicates the need for maintaining a high level of resistance to bacterial wilt in the cultivar Gajah by proper selection and maintenance of breeder seed through plant progeny evaluation under bacterial wilt disease pressure.

Further, the data in Table 2 show that eight of the selected introduced lines are more or less similar in their

Table 2. Percent survival of selected ICGV lines in comparison with 21 selected lines of the resistant cultivar Gajah, Gajah unselected bulk, and the susceptible cultivar.

Entry	Actual % survival		Transformed % survival	
21 Gajah lines	61.90 b-f[1] to 92.00a		52.70 c-f to 73.58a+	
ICGV 86621-BWR-B	75.10	a-e	60.85	a-f
ICGV 86623-BWR-B	77.25	a-e	61.58	a-e
ICGV 86977-BWR-B	80.80	a-e	64.26	a-e
ICGV 87176-BWR-B	77.85	a-e	61.93	a-e
ICGV 87182-BWR-B	75.55	a-e	60.48	a-f
ICGV 87182-BWR-4	73.70	a-e	59.19	a-e
ICGV 87183-BWR-4	55.90	def	48.51	af
ICGV 87184-BWR-B	58.80	c-f	50.10	def
ICGV 88252	55.50	ef	48.17	ef
ICGV 88261-BWR-B	72.60	a-f	58.44	a-f
ICGV 88275-BWR-B	82.65	a-e	65.39	a-e
ICGV 88278-BWR-B	82.05	a-e	65.46	a-e
Ah 1 x NC Ac 17090-BWR-1	68.40	a-f	55.84	a-f
Ah 1 x NC Ac 17090-BWR-4	67.85	a-f	55.46	a-f
Gajah unselected bulk	45.85	f	42.61	f
J 11	1.90	g	5.85	g
LSD (5 %)	23.12		15.57	
CV (%)	15.4		25.57	

1. Means within a column followed by a common letter are not significantly different at the 5% level using Duncan's Multiple Range Test.

resistance to the selected highly resistant lines of the well-known bacterial wilt-resistant cultivar Gajah.

Genotypes ICGV 86187, ICGV 86594, ICGV 86977, ICGV 87176, and ICGV 88252 have been reported to have moderate level of resistance with survival ranging from 40 to 57.1% under controlled laboratory evaluations at the Bogor Institute of Food Crops (M. Machmud, personal communication, 1990), against the observed field survival ranging from 41.7 to 80.8%. However, genotypes ICGV 86350 and ICGV 87206 had 33.4 and 40.0% survival in the laboratory at Bogor but we observed only 13.3 and 16.4% survival for the two genotypes in the field.

In general, survival in field screening is relatively higher than that under controlled laboratory conditions and the disease ratings in the field and lab do not necessarily correlate well. European potato germplasm susceptible to bacterial wilt under controlled conditions was found to be resistant under field conditions in a study by Schiediche (1988).

Although none of the newly identified sources provide a source of resistance greater than that already available in the cultivar Gajah, several lines with a moderate (50%) to high (70% and above) survival rate are useful for increasing the genetic diversity. The lines ICGV 87165 and ICGV 88252, highly resistant to late leaf spot and rust, and ICGV 88271 and ICGV 88274 moderately resistant to late leaf spot and highly resistant to rust, with a 51 to 66% survival rate in field screening for bacterial wilt, offer excellent sources of multiple resistance to the three diseases. In the absence of a general and absolute resistance to *Pseudomonas solanacearum* it would be desirable to utilize diverse sources of resistance in breeding wilt-resistant groundnut varieties with the appropriate level of resistance for a specific agroecological environment and cropping system.

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First Record of Insect Pests and Predators of Thrips and Jassids on Groundnut in India

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During our routine insect pest surveys carried out in and around Junagadh in the Saurashtra area of India during the rainy season, 1988, several sucking pests and the predators belonging to the anthecoridae and spiders predating on thrips (*Caliothrips indicus*) and jassids on groundnut were recorded. Their predatory efficiency has been confirmed in laboratory studies. A list of these predators and pests is given below.

Pest/predator	Remarks
Orius (*Dimorphella*) *albidipennis* (Router) *Orius* (*Dimorphella*) *maxidentex* Ghauri *Orius* (*Dimorphella*) spp (Hetereptera: Anthocoridae)	Predators on thrips (*Caliothrips indicus*)
Thyene sp *Aelurillus* sp *Menomerus* sp *Saitis* sp (Araneae: Salticidae)	Predators on thrips (*Caliothrips indicus*) and Jassids (*Empoasca kerri Pruthi* and *Balclutha hortensis* Lindb.)
Cicadulina bipunctata (Melicher) (Homeptera: Cicadellidae)	It slowly competes with *Balclutha hortensis* Lindb. and Empoasca kerri Pruthi and by the last week of September the population is reduced by 50% of the total catch in sweepnet on the rainy season crop.
Sogatella sp (Homoptera: Delphacidae)	4-5 insects/5 sweeps/5 m row in rainy season 1988.
Hemiberlosia latanise (Signoret) (Hemoptera: Diaspididae)	It was observed feeding and multiplying enormously on a hybrid of the cross between *A. hypogaea* (cv J 11) and *A. chacoense*.

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Leaf Defoliation and Yield Potential of Groundnut Genotypes Under Protected and Unprotected Conditions

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More than 90 species of insects attack groundnut crop throughout its growth period (Reddy 1988). Tobacco caterpillar (*Spodoptera litura* F.), Bihar hairy caterpillar (*Spilosoma obliqua* Wlk.), and gram pod borer (*Helicoverpa armigera* Hub.) which were minor pests in the past, have become serious pests probably because of bad pest-management practices such as overdosing with insecticides, destruction of natural enemies, abandonment of cultural control, and introduction over large areas of high-yielding but pest-susceptible crop varieties which are grown throughout the year (Ayyanna et al. 1982; Ramakrishna et al. 1984). The cultivation of resistant varieties has been recognized as the ideal and economical method of reducing crop losses (Stakman and Harrar 1957). Along with plant resistance, insecticides and biological control have been identified as potential pest-management strategies (van Emden 1987). The present study was conducted to assess the impact of defoliators on the yields of 11 selected groundnut genotypes under protected and unprotected conditions.

A field trial was conducted in the 1988 rainy season at the Crop Research Center (CRC), G.B. Pant University of Agriculture and Technology, Pantnagar, Nainital, Uttar Pradesh, India. Groundnut genotypes known for insect pest resistance viz., Chandra, EC 36892, ICGS 1, ICGV 86029, ICGV 86030, ICGV 86031, Kausal, M 13, NC Ac 17090, NC Ac 343, and Robut 33-1 obtained from International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), India, were sown on 1 July 1988 in a split plot design with genotypes as the main treatment and insecticidal protection and no protection as subtreatments. Each treatment had 3 replications. Plot size was 4 rows of 4m, with a row-to-row spacing of 30 cm, and plant-to-plant spacing of 15 cm. Standard agronomical

Table 1. ***Spilosoma obliqua*** **and** ***Spodoptera litura*** **infestation on groundnut genotypes under protected (P) and unprotected (UP) conditions, rainy season 1988.**

	Spilosoma obliqua m^{-1}				*Spodoptera litura* m^{-1}		Leaf injury (%)		Pod weight ($t\ ha^{-1}$)	
	50 DAE[1]		85 DAE		75 DAE		90 DAE			
Genotypes	P	UP	P	UP	P	UP	P	UP	P	UP
Chandra	3.3	4.7	25.7	32.0	9.7	10.7	11.7	36.7	2.8	2.6
	(1.8)[2]	(2.1)[2]	(5.0)[2]	(5.6)[2]	(3.0)[2]	(3.3)[2]	(19.9)[3]	(37.1)[3]		
EC 36892	3.3	5.0	26.7	34.7	4.0	5.3	13.3	31.7	1.7	1.7
	(1.8)	(2.2)	(5.1)	(5.9)	(2.0)	(2.3)	(21.3)	(34.2)		
ICGS-1	2.0	4.3	15.0	18.7	5.0	6.3	11.7	40.0	4.0	3.6
	(1.4)	(2.1)	(3.6)	(4.2)	(2.2)	(2.5)	(19.9)	(39.2)		
ICGV 86029	5.0	11.3	14.3	18.0	12.0	11.3	13.3	33.3	3.7	3.3
	(2.2)	(3.3)	(3.7)	(4.2)	(3.5)	(3.4)	(21.3)	(35.2)		
ICGV 86030	4.0	5.3	10.7	11.3	7.7	7.7	13.3	36.7	3.1	2.8
	(2.0)	(2.3)	(3.2)	(3.3)	(2.7)	(2.7)	(21.3)	(37.2)		
ICGV 86031	2.0	4.7	17.3	22.7	4.7	7.0	15.0	26.7	2.0	1.8
	(1.4)	(2.1)	(4.1)	(4.6)	(2.1)	(2.6)	(22.6)	(31.0)		
Kausal	4.7	6.0	26.3	26.0	14.7	13.3	16.7	43.3	2.6	2.4
	(2.1)	(2.4)	(5.0)	(5.0)	(3.8)	(3.7)	(24.1)	(41.2)		
M 13	6.0	10.3	8.3	10.0	6.3	8.3	11.7	28.3	2.9	3.0
	(2.4)	(3.2)	(2.9)	(3.2)	(2.5)	(2.9)	(19.9)	(32.1)		
NC Ac 17090	3.0	5.0	22.7	20.0	10.0	11.3	16.7	36.7	2.4	2.3
	(1.7)	(2.2)	(4.7)	(4.4)	(3.2)	(3.4)	(24.1)	(37.2)		
NC Ac 343	4.3	6.0	12.3	12.3	9.7	10.3	5.0	13.3	3.6	3.5
	(2.1)	(2.4)	(3.5)	(3.5)	(3.1)	(3.2)	(12.9)	(21.3)		
Robut 33-1	2.7	6.0	9.7	14.7	9.0	9.07	15.0	40.0	3.8	3.6
	(1.6)	(2.4)	(3.0)	(3.7)	(3.0)	(3.0)	(22.8)	(39.2)		
SE (genotypes)	(±0.24)		(±0.51)		(±0.15)		(±1.45)		± 2.4	
SE (subtreatments)	(±0.06)		(±0.07)		(±0.04)		(±0.54)		± 0.3	
SE (Genotype x subtreatments)	(±0.28)		(±0.54)		(±0.18)		(±1.92)		± 2.4	
CV (%)	(15.7)		(9.2)		(8.5)		(11.0)		5.6	

1. DAE = Days after emergence; P = Protected crop; UP = Unprotected crop.
2. Figures in the corresponding columns refer to square root transformations.
3. These are angular transformation values.

practices were followed to raise a healthy crop. Carbendazim @ 120 g a.i. ha^{-1} was sprayed at 60 and 75 days after crop emergence (DAE) to protect the crop from foliar (leaf spots) diseases.

The crop was sprayed with endosulfan (35 EC) @ 700 mL a.i. ha^{-1} soon after the 2nd/3rd instar larvae of defoliators (*S. obliqua* and *S. litura*) were observed in the field. Sprays were repeated at 10-day intervals in the protected plots. The numbers of *S. obliqua* and *S. litura* larvae were counted at 50, 75, and 85 days after crop emergence (DAE). Percent leaf area defoliated was recorded visually on a 0-100% scale.

In the 1988 rainy season, there was an outbreak of *S. obliqua* at the CRC farm. Presence of *S. obliqua* larvae were first noticed in groundnut when the crop was at the flowering and pegging stages. Maximum number of larvae were found in the unprotected plot of ICGV 86029 (11 larvae m^{-1}) at 50 DAE. The next larval peak appeared at pod filling stage and the maximum number of larvae were found on EC 36892 (35 larvae m^{-1}) and the minimum on M 13 (10 larvae m^{-1}). *Spodoptera* appeared in the field when the crop was in the podding stage. During the day, most of the larvae were hidden on the soil surface in the leaf litter around the stem. The maximum number of larvae (13 larvae m^{-1}) were found on Kausal and the minimum on EC 36892 (5 larvae m^{-1}) at 75 DAE under unsprayed conditions. However, there were no differences observed in larval populations of *S. obliqua* and *S. litura* under protected and unprotected conditions (Table 1). This was probably due to the frequent movement of the larvae from one plot to another. The defoliation caused by them, however, differed significantly. Defoliation at 90 DAE was low in unprotected plots of NC Ac 343 (13.3%) followed by ICGV 86031 (26.7%) and M 13 (28.3%) which had few larvae per unit area. Genotypes EC 36892, ICGV 86029, ICGV 86030, Chandra, and NC Ac 17090 had moderate defoliation (31.7-36.7%) and the other genotypes had a higher level of defoliation (40%). In general, all the genotypes tested showed less defoliation in protected plots compared to the unprotected ones. Though there was continuous defoliation during pegging, podding, and pod filling, we found no yield reduction, and all the selected genotypes yielded at par under protected and unprotected conditions (Table 1). Pod yield was greatest, 4.0 t ha^{-1}, in protected ICGS 1 followed by Robut 33-1, ICGV 86029, and NC Ac 343. The studies at ICRISAT had also shown that 50% defoliation at flowering and 30% at pegging and podding stage did not reduce the yield significantly in the rainy season (ICRISAT 1987).

Genotype ICGV 86031 which suffered less damage was found unsuitable for feeding by early instar larvae most probably due to its hard and tough leaves. It was noticed that newly hatched larvae after initial attempts to feed on the leaves of the ICGV 86031, after 6-10 h moved on to other succulent leaves. However, on Robut 33-1, larvae fed gregariously at the oviposition site. On NC Ac 343 the young larvae were feeding gregariously but growth was poor compared to the same aged larvae in other plots. This could be due to antibiosis effect of the cultivar. In M 13, the low defoliation could be due to field resistance. These genotypes, therefore, could be grown successfully in areas endemic to damage by defoliators after testing for their agronomic superiority.

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Evaluation of Some Groundnut Varieties for Resistance Against Termite (Isoptera: Termitidae) and Julid (Myriapods: Diplopods) Damaged Pods in Burkina Faso

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Termites and julids are very serious arthropod pests of groundnut in Burkina Faso causing scarring and perforation of pods just before the groundnut harvest (Lynch et al. 1986). Other damages which are more qualitative, such as increase in the aflatoxin content in the damaged pods, were also directly linked to these pest attacks (Wilson and Flowers 1978; Johnson and Gumel 1981; Lynch et al. 1991). The Burkina Faso farmers cannot use chemical control against these pests due to their poor purchasing power. Varietal resistance, which is less expensive and definitely more environment-friendly, offers a better alternative (Jackai et al. 1985). The objective of the present study was to identify varieties less susceptible to termite and julid damage from 15 selected groundnut varieties.

The experiment was conducted at two locations in Burkina Faso i.e., the experimental station of the University of Ouagadougou at Gampela and the Institut national d'études et de recherches agricoles (INERA) Research Station at Farako Bâ in 1990 on two plots of 10 m × 2.70 m in Fischer Block design (Tukey 1953) with four replications. The individual resistance level of the varieties was determined during harvesting, by selecting 16 samples of 100 pods each and studying the percentage of pods scarred by termites and perforated by julids.

The results of varietal resistance to pod scarification by termites generally varied at the two experimental sites (Table 1). This variation is probably due to the rainfall which was much higher at Farako Bâ than at Gampela, especially during pod formation and maturation in October. In fact, Leuck (1967) and Lynch (1984) noted that pod scarification by soil arthropods is much more serious on groundnut plants that undergo severe drought stress during the pod maturation phase. Nevertheless, the varieties NC Ac 2243, RMP 40, and NC Ac 343 were highly resistant both at Gampela and Farako Bâ. TMV 2 was the

Table 1. Evaluation of groundnut varieties for resistance to termite and julid damage on pods (scarification and perforation) at Gampela and at Farako Bâ, Burkina Faso, 1990.

	Pods scarified by termites (%)[1]		Pods perforated by julids (%)		Pod yield ($kg\ ha^{-1}$)	
Variety	Gâmpela	Farako Bâ	Gampela	Farako Bâ	Gampela	Farako Bâ
RMP 12	2.25a[2]	5.00bc	4.75a	0.63a	1043bcd	536a
NC Ac 2243	2.80a	1.38a	3.88a	0a	448e	11d
RMP 40	3.75a	4.63ab	4.38a	0.50a	958bcd	315ab
NC Ac 343	3.80a	4.25ab	4.00a	0.13a	1713a	100cd
NC Ac 2240	3.88a	6.88cd	4.75a	0a	443e	83cd
NC Ac 2242	4.00a	3.25ab	5.38a	1.83a	572de	40d
NC Ac 2230	6.88ab	5.63bc	4.13a	2.63ab	848de	292b
J 11	7.00ab	6.25cd	3.00a	0.63a	1203abc	397ab
M 13	8.63ab	5.00bc	6.13a	0.75a	1736a	408ab
NC Ac 10033	9.88ab	3.30ab	6.25a	0.38a	1165ab	252bc
Te 3	12.13ab	-	5.80a	-	1621ab	-
NC Ac 2142	12.60b	6.50cd	10.88b	1.63a	1040bcd	73cd
NC Ac 17888	12.75b	5.25bc	6.75a	1.63a	1071bcd	256bc
Robut 33-1	13.25b	8.75d	6.00a	7.88b	1392abc	450ab
TMV 2	14.00b	9.50d	7.66ab	7.75b	1298abc	440ab

1. Percentages were changed to arc sine √% before analysis.
2. The averages in the same column followed by the same alphabetical letters are not statistically different ($P = 0.05$) according to Tukey's average separation test (1953).

variety most susceptible to termite attack at both the sites. It can therefore be used as a control in future tests.

The data in Table 1 also shows that the results on genotype resistance to julid attack are more homogeneous at both the sites, unlike the results obtained for termite attack. NC Ac 2243, NC Ac 343, and RMP 40 have once again proved to be more resistant varieties that can be used to minimize julid damages both at Gampela and Farako Bâ.

The relationship between resistance level of varieties and their pod yields is low (Table 1 and 2). For example, at Gampela, although NC Ac 2243, RMP 40, and NC Ac 2240 showed a high level of resistance to the combined attacks of termites and julids, they had lower pod yields compared to the other susceptible varieties.

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Multiple Insect Pest Resistance in a Groundnut Variety, NC Ac 343

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Insect pests cause severe losses to groundnut in India and are recognized as one of the major constraints to groundnut production. In particular the leaf miner, *Aproaerema modicella*, Deventer is a key pest of groundnut causing 27 to 40% yield loss by mining and feeding the leaves. The most affected areas in India are the states of Tamil Nadu, western and central Andhra Pradesh, Karnataka, western Maharashtra, and Orissa. Generally, chemical and cultural control methods are adopted for the control of this pest. Now cultivation of resistant cultivars has been emphasized, since it is an economical, safe, and satisfactory method of pest control. As groundnut is grown mostly as a rainfed crop, control of pests by chemicals is highly prohibitive. Hence, control is aimed to be achieved through the development of resistant cultivars. Very few reports on screening groundnut germplasm against leaf miner are available (Vikram Singh 1979; Wightman et al. 1987; Mahadevan et al. 1988). Vikram Singh (1979) reported that genotypes USA 61 and No.243 were resistant to leaf miner. Similarly Mahadevan et al. 1988 reported that the variety, ICGS 50 is resistant, not only to leaf miner but also to other foliar insects and late leaf spot disease.

The present study was undertaken at the Oilseeds Research Station, Tindivanam, Tamil Nadu to select lines possessing resistance to the leaf miner. For this purpose, seeds of 200 entries were sown in nonreplicated 3.0 m rows. For every four rows of groundnut one row of soybean was grown as infector crop, sown 15 days before groundnut. Leaf miner incidence was visually graded (1-9 scale) on the basis of percentage of dry area on leaves. The incidence of leafhopper and thrips was also recorded on the basis of the percentage of damaged leaflets.

Twenty four entries selected from the initial screening were tested under unprotected conditions with three replications during the 1987 rainy season. Of the 24 entries, NC Ac 343, a virginia runner variety from USA with abundant hairs on the stem and sparse hairs on the young leaflet recorded the lowest damage by jassids and leafhoppers (Table 1). The entry NC Ac 343 recorded a damage rating of 2 and severity index of 0.16 for leaf miner as against 4 and 0.36 in the susceptible control, TMV 2. When the yield potential was assessed in plots of 5.0 × 4.0 m, NC Ac 343 recorded the highest pod yield of 1517 kg ha^{-1}, following JL 24 (1617 kg), but it had yielded higher than the other susceptible controls viz., TMV 2 and Robut 33-1. Under protected conditions NC Ac 343 also recorded minimum leaflet damage by thrips (50.80%) as against 56.87% in TMV 2 and 72.15% in JL 24. It was also found to be moderately resistant to late leaf spot.

In the 1988 kharif season, among the 41 varieties tested in the National Drought Nursery, NC Ac 343 had recorded the least field wilting (1.8%) during a stress period at 5% soil moisture, compared to the national control varieties JL 24 (10.7%) and TMV 2 (2.3%).

Table 1. Incidence of groundnut insect pests and pod yield of four groundnut varieties, Tindivanam, Tamil Nadu, India, rainy season 1987.

		Jassid incidence		Leaf miner incidence			
Entry	Leaflet damage by thrips (%)	Mean number of nymphs plant^{-1}	Leaflet damage (%)	Leaflets having mines (%)	Damage rating	Severity index	Pod yield (kg ha^{-1})
NC Ac 343	22.4	1.0	33.4	72.7	2	0.16	1517
Robut 33-1	32.6	1.4	37.2	89.5	2	0.18	906
JL 24	31.9	1.5	40.2	84.3	6	0.54	1617
TMV 2	42.7	1.4	40.7	82.9	4	0.36	1027
SE	±1.9	±0.1	±1.9				

From these data it is evident that NC Ac 343 possesses resistance not only to leaf miner but also to other sucking pests and to drought. This can be utilized as a very good donor in resistance breeding programs.

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Effect of Pod Feeding Pests on Groundnut Seed Quality in Zambia

J. Kannaiyan, S. Sithanantham, P.H. Sohati, and **H.C. Haciwa** (Food Legumes Research Team, Msekera Regional Research Station, Box 510089, Chipata, Zambia)

Soil pests such as termites, white grubs, wireworms, and millipedes are known to cause considerable damage to groundnut pods in Zambia (Sithanantham et al. 1989). Termite-scarified pods are prone to *Aspergillus flavus* infection resulting in poor seed quality (Feakin 1973). Other soil pests (white grubs, wireworms, and millipedes) which bore groundnut pods may also cause similar seed-quality problems. Kannaiyan et al. (1989) reported the occurrence of *A. flavus* and aflatoxin problems in the country.

During the 1989/90 season a number of groundnut genotypes showed considerable pod scarification (by termites) as well as pod borer damage (by white grubs, wireworms, and millipedes) at Msekera station. Therefore a study was planned to find out the effect of scarified and bored pods on seed germinability and *A. flavus* contamination in four promising groundnut genotypes. The results are presented below.

During the 1989/90 season, we collected from each of the four replications 100 pods each of scarified, bored, and healthy categories, from four promising genotypes – MGS 2, MGS 3, MGS 4, and Makulu Red – from the experimental plots at Msekera station. From each set, 100 seeds were randomly sampled to estimate the percent germinability as well as seed contamination by *A. flavus* by following the standard 'blotter test' recommended by the International Seed Testing Association (ISTA).

The results presented in Table 1 show that across genotypes, the seeds from scarified and bored pods had significantly lower percent germinability and higher percent *A. flavus* contamination over healthy samples. Between two types of pod damage by soil pests, seeds sampled from the bored pods had significantly lower percent seed germinability and higher percent *A. flavus* contamination than the seed sampled from scarified pods. Among the genotypes, only Makulu Red showed significantly lower seed quality (low germinability and higher *A. flavus*) in scarified pod seed samples over the healthy ones. However, the seed samples from the bored pods in all four genotypes showed significantly lower percent germinability and higher percent *A. flavus* contamination than the healthy samples. On the other hand, MGS 2 showed least seed contamination by *A. flavus* as well as higher percent germinability.

The present study clearly indicated that the seed samples from bored pods (damaged by wireworms, etc.) are highly prone to *A. flavus* contamination resulting in lower germinability than termite-damaged scarified pod samples.

Table 1. Effect of pod damage by soil insect pests on seed quality in four groundnut genotypes, Msekera, Zambia, 1989/90[1].

Genotype	Type of pod damage	Seed germinability (%)	Seed contamination by *A. flavus* (%)
MGS 2	Scarified[2]	77.0	0.8
	Bored[3]	79.0	13.8
	Healthy	81.8	0.0
	Mean	76.2	4.8
MGS 3	Scarified	77.3	3.3
	Bored	55.8	16.5
	Healthy	68.3	4.5
	Mean	67.1	8.1
MGS 4	Scarified	74.5	3.5
	Bored	54.3	44.5
	Healthy	67.8	5.5
	Mean	65.5	17.8
Makulu Red	Scarified	35.5	28.3
	Bored	45.3	28.5
	Healthy	77.8	2.0
	Mean	52.8	19.5
Overall	Scarified	66.1	8.9
	Bored	56.3	25.8
	Healthy	73.9	3.0
	Trial mean	65.4	12.6
	CV (%)	9.4	38.8
SE			
Main treatment (Genotypes)		±2.4	±1.2
Subtreatment (Pod damage)		±1.5	±1.2
Main/Sub (within main)		±3.1	±2.4
Main/Sub (between main)		±4.2	±2.6

1. Split-plot design.
2. Scarified by termites.
3. Bored by white grubs, wireworms, millipedes, etc.

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Lipid Peroxidation of Stored Groundnut Seeds in Relation to Water Activity and Storage Temperature

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Postharvest losses during storage are among the major problems of the tropical environment, where high relative humidities and temperatures are prevalent. As a consequence, mold growth in groundnut seeds contributes considerably to biodeterioration. Groundnut being an oilseed crop is more prone to mold attack than starchy seeds (Fabbri et al. 1983). Lipid peroxidation results in the formation of aldehydes, ketones, and other low molecular weight compounds which may cause off-flavors and odors in stored groundnut seeds. Further, these react with proteins, amino acids, and vitamins and decrease the seed quality. This note reports the results of our study on the role of seed water activity (a_w) and storage temperature on lipid peroxidation in groundnut.

Groundnut seeds (var JL 24) were purchased from a local market in Mysore and adjusted to 0.80, 0.90, or 0.95 a_w by adding the required amount of sterile distilled water and equilibrating at 4°C for 24 h. The a_w was measured with a dewpoint meter (Protimeter, UK). Seeds were stored in desiccators and maintained at the same a_w using saturated salt solutions during storage at 20, 27, or 34°C. The triplicate samples were taken after 7, 14, 21, and 30 days of storage to estimate lipid peroxidation by assaying the amount of malondialdehyde (MDA) that is formed as a result, using trichloroacetic acid-thiobarbutiric acid-hydrochloric acid (TCA-TBA-HCl) reagent (Kwon et al. 1960).

Seeds (10 g) of each treatment were powdered and 1 g powder was further homogenized with 5 mL of the distilled water and centrifuged at 13 000 g for 30 min. The supernatant was mixed with equal volumes of TCA-TBA-HCl reagent. The reaction mixture was incubated at 90°C for 30 min and the reaction was stopped by placing the reaction tubes in an ice bucket. The absorbance was measured at 532 nm and subtracted from the nonspecific absorbance at 600 nm using multi-wavelength scan in a spectrophotometer (U-2000, Hitachi, Japan). The concentration of MDA in the sample was calculated using an extinction coefficient of 1.58×10^5 M^{-1} CM^{-1}. Fungi were also assessed using the visible molding and colony forming units (CFU) determined by dilution plating on to malt extract agar and incubating at 27°C for 5 days.

The malondialdehyde content of groundnut seeds before storage was 328 n moles g^{-1} (Table 1). The seeds stored at 20°C, with few exceptions, contained less MDA than seeds stored at 27° and 34°C. Temperature did not affect MDA content significantly at either 0.8 a_w or 0.9 a_w but the MDA content of seeds with 0.95 a_w was significantly less at 20°C than at 27° and 34°C. MDA content differed significantly after 30 days of storage at different a_w. The MDA content of seeds increased with storage, but this effect was more pronounced with longer storage periods. This indicated that lipid peroxidation was faster in seeds stored with higher a_w and at higher temperatures. Lipase and lipoxygenase either from seeds or fungi are known to enhance lipid degradation in stored groundnut seeds (Angelo and Robert 1983). Although the seeds were apparently healthy, fungi increased during storage, especially in seeds at high a_w and at 27° and 34°C with 14 days of storage than at 20°C, as evidenced by visible molding and CFU (data not shown). The present study has indicated that seed a_w and storage temperature have large effects on lipid peroxidation and contribute greatly to the effects of biodeterioration. The greater the a_w of

Table 1. Lipid peroxidation in groundnut seeds with different water activity (a_w) and stored at different temperatures[1].

		Storage period in days				
	Temperature	7	14	21	30	
a_w	(°C)	Malondialdehyde (n moles g^{-1} seed)				Mean
	20	358	548	700	744	587.5[a2]
0.80	27	486	628	764	788	640.0[a]
	34	352	678	784	796	679.0[a]
	20	560	688	914	936	801.0[b]
0.90	27	648	794	986	1050	843.0[b]
	34	564	834	1024	1110	883.0[b]
	20	828	846	1052	1276	1010.0[c]
0.95	27	1184	1192	1206	1282	1208.0[d]
	34	834	1206	1238	1564	1225.0[d]
	Mean	646[a]	823[b]	986[c]	1063[c]	

1. Results are the mean of four replicates.
2. Figures followed by same letter is not statistically significant at 5% level in Duncan's Multiple Range Test.

the seeds and the higher the storage temperature, the faster is the lipid peroxidation and deterioration of groundnut seeds.

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							Branching pattern	Number of branches: Primary	Number of branches: Secondary	Potential yield	Geographical area			
							Leaf shape and color	Seeds/pod	Pod size	Days to maturity	Season			
							Pod constriction	Pod beak	Pod reticulation	Reaction to disease and insects	Soil type			
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11. Originating center where the cultivar was developed and name of the breeder.

Note: Please use a separate sheet for each cultivar.

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