International *Arachis* Newsletter

No. 16 1996

International *Arachis* Newsletter

Co-sponsors

Peanut Collaborative Research Support Program (Peanut CRSP)

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

Publishing objectives

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

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

What to contribute?

Send us the kind of information you would like to see in IAN.

- **Contributions should be current, scholarly, and their inclusion well-justified on the grounds of new information.**
- Results of recently concluded experiments, newly released varieties, recent additions to germplasm collections, etc.
- Genome maps and information on probe-availability and sequences, and populations synthesized for specific traits being mapped. Glossy black and white prints of maps should be included, if possible. Partial maps can also be submitted.
- Short reports of workshops, conferences, symposia, field days, meetings, tours, surveys, network activities, and recently launched or concluded projects.
- Details of recent publications, with full bibliographic information and 'mini reviews' whenever possible.
- Personal news (new appointments, awards, promotions, change of address, etc.)

How to format contributions?

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

The Editors will carefully consider all submitted contributions and will include in the Newsletter those that are of acceptable scientific standard and conform to requirements. The language of the Newsletter is English, but where possible, articles submitted in other languages will be translated. Authors should closely follow the style of the reports in this issue. Contributions that deviate markedly from this style will be returned for revision, and could miss the publication date. Communications will be edited to preserve a uniform style throughout the Newsletter. This may shorten some contributions, but particular care will be taken to ensure that the editing will not change the meaning and scientific content of the article. Wherever substantial editing is required, a draft copy of the edited version will be sent to the contributor for approval before printing.

Contributions and requests for inclusion in the mailing list should be sent to:

Southern and Eastern Africa
P Subrahmanyam
SADC/ICRISAT Groundnut Project
Chitedze Agricultural Research Station
P O Box 1096
Lilongwe, Malawi
Fax +265 741872
E-mail ICRISAT-MALAWI@CGNET.COM
Tel +265 720968, 720906

Western and Central Africa
B R Ntare
IITA Office
Sabo Bakin Zuwo Road
PMB 3491
Kano, Nigeria
Fax +234 64 669051, 663492
E-mail ICRISAT-W-NIGERIA@CGNET.COM
Tel +234 64 662050

Rest of the world
S N Nigam
ICRISAT Asia Center
Patancheru 502 324
Andhra Pradesh, India
Fax +91 40 241239
E-mail ICRISAT@CGNET.COM
Tel +91 40 596161 or
+1 415 833 6641

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News and Views

From the Editor

The results of a good deal of important research remain locked in vernacular publications, thus restricting their wider circulation among scientists in other countries/regions. The International *Arachis* Newsletter (IAN) provides an informal vehicle through which you can share your knowledge and experience with fellow scientists worldwide. The contributions in this issue of IAN mainly come from Asia, but we all know that very important research is being pursued in Africa and Latin America. However, the details and results of this work remain sketchy to scientists outside these regions. I urge our scientific colleagues in other parts of the world to share their knowledge and experience widely. The more we share knowledge with each other, the more we progress. Similarly, scientists from developed countries and advanced institutions are also requested to publish their results or summaries of their work in IAN thus reaching a wider audience throughout the world. Presently 2700 copies of IAN are sent to individuals and libraries worldwide. Many of these individuals and remote research stations have only limited access to formal scientific journals. For them, IAN is a main source of new information on groundnut. We can help these less fortunate scientists by sharing information with them through IAN.

The Newsletter also welcomes submissions on new groundnut recipes, anecdotes, news of groundnut people, book reviews, and any other aspect of the crop. I am confident that with your cooperation we can make IAN more informative, more interesting, and more useful.

At the end of this issue of IAN, you will find an important notice about the Agreement on ICRISAT Germplasm Exchange and the Standard Germplasm Order Form. This form must now accompany all germplasm requests to ICRISAT. Readers are encouraged to share this information with their colleagues, especially plant breeders.

S N Nigam

Awards

Dr D J Patel, Professor and Head, Department of Nematology, Gujarat Agricultural University, India, has received the Hexamar Research and Development Foundation Award for the year 1996, for his outstanding contributions in the field of nematology. The Bioved Research Society, Allahabad, Uttar Pradesh, India, presented this award which includes a citation, a memento, and a cash prize.

Dr S B Sharma, Scientist (Nematology), Crop Protection Division, ICRISAT Asia Region, was conferred the CGIAR Award for Outstanding Local Scientist, in recognition of his research on parasitic nematodes affecting the production of pigeonpea, chickpea, and groundnut.

Transfers

Two ICRISAT groundnut scientists have moved to new locations in the Western and Central Africa Region—Dr F Waliyar, Principal Pathologist, to Mali, and Dr B R Ntare, Principal Groundnut Breeder, to Nigeria, both from the ICRISAT Sahelian Center, Niger.

Obituary

With great regret we announce the death of Dr Ken R Bock who was Plant Pathologist and Team Leader of the ICRISAT Regional Groundnut Research Program for Southern Africa, based at the Chitedze Agricultural Research Station, Lilongwe, Malawi from 1983 to 1989. He subsequently retired to live in Kenya.

After a long illness Ken moved to the UK, where he died in late June. His son Clive Bock, then a Research Fellow in the Crop Protection Divison at ICRISAT, and other members of his family were in the UK with him at the time.

Ken will long be remembered, not only for his scholarly work on all aspects of the groundnut rosette virus disease but also for his great kindness and willingness to help everyone he met.

Ken took early retirement to pursue his first love—the love of nature. Not many scientists are aware that Ken was a vivid student of nature, spending his leisure time and money in pursuing this hobby. He was a born nature lover, and a very active member of the National Fauna Preservation Society of Malawi. He helped the Society in raising funds and also to identify and label all the trees

K R Bock, Team Leader SADC/ICRISAT Groundnut Project with the participants of the Third Regional Workshop on Groundnut for Southern Africa, Chitedze Agricultural Research Station, Lilongwe, Malawi, 1988.

and plants in the Nature Park in Lilongwe. After his retirement, Ken became progressively involved in marine conservation. He chose to settle down near Mombasa in Kenya to pursue his interest in this area. He was updating his earlier book on fishes of the Kenya Coast, and for this he needed to scuba dive 2–3 hours each day. He was frequently called in by the Marine National Park in Kenya to assist them in their activities. Being a keen observer of nature, Ken was always able to find natural solutions to various problems.

Ken was highly practical and down-to-earth in his approach. Among his peers, he was most a respected scientist, and a strong believer and supporter of the national agricultural research systems. He always looked for opportunities to help the national programs.

His trade-mark LandRover and pipe were familiar sights across all the countries involved with the SADC/ICRISAT Groundnut Project. A rare mix of a scientist, a naturalist, and a down-to-earth practical man, Ken will be sorely missed by everybody who knew him.

Malawi and Zambia: In-Country Training Courses on Groundnut Production Technology

The Southern African Development Community/International Crops Research Institute for the Semi-Arid Tropics (SADC/ICRISAT) Groundnut Project based at the Chitedze Agricultural Research Station, Lilongwe, Malawi, conducted two in-country training courses on groundnut production technology in Malawi and Zambia.

These courses aimed to develop and upgrade the skills of research, extension, and training technicians, and to encourage the exchange of ideas between research and extension technicians working on groundnut for effective transfer of production technologies.

In **Malawi**, the course was conducted 19–23 Feb 1996 at Natural Resources College, Lilongwe, in collaboration with the Malawian Ministry of Agriculture and Livestock Development. Forty-two technicians from national research, extension, and training departments participated in the course. Resource persons from the Chitedze Agricultural Research Station were Drs A J Chiyembekeza (Course Coordinator), J H Luhanga, C T Kisyombe, C E Maliro, N E Nyirenda, F K Nyondo, F W Kisyombe, and J W Mchowa. The course was inaugurated by Dr C Matabwa, Deputy Chief Agricultural Research Officer, Malawi. He emphasized the importance of groundnut to smallholder farmers as a principal source of oil, protein, and cash income. He was concerned about low groundnut yields in farmers' fields in Malawi, which range from 400 to 700 kg ha^{-1}, against 4000 kg ha^{-1} obtained on the research stations in the country. Diseases, insect pests, poor cultural practices, and non-availability of seed of improved varieties are the major constraints to groundnut production. Dr Matabwa was happy to note that all the groundnut production constraints were addressed in the training course.

Participants at the In-Country Training Course on Groundnut Production Technology, Malawi.

The training course in **Zambia**, was conducted from 26 Feb to 1 Mar 1996, at Crystal Spring Motel, Chipata, in collaboration with the Zambian Department of Agriculture. There were 26 participants. The resource persons were Drs K Kanenga (Course Coordinator), T Raussen, P H Sohati, and M L Mwila from the Msekera Agricultural Research Station, and Dr C J Swanevelder from the Grain Crops Research Institute, South Africa.

Three ICRISAT scientists, Drs P Subrahmanyam, L J Reddy, and Faujdar Singh served as resource persons for both courses.

The 5-day course in each country covered a range of subjects: the groundnut plant and its reproductive biology, production practices, varietal improvement and new varieties available in each country, management of diseases and insect pests including screening techniques, cropping systems, economic aspects of seed production, and exchange of seeds from farmer to farmer.

Visits to farmers' fields provided hands-on training in the identification of various botanical varieties grown in both the countries, and in disease and insect pest identification.

Working Group Meeting on Groundnut Viruses

An International Working Group Meeting on Groundnut Viruses in Africa was held 18–19 Mar 1996 at the Plant Protection Research Institute, Pretoria, South Africa. It was attended by scientists from Belgium, Burkina Faso, Germany, Kenya, Malawi, Nigeria, South Africa, UK, USA, and Zimbabwe. The purpose of the meeting was to review progress made in the detection, identification, characterization, and management of groundnut viruses in Africa, with special emphasis on rosette and clump viruses; to this end, country representatives summarized the status of research on groundnut viruses in their countries.

In order to accomplish integrated management of rosette and clump virus diseases, it was agreed that consolidated efforts should be made to understand their epidemiology. The provision to NARS in Africa of diagnostic aids and training in the identification and detection of viruses, and strengthening of their laboratory facilities were among the important aspects discussed.

This was the first time ever that so many plant virologists from different countries assembled in South Africa. The meeting, sponsored by Peanut CRSP, the SADC/ICRISAT Groundnut Project, the Belgian Administration for Development Cooperation, Overseas Development Administration (UK), Natural Resources Institute (UK), British Council in Malawi, and the Noble Foundation was one of the most successful ones organized by ICRISAT.

Virus Identification Training Course

A training course on the detection and identification of groundnut viruses in Africa was held in the Virology Laboratory of the Plant Protection Research Institute, Pretoria, South Africa, from 4 to 16 Mar 1996. Nine participants from Burkina Faso, Kenya, Malawi, Mali, Nigeria, South Africa, and Zimbabwe attended.

They received hands-on training in such virus detection methods as enzyme-linked immunosorbent assay (ELISA), nucleic acid hybridization techniques, polymerase chain reaction, mechanical sap inoculations, and grafting. This training will help scientists working in Africa to precisely detect economically important groundnut viruses, especially rosette and clump. It will minimize the risk of spreading seedborne groundnut viruses between countries, and facilitate the maintenance of virus-free germplasm and access to the most reputed virology laboratories in developed countries. It will also foster collaboration among the NARS in Africa, and with ICRISAT.

First Western African Groundnut Aflatoxin Working Group Meeting

The First Western African Groundnut Aflatoxin Working Group Meeting was held in Accra, Ghana, from 31 May to 2 Jun 1995. The meeting was co-sponsored by the Peanut Collaborative Research Support Program (Peanut CRSP), the Conférence des responsables de recherche agronomique africaines (CORAF), and ICRISAT, in coordination with the Centre de coopération internationale en recherche agronomique pour le développement (CIRAD). This 3-day meeting was hosted by the Food Research Institute, Accra, Ghana. The objectives of the meeting were to:

- bring together active researchers to exchange the latest information on the groundnut aflatoxin problem.
- review the status of research on the groundnut aflatoxin problem in western African countries.
- recommend priorities for collaborative research at national and international levels.
- assign, wherever possible, research modules to individual institutions or groups.
- identify specific training needs, and organizations that can offer training.
- determine the resources needed and develop project proposals for funding.

The status of the groundnut aflatoxin research worldwide was briefly reviewed, and current research on the problem by national institutions was presented. The meeting concluded that prospects are excellent for collaborative research in management of the aflatoxin contamination in groundnut and groundnut products.

News from CLAN

Workshops and Regional Meetings

Workshop on On-farm Adaptive Research, 19–20 Sep 1995, Grain Legumes Research Program (GLRP), Rampur, Nepal

The workshop was jointly organized by the Nepal Agricultural Research Council (NARC) and CLAN/ICRISAT at GLRP, Rampur, Nepal. Forty-one participants from the Department of Agriculture, Nepal, involved in extension and on-farm research activities, and researchers from GLRP and the Oilseeds Research Program, scientists from ICRISAT participated in the workshop. The presentations included on-farm research results of chickpea, pigeonpea, and groundnut, on-farm adaptive research methodologies, and adoption and impact assessment of the improved technologies.

Participants discussed ways to strengthen the research-extension-farmer linkages, and proposed an extensive adoption program for improved technologies. The group suggested a few changes to the improved technology generated, and identified new constraints to back-up research.

CLAN Country Coordinators' Steering Committee Meeting, 4–6 Dec 1995, IAC, India

The meeting was organized to review genetic research activities within each member country and the region, for increased complementarity and to evolve a more cost-effective research agenda; to review and suggest ways of improving effective exchange of genetic material, technology, and information among network member countries, and human resource development activities; to assess interactions and linkages with regional and international institutions having similar interests, and explore opportunities for closer links with other networks operating in the region; and to provide guidelines for future network activities to enhance cooperation among network members for increased productivity, production, and natural resource management of the CLAN priority crops in the region.

The meeting was attended by the Country Coordinators of Bangladesh, China, India, Indonesia, Myanmar, Nepal, Philippines, Sri Lanka, Thailand, and Vietnam, and representatives from the International Rice Research Institute (IRRI), the International Center for Agricultural Research in the Dry Areas (ICARDA), and the Food and Agriculture Organization of the United Nations (FAO).

The Country Coordinators presented status reports on ongoing collaborative research, and indicated priorities for future collaborative research activities. The group agreed to have Steering Committee Meetings annually, with Thailand hosting the next Meeting in December 1996. The Committee recommended that regional meetings and conferences to meet the needs of member countries should be continued. Exchange of scientists was considered an important activity to broaden the knowledge of researchers.

The need to have the Coordination Unit (CU) located at ICRISAT Asia Center (IAC), Patancheru, India, was strongly endorsed. The group felt that locating the CU in one of the member countries is not yet a viable alternative, and suggested that IAC should support the CU as its commitment to the network, until such time that NARS can support the CU.

National Groundnut Workshop

A National Groundnut Workshop, 18–19 Dec 1995, was organized jointly by the Research Institute for Legumes and Tuber Crops (RILET), Malang, Indonesia, and CLAN/ICRISAT to discuss the current status and future prospects for groundnut research in Indonesia. About 100 participants drawn from various research stations, extension divisions, and representatives from industries in Indonesia attended the workshop. Twenty-seven research papers including two from ICRISAT were presented.

Human Resource Development

In-country Training Course on On-farm Adaptive Research, 17–20 Oct 1995, Ilagan, Philippines

The training course was co-sponsored by the Philippine Council for Agriculture, Forestry, and Natural Resources Research and Development (PCARRD), the Department of Agriculture (DOA), Region 2, and CLAN/ICRISAT, at Ilagan, Isabela Province. Sixteen participants from state agricultural universities, regional research stations, local government units, and the Departments of Agriculture of Regions 1 and 2 participated in the training course. Resource faculty were drawn from DOA, PCARRD, Users Perspective with Agricultural Research and Development (UPWARD), and ICRISAT. The training program involved presentations on various aspects of on-farm research, and diagnostic surveys using rapid rural assessment methods in San Mariano and Quirino municipalities of Isabela Province to get hands-on experience in identifying and prioritizing farmer-perceived constraints to groundnut production. Experiments for back-up, on-station, and on-farm research were planned with the participation of farmers and municipality officials. Further surveys were planned during the cropping season to assess the pest and disease situation.

Training Course on Nuclear Polyhedrosis Virus, 10–13 Oct 1995, IAC, India

The Natural Resources Institute (NRI), UK, and ICRISAT jointly organized a training course on Quality Control in Nuclear Polyhedrosis Virus (NPV) Production. The training course was attended by 13 participants from various Indian national and state research institutes, and the agrochemical industry. The objectives of the course were to train producers of insect polyhedrosis viruses and Integrated Pest Management (IPM) extension personnel in the identification of NPV strains, quality control of NPV formulations, and efficacy in bioassay and NPV field application. The course was found to be very informative by the participants and was heavily oversubscribed.

Study Program on Methodology for Adoption Tracking and Impact Evaluation, 25 Oct to 7 Nov 1995, IAC, India

A 2-week study program on adoption tracking, and impact assessment was organized to prepare work plans to assess the impact of CLAN in Asia. This study program was a prelude to the adoption and impact workshop to be held during 1996. The study program comprised lectures on fundamental concepts and approaches on adoption and impact evaluation, and field work on formal sample surveys, rapid rural appraisal, and formal and informal seed sector interactions. Participants from India (6), Indonesia (1), Nepal (1), Sri Lanka (1), and Vietnam (1) attended the study program.

Special Report on Working Groups

A Working Group (WG) consists of scientists willing to work together and commit resources to address and tackle high-priority regional problems. WG meetings review past research and prepare plans for future collaboration, and research responsibilities are shared among the members. The activities are harmonized by a Technical Coordinator. A summary report of publications and other activities of two WGs are presented below.

Groundnut Bacterial Wilt Working Group

- The third meeting of the Groundnut Bacterial Wilt Working Group was held in Wuhan, China, from 4 to 5 Jul 1994. The meeting, and an associated short training course (*Techniques for the diagnosis and identification of the bacterial wilt pathogen,* Pseudomonas solanacearum, *and for resistance screening against groundnut bacterial wilt*) were co-sponsored by the Chinese Academy of Agricultural Sciences (CAAS), CLAN/ICRISAT, and the Peanut Collaborative Research Support Program (Peanut CRSP). The proceedings of the meeting, with abstracts in Chinese (for the first time), containing the latest research results of the collaborative research were published by ICRISAT. Copies of these publications are available on request from ICRISAT.
- The next meeting of the working group is planned for 1997 (possibly in Malaysia).
- Subsequent to the above-mentioned training course on bacterial wilt, a technical manual dealing with techniques for diagnosis of *Pseudomonas solanacearum*, and for resistance screening against groundnut bacterial wilt has been published by ICRISAT (See IAN no. 15, p. 6).
- ICRISAT has also published an information bulletin on bacterial wilt of groundnut containing information on disease epidemiology, races and biovars of *Pseudomonas solanacearum*, serological testing for pathogen, greenhouse and field screening technology, and disease management options.

Groundnut viruses in the Asia-Pacific Region

- Opportunities for collaboration between WGs on groundnut viruses in Asia and Africa have been identified.
- The ICRISAT publication 'Recent studies on peanut bud necrosis disease' gives state-of-the-art information on the disease.
- A training course on 'Identification and detection of viruses in legumes, with special emphasis on groundnut' was conducted during Feb–Mar 1995, in Thailand.
- The fourth Working Group meeting held 13–15 Mar 1995 in Khon Kaen, Thailand, reviewed the progress made on detection, identification, characterization, and management of major groundnut viruses in the Asia-Pacific region. The proceedings have been published by ICRISAT (See 'New ICRISAT Publications' at the end of this issue). Future research emphasis will be on studies directed towards host-plant resistance (conventional and non-conventional), cultural practices, biological control of vectors, variation in virus, and use of virus-free seed.

First Meeting of the Asia Working Group on Groundnut Aflatoxin Management, 27–29 May 1996, Hanoi, Vietnam

A new Working Group on groundnut aflatoxin management was initiated at the meeting co-sponsored by CLAN/ICRISAT and the Ministry of Agriculture and Rural Development, Hanoi, Vietnam. Twenty-five scientists from China, India, Malaysia, Philippines, Thailand, Vietnam, and ICRISAT participated. Status reports on groundnut aflatoxin research worldwide, and current research in national programs were presented. Plans for future collaborative research were prepared. Participants agreed on the need to emphasize the management of aflatoxin contamination. Agronomic and cultural management to reduce aflatoxin contamination at preharvest, postharvest, and storage were planned. It was also considered important to enhance awareness of producers, traders, processors, and consumers regarding the aflatoxin risks to human and animal health. Breeding for resistance to aflatoxin contamination was considered essential, although that is a long-term strategy.

Dr V K Mehan, Senior Scientist (Pathology), IAC, was asked to be the Technical Coordinator for the Working Group, to be supported by CLAN. National Coordinators for in-country research on aflatoxin management were also identified.

Erratum

We regret the mistake in the caption of Table 1 on page 14 of IAN no. 15 (1995). Instead of 'Agricultural Research Station, **Fatehpur**', read 'Agricultural Research Station, **Durgapura - Jaipur**'.

Research Reports

Genetics and Plant Breeding

Improved Groundnut Variety Released for Cultivation in Southern Vietnam

Ngo Thi Lam Giang[1], Phan Lieu[1], Tran Minh Nam[2], Tran Dinh Long[3], Vu Tuyen Hoang[4], and S L Dwivedi[5] (1. Oil Plant Institute of Vietnam, Ho Chi Minh City, Vietnam; 2. University of Ho Chi Minh City, Vietnam; 3. National Institute of Agricultural Science (INSA), Hanoi, Vietnam; 4. Institute of Food and Foodstuff Crops, Hanoi, Vietnam; and 5. Genetic Enhancement Division, ICRISAT Asia Region, Patancheru 502 324, Andhra Pradesh, India)

Groundnut (*Arachis hypogaea* L.) is one of the important annual oil crops with high economic value in Vietnam. While the groundnut area in Vietnam in 1993 was 235 000 ha, it increased to 250000 ha in 1995. The eastern region of southern Vietnam accounts for about 31.7% (74700 ha) of the total area in the country. The major groundnut regions in southern Vietnam are Ho Chi Minh City territory and Tay Ninh, Song Be, Long An, and Dong Nai provinces.

In Ho Chi Minh City territory and Tay Ninh province, groundnut is grown under irrigated conditions. The average pod yields are 2.2 t ha^{-1}. However, several farmers harvest pod yields of 3.0–3.5 t ha^{-1} under good crop management conditions. In the Song Be, Dong Nai, and Long An provinces, the crop is mainly grown under rainfed conditions. The average pod yields are 1.2 t ha^{-1}. The major cropping patterns involving groundnut are groundnut-groundnut-rice and groundnut-rice-rice. Groundnut is mainly grown in winter-spring (Nov–Mar) and summer-autumn (Mar–Jun) seasons. In the rainy season, it is grown to produce seed for the following winter-spring season crop. The short-duration (90 days) and spanish bunch types, LY, Moket, and Giay are the cultivars commonly grown by the farmers. Of these, LY is widely adapted and the most preferred one.

In Vietnam, there is no organized seed sector (government or private) responsible for groundnut seed production and maintenance of varietal purity. In general, farmers maintain their own seed stocks for sowing. In case the seed is not sufficient, they purchase whatever seed is available in the market and grow it with their own seed. The original LY, for example, had 2-seeded, small, smooth pods with a thin shell and tan colored seeds; Vietnamese farmers now grow LY that produces a mixture of pod types.

The Oil Plant Institute of Vietnam (OPI) is the principal groundnut research institution in southern Vietnam. It initiated a project in 1989 with the Tay Ninh province, Ho Chi Minh City, and ICRISAT to purify and select improved types from the local LY population. OPI collected 500-g, bulk pod samples from 20 locations each in Cu Chi under Ho Chi Minh City territory, Trang Bang and Go Dau districts in the Tay Ninh province, and from the Song Be town in the Song Be province. These samples were bulked, and the resulting seed was grown in Cu Chi. One thousand plants were randomly harvested. Of these, only 400 plants were selected based on the pod and seed characteristics of LY. These 400 single plants were progeny rowed in the following season. Twenty progeny bulks with superior pod/seed characteristics were retained for evaluation. Finally, three progeny bulks (LY 1, LY 2, and LY 3) were compared with the local LY. These selec-

Table 1. Pod yield (t ha^{-1}) of VD 1 and control cultivar LY, southern Vietnam, 1991/92–1994/95 winter-spring seasons[1].

	1991/92	1992/93	1993/94		1994/95		
Variety	Cu Chi	Cu Chi	Cu Chi	Trang Bang	Trang Bang	Cu Chi	Average
VD 1	3.69	3.59	4.03	3.50	2.63	3.21	3.44
LY (control)	3.03	3.13	3.46	3.01	2.18	2.79	2.93
SE	±0.201	±0.138	±0.082	±0.100	±0.107	±0.102	
CV(%)	12	4	4	6	9	7	

1. The trial comprised 4 varieties including the control.

tions were evaluated for pod yield, shelling percentage, sound mature seed, 100-seed mass, and oil content during the 1991/92 to 1994/95 winter-spring seasons. In 1995, based on overall performance, LY 1 was released as VD 1 for cultivation in southern Vietnam, by the Ministry of Agriculture and Rural Development (MARD).

In 4 years of yield trials conducted in farmers' fields in Cu Chi and/or Trang Bang during the 1991/92 to 1994/95 winter-spring seasons, VD 1 recorded an average pod yield of 3.44 t ha^{-1} compared with 2.93 t of the local LY (Table 1). VD 1 had 77% shelling, 90% sound mature seed, 42 g 100-seed mass, and 47% oil content (Table 2).

Table 2. Ancillary data of VD 1 and control cultivar LY, southern Vietnam, 1991/92–1994/95 winter-spring seasons[1].

Variety	Shelling (%)	Sound mature seeds (%)	100-seed mass (g)	Oil content (%)
VD 1	77	90	42	47
LY (control)	76	88	40	44

1. Average of six locations.

VD 1 belongs to subspecies *fastigiata* var *vulgaris.* It has an erect growth habit with medium-sized, light green, oblong-to-elliptic leaves and yellow flowers. The plants have 4–6 primary and 4–8 secondary branches. Pods are mostly 2-seeded and round, without a beak, but with a slight constriction and no/slight pod reticulation. The average pod length and width are 25 and 14 mm. The seeds are tan in color and round. The average seed length and width are 12 and 9 mm. Compared with the pods of local LY, VD 1 has round and relatively bigger pods.

Vietnamese farmers liked VD 1 because of its short duration (90 days), high pod yield, and good adaptation to acidic soil conditions. OPI has taken up seed production and distribution to the farmers in Ho Chi Minh City territory and Tay Ninh province.

Breeding an Early-maturing and High-yielding Groundnut Variety—Nonghua 22—in China

Liushen Gao, Zixin Jiang, Biguang Long, Fuzhen Feng, and **Fangdi Deng** (China Agricultural University, Beijing 100094, China)

The North China Plain is an important groundnut-producting region in China, accounting for 13.7% of the groundnut area and 10.5% of the country's production. However, this area is the largest low-yield area and its productivity is 86.8% of the country's average. With 3500°C cumulative temperature, and 500–600 mm precipitation, the North China Plain has inadequate heat and rainfall for a double crop each year. The groundnut cropping system is changing from spring groundnut to summer groundnut/winter intercropping.

Due to the lack of resources, breeding programs in the plain relied heavily on introductions. All groundnut varieties grown in the plain were introduced from other districts of the country. Traditional varieties were used before the 1970s. Such new varieties as Bash 1016, Xuzhou 68-4, Haihua 1, Hua 37, and Luhua 9 were introduced into this area after the 1980s, and they have greatly increased the region's groundnut yield and quality. However, these varieties have a longer growing period and are not suitable for intercropping. In recent years, the varieties have degenerated due to the inadequate multiplication system, and no attention has been paid to their purification. The absence of a suitable new variety is becoming the critical limitation to increasing output in this groundnut production area.

The groundnut breeding group at the China Agricultural University (CAU) started breeding new varieties in 1979. After 10 years of research, several early-maturing and high-yielding groundnut varieties, such as Nonghua 10, Nonghua 16, and Nonghua 22, have been bred and are now used in production. This paper reports the breeding and extension of Nonghua 22.

Nonghua 22 is derived from a cross of Hua 31 and Fu 50 made in 1980. It was selected following the pedigree method. During 3 years of cooperative varietal tests from 1991 to 1993, Nonghua 22 gave an average pod yield of 4.2 t ha^{-1}, 15.2% more than the control variety Hua 37.

In demonstration trials during 1992/93, yields were higher than those of control varieties (Table 1). Propagation and demonstration trials of intercropping with winter wheat were done in the Yi Xian county, Hebei province, in 1994; the average yield of Nonghua 22 was 5.3 t ha^{-1}. The highest-yielding plot recorded 6.8 t ha^{-1}.

Table 1. Average pod yield (t ha^{-1}) of Nonghua 22 and control varieties in 1992/93 demonstration trials, China.

Test location	Pod yield (Nonghua 22)	Pod yield (control)	Yield increase over control (%)
1992			
Tongxian[1]	4.431	3.604	22.8
Daxing[1]	4.421	3.715	13.5
Zhuozhou[1]	3.834	3.366	13.9
Fangshan[1]	3.600	3.132	14.9
Average	4.021	3.454	16.3
1993			
Tongxian[1]	4.096	3.517	16.2
Tongxian[1]	4.362	3.900	11.4
Xianghe[1]	4.326	3.741	15.6
Xianghe[2]	3.681	3.273	12.5
Average	4.116	3.607	14.1

1. Control = Luhua 9.
2. Control = Hua 37.

Nonghua 22 matures early (125 days) and has 13–24 pods $plant^{-1}$. The plant is erect (35–40 cm height) and compact, with 10–12 branches. It has a sequential flowering habit. Pods are wide at the waist, and are characterized by a prominent beak and shallow pod constriction. Pods are usually 1–2 seeded, occasionally 3-seeded.

Nonghua 22 is tolerant of drought, and resistant to leaf spots. It is suitable for intercropping with winter wheat.

Although spring-sown groundnut dominates the North China Plain, the area under summer groundnut and intercropping is increasing. Nonghua 22 meets both the requirements because of its early maturity and high yield. It tolerates shading in intercropping.

Sources of Resistance to Rust, Late Leaf Spot, and Bacterial Wilt in Guangdong, Southern China

Liang Xuanqiang, and **Yeh Weilin** (Crops Research Institute, Guangdong Academy of Agricultural Sciences, Wushan 510640, Guangzhou, China)

Rust (*Puccinia arachidis*), late leaf spot (LLS) (*Phaeoisariopsis personata*) and bacterial wilt (BW) (*Pseudomonas solanacearum*) are the main constraints to groundnut production in southern China. In the 1991 autumn and 1992 spring seasons, sources of rust and LLS resistance obtained from ICRISAT were grown in rust and LLS screening nurseries at the Crops Research Institute (CRI), for evaluation under southern China conditions. The highly susceptible cultivar Yue You 116 was used as an infector in both years in both nurseries. Two infector rows were sown for every three rows of test genotypes. Plants were sprayed with urediniospore suspensions of rust, and conidial suspensions of LLS at the fourth-leaf stage during the evening. Rust and LLS reactions were scored on a 1–9 scale, where 1 = highly resistant, 2–3 = resistant, 4–5 = moderately resistant, 6–7 = susceptible, and 8–9 = highly susceptible.

Simultaneously, these lines were also grown in a natural BW sick plot to study the incidence of BW. Before sowing, seeds were immersed in a bacterial suspension of *P. solanacearum*. Yue You 92, a variety with high wilt resistance (8% incidence) was used as a control. Each trial entry was compared with this for its level of resistance.

Rust reactions of the test genotypes are shown in Table 1. All the test entries showed resistance to rust with average disease scores ranging from 2.2 in ICG 7883 to 5.2 in ICG 7340 (as against 8.0–8.1 in the susceptible controls). Most entries showed high resistance to late leaf spot.

Cumulative BW incidence in all genotypes is shown in Table 1. Fourteen genotypes, ICGs 7893, 10042, 10068, 10052, 10061, 10978, 9294, 6330, 7340, 10951, 1707, 10936, 10029, and 7621 showed higher resistance to BW than Yue You 92, in which wilt incidence was only 8%.

Several of these genotypes have been used as resistance sources in the breeding program at the Crops Research Institute in Guangzhou.

Table 1. Sources of resistance to rust, late leaf spot, and bacterial wilt from ICRISAT identified at Guangzhou, China, 1991/1992.

Genotype	Rust score[1]	Bacterial wilt (%)[2]	Genotype	Late leaf spot score[1]	Bacterial wilt (%)[2]
ICG 4746	2.5	-81.2	ICG 10035	2.5	-39.4
ICG 7883	2.2	/	ICG 11485	2.5	-12.0
ICG 1710	2.8	/	ICG 10975	2.7	/
ICG 7888	2.9	-77.7	ICG 1710	2.9	/
ICG 7893	2.9	36.1	ICG 6022	2.8	/
ICG 10053	2.8	/	ICG 10951	2.9	49.3
ICG 6340	3.1	-64.7	ICG 1707	3.2	44.2
ICG 10030A	3.0	-58.5	ICG 4747	3.2	-39.4
ICG 10042	3.0	24.0	ICG 7881	3.1	-27.7
ICG 10068	3.1	28.3	ICG 7884	3.1	-81.2
ICG 7890	3.3	-77.7	ICG 10936	3.3	12.0
ICG 10031	3.2	-28.2	ICG 2716	3.3	-39.4
ICG 10052	3.3	35.6	ICG 7013	3.4	-49.7
ICG 10061	3.2	21.4	ICG 7897	3.5	-58.8
ICG 10939	3.2	-57.3	ICG 6330	3.7	12.3
ICG 10978	3.3	8.9	ICG 6340	3.7	-60.4
ICG 9294	3.4	37.2	ICG 7880	5.1	-77.7
ICG 6330	3.6	12.0	ICG 10029	5.0	7.6
ICG 11285	3.7	-5.6	ICG 10891	5.2	-70.6
ICG 1697	4.9	-26.7	ICG 7621	5.6	9.9
ICG 6284	4.7	-76.2	ICG 10931	6.3	-22.0
ICG 7340	5.2	31.6	ICG 10920	5.8	-31.5
Susceptible controls			**Susceptible controls**		
ICG 221	8.1	-88.2	ICG 221	8.6	-95.1
ICG 799	8.0	-74.5	ICG 799	8.9	-74.5
Yue You 116	8.0	-57.3	Yue You 116	7.7	-57.3

1. Rust and late leaf spot scored on a 1–9 scale.
2. Relative resistance to bacterial wilt, compared with Yue You 92 (highly resistant, 8% disease incidence). Positive values indicate lower incidence, and negative values higher disease incidence than Yue You 92. /indicates disease incidence similar to that of Yue You 92.

Rust Reaction of Foliar Disease Resistant Groundnut Varieties from ICRISAT in Guangdong, Southern China

Liang Xuanqiang, Li Shulin, and **Li Shiaoxoung**
(Crops Research Institute, Guangdong Academy of Agricultural Sciences, Wushan 510640, Guangzhou, China)

Rust (*Puccinia arachidis*) is the most widely distributed and economically important groundnut disease in southern China where it causes annual yield losses of 20–30%. One of the objectives of the groundnut breeding program in southern China is to develop high-yielding cultivars with high resistance to rust. Several new cultivars, Yue You 223, Shan You 523, and Shan You 71, which have resistance genes introduced from the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), have been released during the last 10 years. These cultivars now cover 70% of the groundnut area in southern China.

During the 1991 autumn and 1992 spring seasons, several foliar disease resistant varieties from ICRISAT were grown at the Crops Research Institute, Guangzhou, to evaluate their reaction to rust. The trial was conducted with three replications. The susceptible variety Yue You

200 was used as an infector (2:3 ratio of infector rows to rows of test varieties). Infected leaves were scattered in the test field. Disease reactions were recorded about 5 days before harvest, using a modified 1-9 scale.

Disease scores are shown in Table 1. Most of the varieties showed high resistance to rust with average disease scores ranging from 1.7 to 6.0. The susceptible control Yue You 200 was 6.1. ICGVs 86687, 86699, 86023, and 86680 showed high resistance, with a few very small pustules on the lower leaves. These varieties have been used as sources of rust resistance genes to transfer resistance into existing high-yielding cultivars by backcrossing.

Table 1. Reactions of some groundnut varieties to rust, Guangzhou, China, 1992/93.

	Disease score[1]		
Genotype	1991	1992	Mean
ICGV 86687	1.3	2.0	1.7
ICGV 86699	1.3	2.0	1.7
ICGV 86023	2.0	2.0	2.0
ICGV 86680	2.0	2.0	2.0
ICGV 86691	2.3	2.0	2.2
ICGV 86694	2.3	2.0	2.2
ICGV 87254	2.3	2.0	2.2
ICGV 86675	2.7	3.0	2.9
ICGV 86020	2.7	3.0	2.9
ICGV 86590	3.0	3.0	3.0
ICGV 86707	3.0	3.0	3.0
ICGV 87237	3.0	3.0	3.0
ICGV 87240	3.0	3.0	3.0
PI 476146	3.0	3.0	3.0
PI 476172	3.0	3.0	3.0
PI 476173	3.0	3.0	3.0
NC Ac 17506	3.0	3.0	3.0
ICGV 86606	3.0	4.0	3.5
PI 476163	4.0	3.0	3.5
ICGV 87281	3.7	4.0	3.9
ICGV 87350	3.7	4.0	3.9
PI 476195	3.7	4.0	3.9
ICGV 86594	4.0	4.0	4.0
ICGV 86600	4.0	4.0	4.0
ICGV 86652	4.0	4.0	4.0
ICGV 86659	4.0	4.0	4.0
ICGV 87160	4.0	4.0	4.0
ICGV 87264	4.0	4.0	4.0
PI 275747	4.0	4.0	4.0
PI 476174	4.0	4.0	4.0
PI 337394F	4.3	4.0	4.2
ICGV 87280	4.3	4.0	4.2
VRR 245	5.0	5.0	5.0
Ah 7223	5.0	5.0	5.0
PI 337409	6.0	5.0	5.5
UF 71513-1	5.8	6.2	6.0
Susceptible control			
Yue You 200	6.0	6.2	6.1

1. Scored on a modified 1-9 scale where 1 = highly resistant, 2-3 = resistant, 4-5 = moderately resistant, 6-7 = susceptible, and 8-9 = highly susceptible.

Screening Groundnut Germplasm for Resistance to *Aspergillus flavus* Invasion and Colonization in Guangdong, Southern China

Li Siulin, Liang Xuanqiang, and **Li Shaoxion**
(Crops Research Institute, Guangdong Academy of Agricultural Sciences, Wushan 510640, Guangzhou, China)

Postharvest invasion of groundnut by *Aspergillus flavus* and the subsequent production of toxic metabolites is a serious and constant feature of groundnut production under the high-temperature, high-moisture conditions in southern China. Breeding for resistance to *A. flavus* is therefore an important objective in the region.

Screening for resistance to *A. flavus* invasion and colonization was conducted at the Crops Research Institute, Guangzhou, China, during 1992/93. Seeds of the various test genotypes were artificially inoculated with *A. flavus* strain As 3.2890, which produces aflatoxin B_1 (more than 100 ppb) as reported by the Institute of Microbiology, Academy Sinica. The medium and assay method followed Cai Ahui (1986). Genotypes with less than 15% infection were considered highly resistant, those with 15-30% infection moderately resistant, 30-50% moderately susceptible, and over 50% highly susceptible.

Two hundred and seventy germplasm accessions were tested (212 from Guangdong province, 19 from other provinces in China, and 39 from ICRISAT). Four out of the 270 accessions (Meixianhongyi, Zhanggiu, VF 71513-1 and Xinhuixiaoli) were highly resistant, and 10 others were moderately resistant (Table 1). Fifteen accessions were moderately susceptible while the remaining 251 accessions were highly susceptible. Germplasm lines with high resistance to *A. flavus* invasion and colonization have been used as resistance sources in breeding for aflatoxin resistance.

Table 1. Germplasm lines resistant to *A. flavus* invasion and colonization, Guangzhou, China, 1992/93.

Germplasm line	Infected seeds (%)	Resistance[1]	Origin
Meixianhongyi	3	HR	Guangdong province
Zhanggiu 48	6	HR	Guangdong province
VF 71513-1	7	HR	ICRISAT
Xinhuixiaoli	14	HR	Guangdong province
Goubi	17	MR	Guangdong province
Dalilandou	18	MR	Guangdong province
PI 337394F	18	MR	ICRISAT
Ah 7223	18	MR	ICRISAT
Kaihua 3	19	MR	Guangdong province
VRR 245	22	MR	ICRISAT
PI 337409	22	MR	ICRISAT
Dongxuan	25	MR	Guangdong province
Baisha 5124	25	MR	Guangdong province
Yuenadou	25	MR	Vietnam

1. HR = highly resistant, MR = moderately resistant.

Reference

Cai Ahui. 1986. Research on aflatoxin contamination of groundnut and screening for disease resistance. Zhongguo Nongya Wenzhai (Zhiwu Baohu) 3:22.

Performance of Drought-resistant ICRISAT Groundnut Varieties in Rainfed Fields in Guangzhou, Southern China

Liang Xuangqiang, Lin Xiaoxun, and **Zhang Guangrou** (Crops Research Institute, Guangdong Academy of Agricultural Sciences, Wushan 510640, Guangzhou, China)

Drought is an important abiotic stress for groundnut production in southern China, where more than 70% of the groundnut is sown in rainfed upland fields. Breeding for drought resistance/tolerance is one of the breeding objectives in this region. In the absence of suitable drought-resistant/tolerant genotypes and an effective selection method, little progress has been made since 1970. Recently, some drought-resistant varieties developed at ICRISAT were introduced, and grown in rainfed upland fields in Guangzhou, in the 1992 autumn and 1993 spring seasons. Mean yields in the two trials are shown in Table 1. ICGVs 86742, 86707, and 86635, gave significantly higher pod yields than the local control Yue You 116. ICGV 86742 ranked first in both trials, with a mean yield of 2.35 t ha^{-1}, compared with 1.37 t ha^{-1} from the local control Yue You 116.

ICGV 86707, and ICGV 86644 gave high yields and high shelling percentages. The results indicated that these varieties have high potential in terms of drought resistance, yield, and good seed/pod quality. However, they also show several undesirable characteristics such as susceptibility to lodging (plant height), susceptibility to rust and late leaf spot (Table 2), and a high percentage of 3- and 4-seeded pods.

Table 1. Yield performance of 15 ICRISAT groundnut varieties in Guangzhou, China, 1992/93).

Variety	Pod yield (t ha^{-1})	Superiority over control (%)	Rank
ICGV 86742	2.35	71.67**[1]	1
ICGV 86707	1.90	38.49**	2
ICGV 86644	1.86	35.43**	3
ICGV 86635	1.78	9.84*	4
ICG 1697	1.54	12.66	5
ICG 3704	1.54	12.22	6
ICGV 86708	1.52	11.01	7
ICGV 86745	1.50	9.59	8
ICG 4790	1.35	−1.58	10
ICG 221	1.33	−2.78	11
ICGV 86473	1.27	−7.38	12
ICG 2716	1.04	−24.02*	13
ICGV 86744	0.66	−51.72**	14
ICG 4601			
Local control	0.63	−54.23**	15
Yue You 116	1.37	9	

1. * significant, ** highly significant.

Table 2. Plant and pod characters[1] of 15 ICRISAT groundnut varieties evaluated in Guangzhou, China, 1992/93.

Variety	Growth habit[1]	Branching pattern[2]	Sound mature pods (%)	Shelling percentage (%)	100-seed mass (g)	Score[3]	
						Rust	Late leaf spot
ICGV 86742	E	S	74.4	70.7	46.8	7	7
ICGV 86707	R	A	90.9	78.8	49.3	8	8
ICGV 86644	S	S	87.4	74.7	41.7	4	5
ICGV 86635	E	S	94.6	73.5	43.5	6	5
ICG 1697	E	S	84.9	76.3	42.5	6	6
ICG 3704	S	S	91.7	73.8	38.3	6	5
ICGV 86708	E	S	86.6	76.0	47.0	6	5
ICGV 86745	E	S	83.6	77.0	41.2	7	6
ICG 4790	E	S	88.2	73.5	60.2	4	3
ICG 221	E	S	90.2	78.1	30.5	8	9
ICGV 86743	E	S	87.6	68.8	59.7	7	7
ICG 2716	E	S	85.7	75.2	47.7	4	4
ICGV 86744	E	S	82.6	75.2	40.7	9	9
ICG 4061	S	S	83.1	73.8	38.3	6	5
ICG 2738	S	S	83.6	74.5	37.0	6	6
Local control							
Yue You 116	E	S	87.5	72.0	46.5	6	5

1. E = Erect, S = Semi-erect, R = Runner.
2. A = alternative, S = sequential.
3. Scored on a 1–9 scale, where 1 = no disease and 9 = plants severely affected.

Evaluating Groundnut Genotypes for Resistance to Late Leaf Spot, Rust, and Bacterial Wilt in Indonesia

Nasir Saleh and **Novita Nugrahaeni** (Research Institute for Legume and Tuber Crops, RILET, PO Box 66, Malang 65101, Indonesia)

Late leaf spot (*Phaeoisariopsis personata*), rust (*Puccinia arachidis*), and bacterial wilt (*Pseudomonas solanacearum*) are important diseases that constrain groundnut production in Indonesia. Yield losses due to late leaf spot and rust can be as high as 60% (Hardaningsih and Neering 1989). Those due to bacterial wilt range from 15 to 35% on resistant varieties and 80–90% on susceptible ones (Machmud and Hayward 1992).

Although some fungicides have been reported to effectively reduce late leaf spot and rust (Saleh and Hardaningsih 1993), the recommendations to use fungicides cannot be followed by farmers, mainly due to their limited capital. The most effective management of leaf spot, rust, and bacterial wilt is through the use of resistant varieties.

Forty-six groundnut genotypes including 39 introductions from the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) and 7 Indonesian improved cultivars were evaluated for their resistance to late leaf spot, rust, and bacterial wilt. Experiments were carried out at Jambegede Experiment Station in the first (Feb–May) and second (Jun–Oct) dry seasons in 1994. A randomized block design with two replications was used. The genotypes were sown in two 4-m rows with 40 cm row-to-row and 10 cm plant-to-plant spacing. Late leaf spot and rust scores were recorded at 6–12 weeks after sowing (with 2-week intervals) using a 1–9 scale (Subrahmanyam et al. 1995) and the numbers of wilted plants were observed every 2 weeks. Bacterial wilt incidence was assessed on the basis of percentage wilted plants.

Late leaf spot scores were higher in the experiment conducted in the first dry season than in the experiment conducted in the second dry season. The reverse was true for bacterial wilt incidence. In both the experiments, the

Table 1. Late leaf spot and rust scores, bacterial wilt incidence, and pod yield of 46 groundnut genotypes at Jambegede Experiment Station in the first dry season (Feb–May 1994) and the second dry season (Jun–Oct 1994), Indonesia.

	First dry season			Second dry season			
Genotype	Late leaf spot score[1]	Rust score[1]	Bacterial wilt[2] (%)	Late leaf spot score[1]	Rust score[1]	Bacterial wilt[2] (%)	Average pod yield (t ha^{-1})
ICG 4790	8.0	3.3	26.6	3.6	2.1	92.1	0.60
ICG 3704	3.0	2.0	0.8	3.0	2.2	92.0	0.87
ICG 10660	3.6	2.3	0.0	1.6	1.9	46.1	0.42
ICGV 87073	4.0	2.3	1.7	4.0	2.3	29.9	1.07
ICG 392	7.6	3.3	9.5	2.6	1.7	85.0	0.72
ICG 1697	4.6	2.6	0.0	5.0	2.7	17.1	0.88
ICGV 88369	3.6	2.3	7.4	1.3	1.1	96.3	0.70
ICGV 88403	6.3	3.3	2.9	4.0	2.5	54.4	1.61
ICG 9296	4.0	2.3	2.5	4.0	2.5	78.4	0.36
ICGV 86015	7.6	3.0	0.0	5.3	4.1	31.7	1.09
ICGV 87059	6.0	2.6	0.7	4.0	2.7	63.4	0.97
T 11	4.3	2.0	0.0	3.6	2.7	49.5	0.60
ICG 4622	6.6	3.6	37.4	3.0	4.0	97.9	0.55
ICG 1015	3.6	2.3	0.0	2.3	2.4	51.7	0.33
T 6	7.6	3.0	0.0	5.6	4.2	25.4	1.10
ICGV 86143	4.6	2.3	6.4	3.6	2.2	45.7	0.75
ICGV 84149	7.3	2.6	3.4	4.0	2.1	59.8	0.81
T 14	7.3	2.6	1.7	5.0	3.1	25.5	0.86
ICGV 86187	7.0	2.6	0.0	4.3	2.6	38.2	0.95
ICG 10823	3.3	2.0	0.9	2.3	2.5	42.8	0.47
T 10	6.0	3.0	7.4	2.6	1.8	81.5	0.54
ICGV 88368	6.3	3.0	3.2	4.6	2.7	33.6	1.10
ICGV 87069	6.3	3.3	20.4	1.6	1.7	80.3	0.62
ICGV 86371	7.0	3.0	12.3	2.3	2.0	82.1	0.70
Chico	5.6	2.6	3.4	2.6	2.3	65.1	0.80
ICG 5145	5.6	2.6	10.1	3.3	2.2	63.1	0.75
ICG 9984	6.3	2.6	2.1	2.3	2.4	52.9	0.67
ICG 9076	4.0	2.3	3.6	2.3	2.4	47.9	0.42
ICG 6163	3.0	2.3	0.0	1.3	2.1	71.6	0.49
T 9	3.6	2.6	0.9	4.6	3.1	32.6	0.67
ICG 6280	4.3	2.3	0.0	3.3	2.3	4.0	0.53
ICGV 86745	4.0	2.6	0.0	3.0	2.5	42.6	0.83
ICGV 88378	4.0	2.3	1.9	2.6	2.1	56.4	0.72
ICG 4229	4.0	2.3	0.0	2.3	2.1	51.1	0.55
ICGV 86402	3.6	2.3	2.7	2.3	2.1	60.2	0.47
ICG 4297	4.3	2.3	4.0	3.6	2.1	67.7	0.62
ICG 10536	6.6	3.0	19.6	1.3	1.0	87.5	0.75
ICG 2670	7.3	2.6	3.9	2.6	1.9	74.9	0.92
ICG 387	7.0	3.3	7.2	2.6	1.5	86.3	1.06
T 13	4.0	2.0	0.0	2.6	1.6	37.3	0.56
Gajah	5.0	2.6	0.8	2.6	2.2	28.4	1.16
Kelinci	5.0	2.3	0.0	4.3	2.1	28.3	0.78
Mahesa	6.0	3.0	0.0	4.6	2.1	3.5	0.92
Badak	5.0	2.6	0.9	5.0	2.2	33.4	1.12
Tapir	5.3	2.6	0.8	5.0	2.2	35.2	1.17
Zebra	4.6	2.6	1.3	5.0	2.1	45.7	1.22
SE	-	-	±0.61	-	-	±1.01	±21.01
CV (%)	-	-	131.5	-	-	21.19	40.44

1. Late leaf spot and rust were scored on a 1–9 scale (Subrahmanyam et al. 1995), where 1 = no disease, and 9 = 81–100% disease severity.
2. Bacterial wilt incidence was based on the percentage of wilted plants.

rust incidence was not severe enough to permit useful screening for the disease. Evaluation for late leaf spot was based on the first experiment, while for bacterial wilt the second experiment was considered. Eight genotypes—ICG 3704, ICG 10823, ICGV 88369, ICG 10660, ICGV 86402, ICG 1015, ICG 6163, and T 9—were considered resistant (scores <4) to late leaf spot. Twelve other lines introduced from ICRISAT were considered moderately resistant to late leaf spot (scores between 4 and 5). Unfortunately, except for ICG 6280 (highly resistant) and ICGV 87073 (moderately resistant) to bacterial wilt, all other late leaf spot resistant/moderately resistant genotypes were moderately to highly susceptible to bacterial wilt (Table 1).

The late leaf spot scores for Indonesian cultivars in the present study were on the lower side. This could be due to the disease incidence not reaching its maximum (a score of 9). From previous evaluations, Gajah, Mahesa, and Tapir have been described as susceptible to, and Kelinci, Badak, and Zebra as tolerant of late leaf spot (Kasim and Djunaenah 1993).

Among the Indonesian cultivars, only Mahesa was highly resistant to bacterial wilt. Gajah and Kelinci were moderately resistant, while Badak, Tapir, and Zebra were moderate susceptible to bacterial wilt. These results are slightly different from the previous description that Gajah, Mahesa, and Tapir are resistant, while Kelinci is moderately resistant and Badak is tolerant of bacterial wilt. According to Machmud (1993), there is an indication that the resistance of Indonesian groundnut cultivars to bacterial wilt has tended to decline over time.

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Evaluating Advanced Groundnut Lines for Resistance to Late Leaf Spot and Rust in Indonesia

Nasir Saleh and **Trustinah** (Research Institute for Legume and Tuber Crops, RILET, PO Box 66, Malang 65101, Indonesia)

Late leaf spot (*Phaeoisariopsis personata*) and rust (*Puccinia arachidis*) are important fungal diseases of groundnut in Indonesia. Both diseases often appear together and cause severe defoliation. Yield losses by these diseases range from 40 to 70% (Hardaningsih and Neering 1989, Hardaningsih et al. 1991). Some fungicides have been reported to reduce the disease incidence and increase yield (Hardaningsih et al. 1991, Saleh 1995). However, for socioeconomic reasons, chemical control is not practiced by farmers. Therefore, the use of groundnut

Table 1. Reactions of 41 groundnut genotype to rust, and late leaf spot at Jambegede, Indonesia, 1995 dry season.

Genotype	Disease score[1] Rust	Disease score[1] Late leaf spot	Yield plant^{-1} (g)
K/PI 405132-90-B1-2-51	5	4	22.13
K/PI 405132-90-B1-2-50	5	6	19.49
MLG 2449	7.5	6	21.86
K/PI 405132-90-B1-2-22B	5	6	17.10
K/C NO. 45-23-B-O-/C	6	6	17.11
C NO. 45-23-B-O-/C	5	6	13.06
ZEBRA	4	5	18.89
PI 405132/K-90-B-4	6	6	15.11
K/PI 390595/K-90-B2-54	5	6	18.22
K/PI 405132-90-B1-2-44	5	6	16.01
K/PI 390595//K-90-B2-3	4	5	15.91
MLG 7512	7.5	6	17.76
C NO. 45-23/LM-90-B-2	5	6	20.65
BADAK	5	5	15.05
MLG 7511	7.5	6	13.35
MLG 7649	7.5	6	19.15
LM/PI 414332//LM-90-B-1	5	6	18.86
CGMO Kidul Bunder	7.5	6	20.29
K/C NO. 45-23-B-6-22	5	6	20.03
K/PI 259747//K-92-B2-5A	5	5	19.78
K/PI 405132-90-B1-2-7	5	5	22.21
K/PI 405132-90-B1-2-31	5	4	18.44
PI 393641/K-40-B2-1	5	6	19.79
MLG 1824	7	6	13.62
G/PI 390595//G-90-B-4	6	6	10.48
MLG 7685	7	6	21.85
ICG 1249	7	6	22.58
MLG 7647	6	5	16.07
ICG 10931	5	6	19.56
PI 393641/G-90-B1-2	5	5	12.89
MLG 7573	7	6	22.48
K/PI 405132-90-B1-2-16	5	5	29.95
PI 393641/K-90-B2-1	5	5	25.82
K/PI 259747-90-B3-2	5	6	20.19
MLG 7646	7	6	18.10
ICGV 87158	7	6	17.26
PI 390595/LM-90-B-2	6	6	13.75
MLG 7516	7	6	17.33
K/PI 259747-0-B2-1	8	6	17.97
ICGV 87055	7	7	8.22
MLG 7682	7	7	8.67
SE	-	-	±10.1
CV (%)	-	-	29.37

1. Late leaf spot and rust were scored on a 1–9 scale (Subrahmanyam et al. 1995) 14 weeks after sowing, where 1 = no disease and 9 = 81–100% disease severity.
2. Bacterial wilt incidence based on the percentage of wilted plants 14 weeks after sowing.

varieties resistant to leaf spot and rust is considered important and an effective way to manage these diseases.

Fifty groundnut genotypes consisting of breeding lines, RILET germplasm lines, lines introduced from the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), and local improved cultivars were evaluated for their resistance to late leaf spot and rust diseases under natural field conditions at the Jambegede Experiment Station, Malang, Indonesia, in the 1995 dry season using a randomized block design with two replications. Advanced breeding lines screened in this experiment were derived from crosses of PI 405132, PI 414332, PI 390595, PI 259747, PI 33393641, and C No. 45-23 (resistant to rust and late leaf spot) and Kelinci (K), Gajah, and local Majalengka (high yield potential, short-duration, resistant/susceptible to bacterial wilt, and resistant/susceptible to leaf spot).

The genotypes were sown at the rate of one seed hill^{-1} in two 2.5-m long rows with 40 cm row-to-row and 10 cm plant-to-plant spacing. The crop was fertilized with 25 kg urea + 25 kg triple superphosphate + 25 kg KCl ha^{-1}.

Of the 50 genotypes sown, 9 genotypes could not be evaluated for their resistance to late leaf spot and rust due to their low germination and the high incidence of bacterial wilt. Both leaf spot and rust diseases were initially observed about 2 months after sowing, and the infections gradually increased until harvest time. Evaluations for leaf spot and rust resistance were done at 14 weeks after sowing, or about 12 days before harvest (the crop was harvested at 110 days).

None of the 41 genotypes evaluated was resistant to rust or late leaf spot; 21 genotypes were considered moderately resistant to rust (scores between 4 and 5), 11 moderately resistant to late leaf spot (scores between 4 and 5), and 10 moderately resistant to both rust and late leaf spot. Two groundnut genotypes, Zebra and K/PI 390595//K-90-B2-3, had rust scores of 4. Genotypes K/PI 405132-90-B1-2-51 and K/PI 405132-90-B1-2-31 had late leaf spot scores of 4 (Table 1).

Badak was described as resistant to rust, and tolerant of bacterial wilt and late leaf spot, while Zebra was tolerant of rust and leaf spot (Kasim and Djunaenah 1993). Sudjono et al. (1995) reported Zebra as highly resistant to late leaf spot at Bogor. In this experiment, Badak and Zebra showed only moderate resistance to late leaf spot and rust.

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Yield Stability of Groundnut Lines Tolerant of Foliar Diseases and Drought in Indonesia

Astanto Kasno, Novita Nugrahaeni, and **Trustinah**
(Research Institute for Legume and Tuber Crops, RILET, PO Box 66, Malang 65101, Indonesia)

Two-thirds of the groundnut grown in Indonesia is sown on drylands, mainly during the postrainy season, and harvested between May and July. In this growing season groundnut suffers from drought and foliar diseases during its reproductive stages. Although the groundnut area has increased since 1990 by an average 0.81% year^{-1}, production declined by 1.01% year^{-1} and productivity by 0.26% year^{-1}. The harvested area of groundnut in 1994 was 642 998 ha, total production was 631 971 t seed, with an average yield of 0.89 t seed or 1.4 t pod ha^{-1}.

Groundnut breeding for drought and foliar disease tolerance has been in progress at the Research Institute for Legume and Tuber Crops (RILET) since 1988. Many promising varieties with resistance to foliar diseases, particularly late leaf spot (*Phaeoisariopsis personata*), and to drought have been developed. Pod yield stability analysis of 10 groundnut genotypes, resistant/tolerant of late leaf spot and drought, was carried out using the Eberhart and Russell (1966) technique. Data were recorded from the multilocational yield test at 15 locations covering 7 provinces (West Java, Central Java, East Java, Bali, West Nusatenggara, East Nusatenggara, and Timor Timur) in the 1992/93 cropping season. The combined analysis of variance for pod yield revealed highly significant differences among genotypes, environments, and for genotype × environment (GxE) interactions. Significant interactions in groundnut for yield and yield components have been reported by several workers (Kasno et al. 1988, Kasno et al. 1989, Shorter and Hammons 1985, Tai and Hammons 1978, and Reddy et al. 1995). Groundnut varieties that show small, or if possible, no GxE interactions are desirable, because of their stable performance across a wide range of environments. The linear component of GxE interaction was significant, and there was a high coefficient of determination, indicating that most of the variation could be predicted and that regression analysis was valid. Stability parameters are presented in Table 1. The overall genotype mean was 2.0 t ha^{-1} and was considered high. The high mean yield was due to the low incidence of foliar diseases and low drought severity. Deviation from regression was not significant for any of the groundnut genotypes tested. Genotypes GH 1697 and ICGV 86707 were stable, and GH 1697 showed signifi-

Table 1. Pod yield and stability parameters of foliar disease resistant groundnut genotypes.

Genotypes	Pod yield ($t\ ha^{-1}$) stability parameters				
	Range	Mean	b_i	S^2_{di}	r^2
GH 1697	1.13–3.82	2.21	1.12	0.060	0.80
No. 7620	1.13–3.29	2.16	1.12*	0.135	0.88
No. 7494	1.11–4.01	2.14	1.30**	0.089	0.82
LM/87165-88-B-32	1.01–2.67	1.87	0.85*	0.052	0.83
K/SHM2-88-B-14	1.10–2.63	1.89	0.73*	0.013	0.93
K/SHM2-88-B-1	1.03–2.71	1.98	0.85*	0.063	0.81
G/C//LM-88-B-1	0.71–2.68	1.76	0.76*	0.041	0.80
ICGV 86707	1.01–3.12	1.84	0.97	0.060	0.83
Badak	1.13–2.75	2.00	0.80*	0.054	0.85
Kelinci	1.00–3.27	2.19	0.95	0.038	0.84
Mean		2.00	1.00		0.83
SE	–	±0.150			
CV (%)	–	15.8			

* – Significant at 5% probability level.
** – Significant at 1% probability level.

cantly higher pod yield than ICGV 86707. The yield and stability of GH 1697 were the same as those of the control variety Kelinci. GH 1697 was derived from individual plant selection within ICG 1697, based on the number of seeds pod^{-1} and its response to foliar diseases. ICG 1697 was introduced from the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) in 1988 through the Australian Centre for International Agricultural Research (ACIAR) project that involves screening for PStV resistance.

GH 1697 (GH = *galur harapan* or 'promising line') is tolerant of drought and foliar diseases, mainly late leaf spot, and is proposed for release as a new improved groundnut variety in Indonesia.

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Identifying Groundnut Genotypes for the Southern Telangana Zone in India

Ramesh Thatikunta and **M M K Durgaprasad**
(Regional Agricultural Research Station, Andhra Pradesh Agricultural University, Palem 509 215, Andhra Pradesh, India)

In Andhra Pradesh, groundnut (*Arachis hypogaea* L.) is cultivated on 2.35 m ha, where it produces 2.55 million t. The rainfed districts of Mahabubnagar, Nalgonda, Rangareddy, parts of Warangal, and Medak that comprise the Southern Telangana Zone account for 11% of the groundnut area in the state. In Southern Telangana groundnut is grown on Alfisols and generally suffers from the mid-season drought that reduces crop yields. The objective of this study was to identify genotypes that can yield well despite mid- or end-season droughts.

Eighteen genotypes and a local control (TMV 2) were grown in a randomized block design with four replications at the Regional Agricultural Research Station, Palem. The net plot consisted of 5 rows each 4.8 m long. The rows were spaced at 30 cm, with 10 cm plant-to-plant spacing within a row. Fertilizer was applied at the rate of 30 kg N, 40 kg P_2O_5, and 50 kg K_2O ha^{-1} as a basal application. Gypsum at the rate of 500 kg ha^{-1} was incorporated into the soil 30 days after sowing. Adequate plant stands, free from weeds and pests were maintained. The crop experienced a 27-day long dry spell from the beginning of pod initiation to full seed development in 1994, and for 16 days from the beginning of peg initiation to the beginning of pod development in 1995. Data on yield and ancillary characters were recorded in the rainy seasons of 1994 and 1995.

During the 1994 rainy season, pod yields of genotypes ranged from 0.89 to 2.41 t ha^{-1} (Table 1). TG 26 (2.41 t

Table 1. Performance of groundnut genotypes at Regional Agricultural Research Station, Palem, Andhra Pradesh, India, rainy seasons, 1994 and 1995.

Genotype	Pod yield (t ha^{-1}) 1994	Pod yield (t ha^{-1}) 1995	Average pod yield (t ha^{-1})[1]	Shelling turnover (%)	100-seed mass (g)	Sound mature seed[2] (%)	Oil content (%)
TCGS 13	1.50	1.16	1.33	66.3	24.5	79.7	43.7
TCGS 25	1.79	0.99	1.39	66.5	30.8	86.9	43.6
TCGS 26	1.37	1.51	1.44	66.0	29.3	88.9	43.3
TCGS 61	1.45	1.24	1.34	66.0	29.5	92.4	43.4
TCGS 27	1.92	1.26	1.59	67.0	25.8	92.6	42.6
TCGS 29	1.55	1.33	1.44	66.5	31.0	87.8	40.8
TCGS 30	0.89	1.19	1.04	65.8	30.0	87.9	44.2
TCGS 37	1.65	1.27	1.46	65.0	28.3	86.0	44.7
TCGS 67	1.19	1.06	1.13	67.3	27.5	85.8	44.4
TCGS 76	1.43	1.20	1.32	65.5	27.8	79.7	42.7
TCGS 84	1.42	1.12	1.27	65.5	30.8	88.0	42.5
TCGS 88	0.58	1.20	0.89	68.5	31.0	87.7	44.5
TCGS 91	1.17	1.53	1.35	64.8	26.0	82.6	46.8
K 150	1.66	1.64	1.65	65.5	29.0	76.4	43.7
TPT 1	1.90	1.27	1.58	66.0	26.0	82.7	43.9
K 134	2.23	1.96	2.09	64.0	26.8	89.3	40.1
TG 26	2.41	0.62	1.51	65.0	22.5	71.4	42.1
ICGV 86347	2.40	1.31	1.86	62.0	28.8	83.9	38.8
TMV 2 (C)	1.22	1.51	1.37	63.8	24.3	76.7	42.3
Average	1.56	1.28	1.42	65.6	27.9	84.5	43.1
SE	±0.20	±0.14	±0.177	±2.3	±1.4	±6.2	±1.2
$CD_{0.05}$	0.40	0.28	0.35	4.6	2.9	12.4	2.4
CV (%)	18.30	15.50	17.60	4.9	7.3	10.4	4.0

1. Averagea pod yield from the analysis of pooled data.

ha^{-1}), ICGV 86347 (2.40 t ha^{-1}), and K 134 (2.23 t ha^{-1}) were the top pod yielders. In addition to these, such other genotypes as TCGS 27, TPT 1, and TCGS 25 yielded significantly more pods than TMV 2 (1.22 t ha^{-1}). During the 1995 rainy season, genotype pod yields ranged from 0.62 to 1.96 t ha^{-1}. Only K 134 yielded significantly more (1.96 t ha^{-1}) than the rest of the genotypes. All other genotypes gave similar pod yields to TMV 2.

On the basis of pooled pod yield, only two genotypes, K 134 and ICGV 86347 differed significantly from the rest (Table 1). K 134 recorded a consistent yield over the years with a mean of 2.09 t ha^{-1}. However, the yield superiority of these two genotypes was not reflected in their ancillary characters. Their shelling turnover was low, ranging between 62% and 68.5%. The maximum 100-seed mass (31 g) was recorded by TCGS 88, but it was a poor yielder. Sound mature seed percentages of 92.6% (TCGS 27), 92.4% (TCGS 61), and 88.9% (TCGS 26) were recorded. The genotypes tested had oil contents ranging between 38.8% and 46.8%.

High-yielding Elite Groundnut Varieties for the Indo-Gangetic Plain of West Bengal, India

A K Patra, S K Tripathy, R C Samui, and
M K Nanda (Department of Agronomy, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur 741 252, West Bengal, India)

Although the State of West Bengal is not the traditional groundnut (*Arachis hypogaea* L.) growing region of India, the crop has ample potential in this Indo-Gangetic alluvial zone, both in the rainy and summer seasons especially to supplement the vegetable oil production of the state. Groundnut is grown on about 8870 ha in West Bengal, with an annual production of 10 170 t. The productivity is 1.14 t ha^{-1} compared with the national average of 0.82 t ha^{-1}. To maximize groundnut productivity, high-yielding varieties adapted to the local growing conditions need to be identified.

An experiment with 12 groundnut varieties in a randomized block design was conducted at the University Farm, Kalyani, during the rainy (1992 and 1993) and summer (1993 and 1994) seasons. The soil of the experimental field was alluvial, with 0.07% total nitrogen, 20.4 kg available phosphorus, and 160 kg available potassium ha^{-1}, and a pH of 7.4. A common fertilizer dose of N 20, P 40 and K 40 kg ha^{-1} in the form of urea, single superphosphate and muriate of potash was applied as a basal treatment. The crop was sown with a spacing of 30 cm × 10 cm during the second week of July in the rainy season, and in the first week of February in summer. The plot size in both the seasons was 4 m × 6 m.

ICGS 44 recorded the highest pod, seed, and oil yield (Table 1). TG 24 and JL 24 also performed well. These varieties can therefore be recommended for rainy season and summer cultivation in West Bengal. Although ICGS 44 was initially released for irrigated postrainy/summer cultivation in Gujarat, it has shown wide adaptation to varying agroecological conditions in India.

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Table 1. Performance of varieties grown in the Indo-Gangetic zone of West Bengal, rainy (1992 and 1993) and summer (1993 and 1994) seasons.

	Rainy season yield (t ha^{-1})			Summer yield (t ha^{-1})		
Variety	Pod	Seed	Oil	Pod	Seed	Oil
JL 24	2.61	1.86	0.89	2.77	1.96	0.97
ICGS 1	2.31	1.59	0.74	2.52	1.69	0.79
ICGS 11	2.53	1.76	0.83	2.61	1.78	0.84
ICGS 44	2.71	1.90	0.92	2.95	2.08	1.03
ICGV 86143	2.04	1.41	0.64	2.36	1.63	0.76
ICGV 86149	2.35	1.64	0.76	2.50	1.72	0.80
ICGV 88079	1.97	1.26	0.56	2.26	1.45	0.65
TGS 1	2.17	1.45	0.65	2.50	1.63	0.74
TG 19A	1.92	1.25	0.55	2.27	1.46	0.65
TG 23	2.42	1.62	0.77	2.59	1.70	0.80
TG 24	2.65	1.81	0.85	2.82	1.87	0.89
$CD_{0.05}$	0.15	0.11	0.06	0.05	0.06	0.04

Performance of Introduced Early-maturing Groundnut Varieties in the Upper Krishna Project, India

A Amaregouda, and **P Y Kamannavar** (Agricultural Research Station, University of Agricultural Sciences–Dharwad, Krishna CADA, Bheemarayanagudi 585 287, Karnataka, India)

Groundnut (*Arachis hypogaea* L.) is an important oilseed crop in the Upper Krishna Project (UKP) area in southern India, and is cultivated on more than 62 500 ha. During the last 5 years (1990–95), the production of summer groundnut increased from 27 743 to 69 890 t, while the productivity increased from 1.80 to 1.85 t ha^{-1}. The increase in production was mainly due to the increased area under summer groundnut. At present, groundnut yields are higher in the rainy season (1.82 t ha^{-1}) than in summer (1.73 t ha^{-1}). Normally, summer yields should be higher because of the unlimited sunshine and low incidence of biotic stresses. However, in UKP the yield levels are low in summer mainly due to the shortage of irrigation water at the end of the growing season. At present, the widely cultivated varieties are TMV 2, S 206, and KRG 1 which mature in 110–120 days. Water supply to the area through the canal system is stopped during March-April, which coincides with the peak pod development stage of these varieties. Therefore, it is essential to identify a suitable variety that will mature early and escape the moisture stress during the pod-maturing stage.

Fifteen early-maturing groundnut varieties obtained from ICRISAT were evaluated at the Agricultural Research Station, Bheemarayanagudi (16°43'N, 76°51'E, and 412 m msl) along with the local cultivars, TMV 2 and KRG 1. A field experiment was conducted on a Vertisol in a randomized block design with three replications. The crop was sown on 17 Dec 1994 after a presowing irrigation. Seeds were sown in a crop geometry of 30 cm × 10 cm and the crop was fertilized (75 kg P_2O_2, and 25 kg each of N and K_2O ha^{-1} through DAP, single superphosphate, and muriate of potash). Gypsum (200 kg ha^{-1}) was applied to the crop 30 days after sowing. In all, the crop received five postsowing irrigations each of 6 cm of water. The crop was harvested on 28 Mar 1995 (101 days after sowing). During this period, the crop accumulated 1420.7°Cd (degree days).

The pod yield ranged from 1.56 to 2.63 t ha^{-1}. The varieties differed significantly among themselves with respect to pod yield, 100-seed mass, shelling percentage, number of developed pods $plant^{-1}$, days to 50% flowering, and plant height (Table 1). The incidence of bud necrosis disease and collar/root rot ranged from 0 to 2.2% and 0.7 to 3.7%.

ICGV 92206 and ICGV 91116 will be further evaluated in multilocational trials of the University of Agricultural Sciences, Dharwad.

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Table 1. Performance of some selected early-maturing groundnut varieties, Agricultural Research Station, Bheemarayanagudi, Karnataka, India, 1994/95 summer season.

Entry	Pod yield (t ha^{-1})	100-seed mass (g)	Shelling percentage	Number of pods $plant^{-1}$ Developed	Number of pods $plant^{-1}$ Undeveloped	Days to 50% flowering	Plant height (cm)
ICGV 92206	2.63	37.4	71.5	15.8	3.4	30.3	26.3
ICGV 91116	2.47	34.1	74.0	13.8	4.7	30.0	23.0
ICGV 93422	2.22	34.0	65.1	14.8	4.9	30.7	26.0
ICGV 94326	2.11	33.9	64.8	12.9	3.4	30.3	26.0
KRG 1 (control)	2.20	34.4	63.1	13.3	3.4	30.0	28.7
TMV 2 (control)	1.58	31.1	60.9	12.5	3.4	30.0	28.3
SE	±0.125	±1.44	±2.3	±0.8	±0.78	±0.7	±1.2
$CD_{0.05}$	255	2.94	4.6	1.7	NS[1]	1.5	2.5
CV(%)	13.4	5.8	5.1	11.3	2.7	3.2	5.8

1. NS = nonsignificant.

An Interspecific Cross Derivative—a New Source of Foliar Disease Resistance

S Kalaimani, V Manoharan, P Vindhiyavarman, C S Sridharan, S Thangavelu, and V Dharmalingam
(Regional Research Station, Tamil Nadu Agricultural University, Vriddhachalam 606 001, Tamil Nadu, India)

Late leaf spot (*Cercosporidium personatum* (Berk. and Curtis) Deighton) and rust (*Puccinia arachidis* Speg.) are important foliar diseases of groundnut. As a result of the breeding program undertaken to transfer foliar disease resistance from the wild species, *Arachis cardenasii* Krap. and Greg., a stable tetraploid breeding line VG 113 was developed at the Regional Research Station, Vriddhachalam, India. The hybrid was produced by crossing *Arachis hypogaea* L. (2n = 40) cv CO1 as the ovule parent, and the wild diploid species *Arachis cardenasii* (2n=20) as the pollen parent. The resulting triploid (2n=30) plants were backcrossed thrice with cv CO1 successively.

The 24 stable tetraploid hybrid derivatives were evaluated for foliar disease resistance and good agronomic traits. Among them, the breeding line VG 113 was found to be promising. VG 113 is a virginia bunch type maturing in 120–125 days. It has dark green leaves, and medium-sized pods with red seeds. It has a seed dormancy period of 45 days compared with 60 days for TMV 10. It shows a resistant reaction to late leaf spot and rust (Table 1).

Table 1. Mean reaction to foliar diseases recorded during the 1994 and 1995 rainy seasons.

Genotype	Reaction to disease (1–9 scale[1]) Rust	Late leaf spot
VG 113	1.9	2.2
Kadiri 3	8.5	8.8
ICGS 76	7.6	7.7
TMV 10	7.0	7.8

1. Scored on a 1–9 scale, where 1 = no disease, and 9 = plants severely affected (Subrahmanyam et al. 1982).

This hybrid derivative must have been conferred resistance by genes from *A. cardenasii*. Stalker et al. (1979) reported evidence of gene transfer from *A. cardenasii* into *A. hypogaea* L. for morphological characters and disease resistance. The pod yield of VG 113 is greater than that of the popular virginia bunch groundnut cultivars (Table 2). Further evaluation of this breeding line for possible release is in progress. It can also be utilized as a source of resistance to foliar diseases in a breeding program.

Table 2. Mean performance of VG 113 in multilocational trials conducted during the 1994 and 1995 rainy seasons.

Genotype	Pod yield (kg ha^{-1}) Vriddhachalam	Coimbatore	Paiyur	Mean
VG 113	1638	1073	1716	1476
Kadiri 3	1030	786	1147	988
ICGS 76	1241	853	1495	1196
TMV 10	1181	1062	1520	1254

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Isolating Foliar Disease Resistant Spanish Bunch Mutants in Groundnut in India

B N Motagi, M V C Gowda, and R Seshagiri
Department of Genetics and Plant Breeding, University of Agricultural Sciences, Dharwad 580 005, Karnataka, India)

Rust (*Puccinia arachidis*) and late leaf spot (*Phaeoisariopsis personata*) are widely distributed fungal diseases of groundnut that cause substantial pod and haulm yield losses. Several fungicides are effective in control-

Table 1. Foliar disease resistance, productivity, and pod and seed features of induced mutants in groundnut, University of Agricultural Sciences, Dharwad, Karnataka, India, 1995 rainy season.

		Field disease score (1–9 scale)			Productivity parameters				Pod features[1]			
Genotype	Cultivar cluster	Late leaf spot	Rust	Days to maturity	Pod yield (g plant^{-1})	Shelling percentage	Sound mature seed (%)	100-seed mass (g)	Beak	Constriction	Reticulation	Seed color[2]
Parents												
DER	-[3]	9	7	97	11.4	74.1	81.6	23.6	S	P	S	LT
VL1	valencia	9	2	103	19.3	70.3	88.7	39.6	A	A	A	DT
Mutants												
1-1	valencia	8	2	104	2519	70.8	76.8	43.2	A	A	A	DT
2-1	valencia	9	3	104	17.7	69.5	65.7	45.0	S	S	A	DT
2-2	valencia	9	4	104	24.8	72.4	78.7	45.6	S	S	S	DT
3-1	short valencia	7	2	105	26.4	71.8	78.3	27.4	A	A		SP
27-1	valencia	8	5	104	27.2	72.3	79.2	46.2	A	A	A	DT
28-1	large spanish	5	4	102	31.1	73.9	87.2	68.9	A	M	A	DT
28-2	large spanish	5	2	102	36.4	74.0	89.4	59.5	A	M	A	DT
29-1	valencia	9	3	105	22.0	71.7	78.9	40.3	S	M	M	DT
45	large spanish	5	3	102	34.2	72.5	88.6	63.8	A	M	A	DT
78-1	valencia	8	4	104	23.5	70.7	81.5	47.7	A	A	A	DT
78-2	valencia	8	4	104	27.7	71.5	76.6	43.0	A	A	S	DT
98	large spanish	5	5	102	28.0	74.0	93.1	64.0	A	M	S	DT
109-1	valencia	8	5	105	22.8	71.0	89.8	39.1	A	S	S	DT
110	large spanish	5	8	102	31.0	72.6	94.3	50.9	A	M	A	DT
121	short valencia	7	2	105	30.9	69.6	83.1	38.0	A	A		SP
139-1	valencia	9	4	103	18.5	72.9	89.0	41.8	A	A	A	DT
161	valencia	9	3	103	20.5	69.6	81.2	34.8	S	M	P	DT
170	valencia	8	3	105	39.8	68.9	86.0	40.1	A	A	M	R
Susceptible control												
JL 24	long manyema	9	8	100	25.9	74.3	95.6	45.0	S	S	A	DT
Resistant controls												
BGPDS 272	virginia	5	2	125	24.0	74.9	93.0	63.7	M	M	M	R
PI 259747	valencia	5	2	118	23.3	74.1	98.5	53.8	M	P	P	P
SE	-	-	-	-	±0.52	±0.44	±2.65	±1.81	-	-		-
Mean		7.4	3.8	104.7	25.8	72.1	85.0	46.2	-	-		-
$CD_{0.05}$	-	-	-	-	1.52	1.29	7.76	5.32	-	-		-

1. Pod features: A = absent, S = slight, M = moderate, P = prominent; 2. Seed color: LT = light tan, DT = dark tan, P = purple, R = red; 3. Cannot be grouped into any of the cultivar clusters.

ling these diseases, but the pest strategy is to cultivate resistant varieties. Several genotypes resistant to late leaf spot and/or rust have been identified, but most of them are valencia (var *fastigiata*) landraces with a number of such undesirable attributes as thick shell, low productivity, late maturity, and poor adaptation, which make them unsuitable for direct utilization (Subrahmanyam et al. 1983). Some wild *Arachis* species are immune or highly resistant to the two diseases. Stable interspecific hybrid derivatives belonging to the virginia group (var *hypogaea*) and possessing high levels of resistance to rust and late leaf spot have been developed at the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), but most of them are late-maturing and suffer from low shelling turnover (Reddy et al. 1992). Spanish bunch cultivars are most popular in India as they mature early and facilitate double cropping under rainfed conditions, besides possessing desirable pod and seed features. However, these cultivars are highly susceptible to the foliar diseases and suffer heavy yield loss. Attempts to develop disease-resistant, productive cultivars through hybridization have not yielded good results. Lines developed either possessed only a moderate level of resistance or retained one or more undesirable features (Wynne et al. 1991). Hence, there is a strong need to identify new germplasm in spanish bunch backgrounds, combining high levels of resistance, early maturity, desirable pod and seed features, and high yield.

On artificial mutagenesis with ethyl methane sulfonate (EMS) in the laboratory, Dharwad Early Runner (DER) yielded resistant, early-maturing, and erect bunch mutants (Nadaf 1993). On subsequent mutagenesis with EMS, one of these mutants, Valencia 1, yielded secondary mutants which showed high levels of resistance with more desirable attributes (Sheshagiri 1994). In the present study, induced mutants were grouped according to the classification of Gibbons et al. (1972), and were evaluated for disease resistance and productivity, besides pod and seed features, along with the parents (DER and VL 1), and resistant (PI 259747 and GBFDS 272) and susceptible (JL 24) controls.

Each genotype was sown in three rows of 2 m length with a spacing of 30 × 10 cm, except for DER (60 × 15 cm, because of its procumbent habit) in two replications in the 1995 rainy season. Each genotype was scored 1 week before harvest for late leaf spot and rust on a 1–9 scale according to Subrahmanyam et al. (1982). The harvested pods were washed and dried, and pod yield, shelling percentage, percentage of sound mature seeds, and 100-seed mass were determined. Pod features (beak, constriction, and reticulation) and seed color were recorded in accordance with IBPGR and ICRISAT descriptors (IBPGR and ICRISAT 1992).

As indicated by the field disease score (1–9 scale), the incidence of late leaf spot and/or rust was significantly lower in the mutants than in the susceptible control and parents (Table 1). The resistant spanish bunch mutants (28-2, 45, and 110) matured very early (103 days) compared with the resistant controls, and had desirable pod and seed features (smooth pods and tan seeds). They were comparable with the high-yielding but susceptible control, JL 24, for productivity parameters (Table 1). These mutants can be widely tested for their commercial release, and/or profitably utilized in future breeding programs.

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Performance of Foliar Disease Resistant Advanced Breeding Lines of Groundnut from ICRISAT in Indonesia

Astanto Kasno, Novita Nugrahaeni, and **Joko Purnomo** (Research Institute for Legume and Tuber Crops, RILET, PO Box 66, Malang 65101, Indonesia)

Rust (*Puccinia arachidis*), early leaf spot (*Cercospora arachidicola*), and late leaf spot (*Phaeoisariopsis personata*) diseases are widely distributed in Indonesia and cause pod yield losses of up to 60% (Hardaningsih and Neering 1989, Soekarno and Sharma 1989). Several fungicides were identified and recommended for control of these diseases (Hardaningsih 1993). However, socio-economic considerations limit the use of fungicide by groundnut farmers. Some varieties, moderately resistant to/tolerant of foliar diseases, have been released. But these varieties have not reached farmers' fields due to the lack of information available to farmers, and the non-availability of sufficient seed for distribution. Breeding groundnut varieties with resistance to foliar diseases, and good quality seed has been intensively done at the Research Institute for Legume and Tuber Crops (RILET), Malang, Indonesia, since 1992 through a hybridization and selection program, and by introducing advanced breeding material, mainly from the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT).

Fifteen selected groundnut genotypes with foliar disease resistance, and a local cultivar (Mahesa) were tested for their performance at the Muneng Experiment Station (Alfisol and dry climate) during the 1995 postrainy season.

The trial was sown in a 4 × 4 triple lattice design with plot size of 5 m × 1.6 m. The row-to-row spacing was

Table 1. Performance of varieties included in the Sixth International Confectionery Groundnut Varietal Trial from ICRISAT, Muneng, dry season 1995.

Genotype	Shelling percent-age	100-seed mass (g)	Sound mature seed (%)	Seed appearance and uniformity score[1]	Score[2]		Final plant stand plot^{-1}	Pod yield[3] (kg ha^{-1})
					Rust	Late leaf spot		
ICGV 91230	69	66.3	87	7	5	5	82	2.87a
ICGV 87846	66	60.3	81	4	4	6	99	2.87a
ICGV 91234	65	59.0	79	9	4	5	75	2.62ab
ICGV 89402	65	72.5	90	7	4	5	97	2.37bc
ICGV 88256	63	62.4	84	7	4	5	128	2.37bc
ICGV 91246	63	66.7	79	9	5	6	72	2.25cd
ICGV 91227	58	56.1	67	7	3	5	94	2.00cde
ICGV 91223	62	65.3	81	8	4	5	111	1.87de
ICGV 87868	67	56.2	88	9	5	5	98	1.87de
ICGV 91247	64	64.4	84	9	5	5	83	1.87de
ICGV 86590	59	46.4	80	9	6	6	136	1.75e
ICGV 87860	64	53.2	77	9	5	5	71	1.75ef
ICGV 91228	61	48.7	79	9	4	5	54	1.62ef
ICGV 87160	62	38.9	96	7	5	5	77	1.37fg
ICGV 90074	60	48.3	65	9	6	5	47	1.37fg
Control								
Mahesa	71	57.9	94	3	7	5	107	1.12g

1. Scored on a 1–9 scale where 1 = excellent appearance and uniformity, and 9 = poor appearance and uniformity.
2. Scored on a 1–9 scale where 1 = no disease and 9 = 81–100% disease severity (Subrahmanyam et al. 1995).
3. Values bordered by common letters are not different at $P \leq 0.05$.

40 cm and plant-to-plant within a row 10 cm. Basal fertilizers (50 kg urea, 100 kg triple superphosphate, and 100 kg KCl ha^{-1}) were added. The crop was regularly irrigated from sowing until 80 days after sowing. No fungicides were applied during the crop growth.

Rust and late leaf spot incidence were scored using a 1–9 scale (Subrahmanyam et al. 1995). Mahesa was used as the standard control cultivar, it is moderately resistant to rust, and susceptible to early leaf spot.

Rust and late leaf spot incidences were considered high, since the disease intensity was higher than 80%. Thirteen varieties gave higher pod yield than Mahesa. ICGVs 91230 and 87846 were the highest yielders in the trial (2.87 t ha^{-1}). However, seed appearance and uniformity in general, were poor in the introduced material (Table 1); only ICGV 87846 compared well with Mahesa. Among the lines tested, only ICGV 91227 showed resistance to rust (score <4). None of the lines tested could be identified as resistant to late leaf spot (LLS), but some lines showed moderate resistance to rust, LLS or both (scores between 4 and 5). ICGV 91230 was moderately resistant to both rust and LLS diseases, and also gave the highest pod yield in the experiment.

The seed appearance of ICGV 91230 and ICGV 87846 needs to be improved through line selection, so that they can be used as parents in a hybridization program.

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Performance of Confectionery Groundnut Varieties under Rainfed Dryland Conditions in Indonesia

Novita Nugrahaeni, Astanto Kasno, and **Joko Purnomo** (Research Institute for Legume and Tuber Crops, RILET, PO Box 66, Malang 65101, Indonesia)

In Indonesia, groundnut (*Arachis hypogaea* L.) is used mainly for confectionery purposes. Spanish-type groundnuts with medium-sized tan seeds are preferred for roasting (unshelled or shelled). For such other products as *kacang telur* (eggnut), *kacang atom* (flavornut), and 'peanut paste', any type of groundnut is acceptable.

The development of a groundnut-based agro-industry is given top priority in the agricultural policy for the second long-term development plan in Indonesia. This will increase the future demand for good quality confectionery groundnut.

Fifteen confectionery groundnut varieties from the Sixth ICRISAT International Confectionery Groundnut Varietal Trial were evaluated together with local cultivar Mahesa at Muneng Experimental Station during the dry season of 1995. Mahesa, a spanish cultivar, has good seed appearance and is moderately resistant to rust, but susceptible to early leaf spot. The climate at Muneng is dry with 3–4 wet months in a year. The trial was sown in an Alfisol field in a 4 × 4 triple lattice design. The basal fertilizers applied were 50 kg urea, 100 kg triple superphosphate, and 100 kg KCl ha^{-1}. Each genotype in a replication was sown in a plot of 5 m × 1.6 m, with a spacing of 40 cm between rows, and 10 cm between plants within a row. One seed $hill^{-1}$ was sown. Irrigation, weed control, and crop protection against pests and diseases were optimal. All the genotypes were harvested 105 days after sowing.

Table 1. **Performance of varieties included in the Sixth International Confectionery Groundnut Varietal Trial from ICRISAT, Muneng, Indonesia, dry season 1995.**

Genotype	Shelling percentage	100-seed mass (g)	Sound mature seed (%)	Seed appearance and uniformity score[1]	Final plant stand plot^{-1}	Pod yield (kg ha^{-1})
ICGV 90173	69	93.2	95	2	108	2.41a[2]
ICGV 90308	66	85.2	87	5	108	2.37a
ICGV 90325	64	89.0	92	3	110	2.35a
ICGV 90196	64	78.3	88	3	114	2.33ab
ICGV 91099	69	89.7	87	2	102	2.30ab
ICGV 91089	66	86.5	85	4	102	2.29ab
ICGV 90208	69	99.2	98	2	89	2.26ab
ICGV 91085	64	99.6	94	8	112	2.23ab
ICGV 90212	71	80.8	95	2	95	2.24ab
ICGV 91104	64	86.4	82	3	120	2.06abc
ICGV 91106	74	84.1	98	4	89	1.95bc
ICGV 90210	66	108.9	97	6	82	1.95bc
ICGV 90312	67	89.5	82	4	105	1.94bc
ICGV 90320	64	74.4	87	4	90	1.85cd
ICGV 91097	61	79.7	83	4	67	1.48d
Control						
Mahesa	66	61.7	97	1	140	2.20abc

1. Scored on a 1–9 scale, where 1 = excellent appearance and uniformity, and 9 = poor appearance and uniformity.
2. Values bordered by common letters are not different at $P \leq 0.05$.

The average number of plants harvested was only 55% of the expected population. Data on pod yield and other characters are presented in Table 1. Pod yield ranged from 1.48 to 2.41 t ha^{-1}. The pod yield of nine varieties was higher than that of the local cultivar Mahesa, but the differences in yield were not significant. But these varieties had higher 100-seed mass (78.3–99.6 g) than Mahesa (67 g). The seed appearance and uniformity of ICGV 90173, ICGV 91099, ICGV 90208, and ICGV 90212 were comparable with those of Mahesa. These lines will be included in an advanced trial for further evaluation. ICGV 90210 had the highest seed mass, but its seeds were not uniform probably due to its late maturity. It could be used as a donor parent to improve the seed size of the local variety.

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Pathology

Research Findings of a Multidisciplinary Project on Rust and Leaf Spots of Groundnut in Burkina Faso

P V Subba Rao[1], R N Strange[1], P Sankara[2], M Abadie[3], A Miningou[4], D Paré[4], and R Schilling[5]
(1. University College, London, UK; 2. Université de Ouagadougou, Burkina Faso; 3. Musée nationale d'histoire naturelle, Paris, France; 4. Institut d'études et de recherches agricoles, Burkina Faso; and 5. Centre de coopération internationale en recherche agronomique pour le développement, Montpellier, France)

A 3-year project funded by the European Union began in 1993. Its aim was to evaluate rust and leaf spot diseases of groundnut in Burkina Faso and to find ways to combat them.

Disease surveys showed that there has been a drastic change in the distribution of rust since 1984 (Sankara 1987). In 1984, high levels of rust (scores between 6 and

8 on a 1–9 scale developed by the International Crops Research Institute for the Semi-Arid Tropics, ICRISAT) were confined to the southern parts of the country, whereas by 1993, they were also observed in the northwestern and central regions. The southern region has an average annual rainfall of 1100–1200 mm, while that of the northwestern and central regions is 700–800 mm. These results suggest that the rust pathogen *Puccinia arachidis* may be adapting to lower rainfall conditions. The severity and distribution of early and late leaf spots were not evaluated.

Field screening of 90 genotypes [48 from ICRISAT, 28 from the Peanut Collaborative Research Support Program (Peanut CRSP), and 14 from the Institut d'études et de recherches agricoles (INERA, Burkina Faso)], conducted at the INERA Station, Niangoloko, in southern

Table 1. Field reactions of 31 groundnut genotypes resistant to *Puccinia arachidis* tested in Burkina Faso, and at ICRISAT Asia Center (IAC), Patancheru, India.

ICG no.	Identity	*Arachis* botanical type	Origin	Rust score[1] Burkina Faso[2]	Rust score[1] IAC[3]
1697	NC Ac 17090	*fastigiata*	Peru	1.0	2.3
1703	NC Ac 17127	*fastigiata*	Peru	2.5	4.7
1707	NC Ac 17132	*fastigiata*	Peru	2.5	4.0
1710	NC Ac 17135	*fastigiata*	Peru	2.5	4.0
1712	NC Ac 17142	*fastigiata*	Brazil	2.6	5.4
2176	EC 76446 (292)	*fastigiata*	Uganda	1.5	3.3
4746	PI 298115	*hypogaea*	Israel	2.0	2.7
4747	PI 295747	*fastigiata*	Peru	1.5	3.7
7882	PI 314817	*fastigiata*	Peru	1.0	3.3
7884	PI 341879	*fastigiata*	Israel	1.0	3.0
7885	PI 381622	*fastigiata*	Honduras	2.5	3.0
7886	PI 390593	*fastigiata*	Peru	1.0	2.7
7887	PI 390595	*fastigiata*	Peru	2.0	3.7
7889	PI 393517	*fastigiata*	Peru	1.0	3.3
7890	PI 393526	*fastigiata*	Peru	2.0	2.3
7893	PI 393531	*fastigiata*	Peru	2.0	2.0
7895	PI 393643	*fastigiata*	Peru	1.0	3.0
7896	PI 393646	*fastigiata*	Peru	2.0	3.0
7898	PI 407454	*fastigiata*	Ecuador	1.0	3.3
7899	PI 414331	*hypogaea*	Honduras	1.4	2.7
10014	PI 476145	*fastigiata*	Peru	2.5	2.7
10022	PI 476151	*fastigiata*	Peru	2.5	2.3
10030	PI 476166	*fastigiata*	Peru	2.5	2.0
10031	PI 476168	*fastigiata*	Peru	2.5	2.3
10034	PI 476172	*fastigiata*	Peru	2.5	2.7
10053	PI 476183	*fastigiata*	Peru	2.5	2.0
10060	PI 476186	*fastigiata*	Peru	2.5	3.0
10940	PI 476173	*fastigiata*	Peru	2.5	2.3
-	IC 792-1	*fastigiata*	Burkina Faso	2.5	3.0
Susceptible control cultivars					
9452	TS 31-1	*vulgaris*	Burkina Faso	9.0	-
-	KH 241-D	*vulgaris*	Burkina Faso	8.0	-

1. Measured on a 1–9 scale, where 1 = no disease, 9 = 100% damage.
2. Mean of 4 replicates.
3. Source: Subrahmanyam et al. 1995; - = not available.

Burkina Faso, showed that 30 of them had very good levels of resistance to rust (disease scores between 1 and 2.6) (Table 1). When tested at ICRISAT Asia Center, India (Subrahmanyam et al. 1995), 28 of these were resistant to rust, and 9 were resistant to both rust and late leaf spot.

Early leaf spot scores and defoliation of 13 groundnut genotypes were recorded 75 days after sowing at four field locations (Saria, Kouaré, Kamboinsé, and Pobé Mengao) in Burkina Faso. While NC Ac 17090 had the lowest defoliation (23–41%) at all locations, other genotypes varied in their reaction, depending on the test location. For instance, QH 243 C had 35% defoliation at Kamboinsé and 46–56% at other locations. On the other hand, SH 67A had low defoliation at Kamboinsé (30%) and Pobé (34%), and higher levels at Saria (44%) and Kouaré (50%). Similar trends were observed for early leaf spot scores. These results suggest the possible existence of genotype × environment and/or genotype × isolate interactions.

Electron microscope studies of the rust infection process showed that in the susceptible genotype, TS 32-1, infection pegs develop from appressoria over stomata and enter the substomatal cavity through the openings between the guard cells. The infection peg expands in the substomatal cavity to form a substomatal vesicle. On contact with the host cell, a primary infection hypha develops from this vesicle and forms a haustorial mother cell. A penetration peg develops from the haustorial mother cell, penetrates the host cell and forms a haustorium at its tip. The primary infection hypha also forms secondary hyphae which give rise to additional haustorial mother cells and haustoria. On the other hand, in the resistant genotype, PI 259747, the infection peg either fails to penetrate through the stomata into the substomatal cavity, or the infection structure disintegrates in the substomatal cavity thus aborting the infection process.

Phytoalexins may be involved in disease resistance in groundnut. New techniques have been developed in order to elicit, extract, separate, and quantify the major phytoalexins in groundnut leaves. The phytoalexin responses of a rust-susceptible (KH 241-D) and a rust-resistant (PI 259747) genotype were similar, but the rate of accumulation was faster in the resistant genotype. A phytoalexin response comparable with that obtained following infection by *Cercospora arachidicola* was achieved by spraying wounded groundnut leaves with salicylic acid (0.01 M) (Subba Rao et al. 1996). This could form the basis of a screening technique to determine the phytoalexin potential of groundnut cultivars.

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Varietal Response to Various Diseases of Groundnut at Different Sowing Dates in the Postrainy Season in India

B P Dandnaik, V B Wadikar, and **D Y Mujawar**
(Oilseeds Research Station, Latur 413 512, Maharashtra, India)

Groundnut is one of the most important oilseed crops in Maharashtra. Inadequate and unpredictable rainfall, coupled with severe disease and pest problems make rainfed groundnut cultivation unprofitable. The postrainy groundnut crop is becoming increasingly important due to improved irrigation facilities.

In order to assess the severity of important diseases during the postrainy season, the effect of three sowing dates (15 Sep, 30 Sep, and 15 Oct) was assessed on four cultivars (JL 24, SB XI, ICGS 44, and LGN 2) in a factorial randomized block design, with three replications. The plot size was 5.4 × 3.6 m, with rows 30 cm

Table 1. Mean percentage disease severity of early and late leaf spots and rust, and incidence of bud necrosis disease and stem rot on four groundnut cultivars at different sowing dates, postrainy season, 1994.

Sowing date	Early and late leaf spots JL 24	SB XI	LGN 2	ICGS 44	Mean	Rust JL 24	SB XI	LGN 2	ICGS 44	Mean	Bud necrosis disease JL 24	SB XI	LGN 2	ICGS 44	Mean	Stem rot JL 24	SB XI	LGN 2	ICGS 44	Mean
15 Sep	20.78	30.28	23.69	20.24	23.74	19.02	38.48	39.28	28.37	31.28	26.67	18.25	33.56	11.74	22.05	12.40	12.50	6.25	8.06	9.80
30 Sep	14.55	8.28	9.97	5.85	9.66	13.91	9.79	16.62	8.1	12.10	22.80	17.22	24.85	13.39	20.06	10.30	11.02	8.62	7.91	9.46
15 Oct	0.22	0.77	5.55	3.92	2.61	4.07	5.89	6.21	2.0	4.54	20.20	10.00	25.55	16.10	19.66	11.96	13.18	10.76	12.62	12.13
Mean	11.85	13.11	13.07	10.03	12.01	12.33	18.05	20.7	12.82	15.97	25.24	17.49	25.89	13.74	20.59	11.55	12.24	8.54	9.53	10.46

	Early and late leaf spots Sowing date	Cultivars	SD × C	Rust Sowing date	Cultivars	SD × C	Bud necrosis disease Sowing date	Cultivars	SD × C	Stem rot Sowing date	Cultivars	SD × C
SE	±1.05	±0.81	±2.11	±1.21	±1.40	±2.43	±0.74	±0.86	±1.49	±0.55	±0.64	±1.11
$CD_{0.05}$	3.12	2.41	6.27	3.61	4.17	7.22	2.22	2.57	4.43	NS	NS	NS

apart and plants within rows spaced at 10 cm. Basal fertilizer application was 20 kg N and 40 kg P ha^{-1}. Five diseases were recorded at monthly intervals until 15 days before harvest—early leaf spot, (*Cercospora arachidicola*), late leaf spot (*Phaeoisariopsis personata*), rust (*Puccinia arachidis*), bud necrosis disease (peanut bud necrosis virus), and stem rot (*Sclerotium rolfsii*).

Disease severity of leaf spots and rust was measured on 10 randomly selected plants in each treatment in terms of percentage leaf area damage by the diseases following schematic diagrams given by Subrahmanyam et al. (1995). In the case of stem rot and bud necrosis, percentage incidence was recorded.

All four cultivars showed decreasing leaf spot and rust severity with successive delays in sowing dates, the diseases being highest on the 15 Sep sowing and lowest on the 15 Oct sowing (Table 1). Bud necrosis disease showed a similar trend on cultivars Jl 24, SB XI, and LGN 2, but the opposite on ICGS 44. Sowing dates did not affect stem rot incidence on JL 24 and SB XI, but the incidence increased on LGN 2 and ICGS 44 with the delay in sowing dates. The results show that the severity of foliar diseases can be reduced if sowing is delayed up to 15 Oct. This could, however, slightly increase stem rot incidence.

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Botrytis Blight of Groundnut in Argentina

A Marinelli[1], **G J March**[2], and **A Rago**[3]

[1. Fitopatología, Universidad Nacional de Río Cuarto (FAV-UNRC), Estafeta Postal 9, 5800 Río Cuarto, Argentina; 2. Micología y Bacteriología, Instituto de Fitopatología y Fisiología Vegetal–Instituto Nacional de Technología (IFFIVE-INTA), Cno. 60 Cuadras km 5 1/2, 5119 Córdoba, Argentina; 3. CONICOR, Argentina]

Symptoms of a disease closely resembling blight caused by *Sclerotinia minor* Jagger/*S. sclerotiorum* (Lib.) de Bary were observed on two groundnut (*Arachis hypogaea* L.) fields sown with the cultivar Florunner in Córdoba, Argentina, during the 1993/94 growing season.

The disease was observed early in April, when groundnut plants were about 120 days old. The first visible symptoms were sparse spots (slight depressions) on branches that were in contact with the soil. These lesions were reddish to brown, with a distinct demarcation zone between infected and healthy tissues. The infected tissues soon became covered with a profuse production of thick dark gray mycelia, conidiophores, and conidia of the fungus. The infection progressed rapidly from branches to leaflets, pegs, and fruits, and sometimes entire plants wilted and turned dark brown.

Dark, flattened or plano-convex sclerotia developed on decayed stems, and globose or irregular-shaped sclerotia (3–7 × 3–4 mm) were found on pods. In order to determine the disease incidence (percentage of diseased plants) each field was sampled 2 weeks before harvest. The sampling strategy was to assess 100 samples along an X-shaped path through each field. There were 50 sampling sites along each of the two arms of the X path. Sampling sites were spaced at about 20-m intervals, and each sample consisted of 50 consecutive plants in the same furrow. The X-shaped path was travelled in such a way that an area of about 10 ha was covered in each field.

Botrytis cinerea (Pers.) Fr. was isolated from diseased branches, leaflets, pegs, and pods. Koch's postulates were proved with an isolate from a diseased plant. An aqueous suspension of conidia produced on potato-dextrose agar was sprayed on 8-week-old groundnut plants potted into sterilized sand. After inoculation, pots were covered with polyethylene bags and incubated for 3 days at 20°C in a plant growth chamber. Blight symptoms were severe and resembled symptoms in the field. This is the first report of botrytis blight in Argentina. The incidence was 0.5–2% in Fields 1 and 2. However, botrytis blight of groundnut has been reported from several other groundnut-producing countries where it can occasionally cause severe yield losses (Porter et al. 1982).

Disease development was preceded by several days of low temperature and wet conditions. These are favorable environmental conditions for infection by *B. cinerea* in groundnut.

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Pythium Leaf Blight of Groundnut—a New Record

P K Mukherjee and **K Raghu** (Nuclear Agriculture Division, Bhabha Atomic Research Centre, BARC, Trombay, Mumbai 400 085, India)

During surveys of groundnut fields in the 1994 and 1995 rainy seasons at the BARC research farm, Trombay, a hitherto undescribed leaf blight symptom was observed on groundnut leaves. Isolation on potato dextrose agar after surface sterilization of infected leaves consistently yielded colonies of *Pythium*.

To prove Koch's postulates, the fungus was multiplied on potato dextrose broth (50 mL in 250 mL conical flasks) at 251°C for 15 days. The mycelial mat was harvested on a nylon mesh and homogenized in sterile distilled water using a Sorvall Omni® mixer. The mycelial suspension (1 mg dry mass mL^{-1}) was sprayed on 15-day-old groundnut seedlings (cv JL 24) grown in autoclaved, 1:1 soil:sand mixture in 2 kg capacity plastic pots. Three plants were maintained in each pot. Plants sprayed with sterile distilled water served as controls. Plants were kept in diffused sunlight at ambient temperature (30±4°C), covered with perforated polyethylene bags to maintain a high level of humidity. Symptom development was recorded daily.

The symptoms (Fig. 1) appeared within 24 h in the form of water-soaked, light brown, circular to irregular spots of 2–3 mm diameter with a lighter center. With time, the spots became larger and irregular in shape, and took the form of patches. The patches were not limited by veins, and turned dark brown to black. In 72 h, the patches covered almost three-fourths of the leaf lamina, and white mycelial growth could be seen on the infected areas. The symptoms appeared on both the upper and lower surfaces of the leaves and on young and old leaves. In 5 days, the entire leaf became blighted and rotted away. Under artificial inoculation, the disease could spread from leaf to leaf through contact. The pathogen infected the stalk and growing tips also, producing elongated dark brown to black lesions. Some partially blighted leaves turned yellow and fell off. The disease failed to progress further when the humidity was withdrawn: the spots could not enlarge in size, and the blighted areas dried up and curled. Microscopic examination of the diseased tissue stained with cotton blue in lactophenol revealed the production of profuse mycelium and reproductive structures (sporangia and oospores) on/in the infected leaves (Fig. 2). The pathogen could be reisolated from the artificially infected leaves, and reproduced the same symptoms when reinoculated. The pathogen has been tentatively identified as *Pythium aphanidermatum* (Edson) Fitz., and this appears to be the first record of this disease on groundnut (Subrahmanyam et al. 1990 and 1992).

Figure 1. Symptoms of Pythium leaf blight on groundnut leaves.

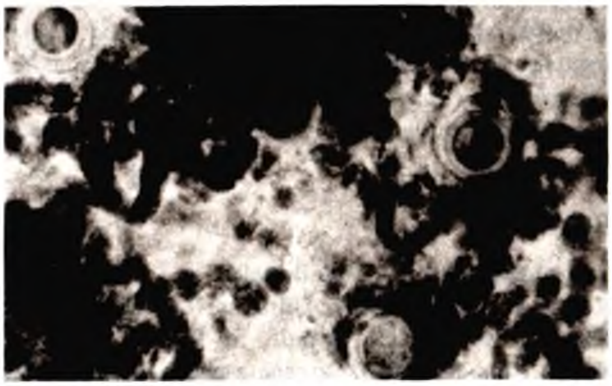

Figure 2. Sporangia and oospores of **Pythium** *sp on/in infected groundnut leaves.*

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'Kalahasti Malady' on Groundnut Outside Andhra Pradesh, India

S B Sharma[1], K S Varaprasad[2], P Balasubramanian[3], and **C V Siva Kumar[3]** (1. Crop Protection Division, ICRISAT Asia Region, Patancheru 502 324, Andhra Pradesh, India; 2. National Bureau of Plant Genetic Resources, Rajendranagar 500 030, Hyderabad, Andhra Pradesh, India; and 3. Department of Nematology, Tamil Nadu Agricultural University, Coimbatore 641 003, Tamil Nadu, India)

The 'Kalahasti Malady' is a serious disease of groundnut in parts of Chittoor and Nellore districts of Andhra Pradesh, India. Reddy et al. (1984) showed that the stunt nematode, *Tylenchorhynchus brevilineatus*, was the causal agent of this disease. The disease is considered to be restricted in distribution and has not been reported outside Andhra Pradesh.

During a preliminary survey of the groundnut-producing regions of Tamil Nadu, in the 1995 postrainy season, characteristic symptoms of the Kalahasti Malady were observed on pegs and pods of the groundnut cultivar Co 2 in Bhavanisagar. The diseased pods were brownish black, and small lesions were observed on the pegs. In a 1-ha field, 25 plants were randomly uprooted and pods were evaluated for disease severity. Pods were generally of smaller than normal size, and on 80% of the plants, the pods were discolored because of lesions. Many lesions appeared to have coalesced to cover about 75% of the pod surface, giving a scabbed appearance. Soil samples were collected from the geocarposphere and rhizosphere. The samples were processed by the sieving and decanting technique, by suspending them in water, passing through 850 μm (20 mesh) and 38 μm (400 mesh) pore size nested sieves, and placing the residue from a 38 μm sieve on modified Baermann funnels (Schindler 1961). The nematodes extracted from the soil samples were identified and counted.

The population density of *T. brevilineatus* ranged between 350 and 600 nematodes 100-cm^{-3} soil; this was the predominant species. Other species present in the samples in low (<50 nematodes 100-cm^{-3} soil) to moderate (51–100 nematodes 100-cm^{-3} soil) numbers were: *Macroposthonia ornata, Pratylenchus brachyurus, Helicotylenchus* sp, *Ditylenchus* sp, and *Aphelenchoides* sp. Occurrence of this disease in Tamil Nadu is significant because this disease was hitherto thought to be endemic to Andhra Pradesh. The disease causes serious loss to groundnut production in the infested areas (Reddy et al. 1984). Extensive surveys of groundnut-producing regions of Tamil Nadu are suggested to assess the distribution and importance of this disease in the state. The disease was first observed in farmers' fields near the Kalahasti area in Andhra Pradesh and hence it was locally known as 'Kalahasti Malady'; however, a 'pod scab' is the most characteristic symptom of infection.

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Comparative Efficacy of Fungicides in Controlling Leaf Spots of Groundnut in India

S Gangopadhyay, J N Bhatia, and **S L Godara** (Department of Plant Pathology, Agricultural Research Station, Rajasthan Agricultural University, Karni Marg, Sri Ganganagar 335 001, Rajasthan, India)

Early and late leaf spots caused by *Cercospora arachidicola* Hori and *Cercosporidium personatum* (Berk and Curt) Deighton, are the most important foliar diseases of groundnut in India. Both leaf spots are endemically present in the groundnut-growing areas of Sri Ganganagar district of Rajasthan and cause considerable yield losses, particularly when they appear early in the season. Indi-

Table 1. Effect of fungicides on germination, early and late leaf spot intensity, and pod yield of groundnut, Rajasthan, India, 1989 and 1990 rainy seasons (pooled).

Fungicide	Dose (%) Seed treatment	Foliar spray	Germination (%)	Leaf spot intensity	Pod yield (t ha^{-1})
Carbendazim 50 WP					
Bavistin®	0.2	0.1	84.22 (67.73)[1]	9.33 (17.36)	2.79
J.K. Stein®	0.2	0.1	80.3 (63.89)	8.00 (16.20)	2.69
Derosal®	0.2	0.1	76.53 (61.18)	7.55 (15.51)	2.59
Thiophanate-methyl 70 WP Topsin-M®	0.2	0.1	84.18 (67.36)	11.11 (18.58)	2.79
Mancozeb 75 WP Dithane M-45®	0.2	0.2	76.4 (61.17)	46.67 (43.10)	2.35
Captafol 80 WP Foltaf®	0.2	0.2	85.41 (68.69)	48.45 (44.10)	2.25
Control	-	-	71.09 (57.58)	72.00 (59.91)	1.92
$CD_{0.05}$			(6.83)	(9.29)	0.695
SE			(±2.38)	(±3.28)	(±0.242)

1. Figures in parentheses are angular transformed values.

vidually, or in combination, the two diseases can cause more than 50% losses in yield (McDonald et al. 1985). The reduction in oil and protein content due to leaf spots has also been reported (Gupta et al. 1987). This paper reports the relative efficacy of selected fungicides against leaf spots of groundnut.

Field trials were conducted during the 1984 and 1990 rainy seasons on groundnut cultivar M 13 in a randomized block design with three replications. The plots were 4 m long and 3 m wide, with a row-to-row spacing of 40 cm. In 1989, this trial was conducted at two locations in Rajasthan—Agricultural Research Station, Sri Ganganagar, and Agricultural Research Substation, Hanumangarh. In 1991 it was carried out only at Sri Ganganagar. The crop was sown during the second fortnight of June in both the years. Six fungicides—three carbendazim formulations (Bavistin® 50 WP, J.K. Stein® 50 WP, and Derosal® 50 WP), and thiophanate-methyl (Topsin-M® 70 WP), mancozeb (Dithane M-45®, 75 WP), and captafol (Foltaf® 80 WP)—were used as seed treatments at the rate of 0.2% (w/w) on the proprietary formulation basis. Each fungicide was sprayed three times at 15-day intervals. The first spray was given after the appearance of the disease, followed by two sprays at intervals of 15 days. Disease incidence was recorded on five plants randomly selected from each plot 15 days after the last spray, following a 0–5 rating scale (Gupta 1985). Observations on germination percentage and pod yield were also recorded.

The pooled data of 2 years given in Table 1 indicate that seed germination was higher in fungicide-treated seed than in untreated seed (control). Maximum germination was observed in the Foltaf® treatment, closely followed by Bavistin® and Topsin-M®. The intensity of leaf spots was significantly lower in all the fungicide treatments than in the control. Although both early and late leaf spots occurred together, the latter was more predominant. In 1989, the disease appeared during the second week of August at both the locations, while in 1990, the initial appearance was recorded during the second week of September. The final disease intensity on the control was 94.67% and 66.67% at Hanumangarh and Sri Ganganagar during 1989, while it was 54.67% during the 1990 crop season. The three carbendazim formulations (Bavistin®, J.K.Stein®, and Derosal®) and Topsin-M® most effectively controlled the diseases. The average leaf spot intensity in these four fungicide treatments varied from 7.55 to 11.11% and did not differ significantly from each other. The Dithane M-45® and Foltaf® treatments were less effective in controlling leaf spots. The pod yield in the Bavistin® and Topsin-M® treated plots was significantly greater than in the control. The J.K.Stein® and Derosal® treated plots also had higher pod yields than that of the control, but the differences were not significant. Pod yields of these four treatments did not differ significantly from each other. These results seem to indicate that all carbendazim formulations and Topsin-M® can be used effectively to control early and late leaf spots in groundnut.

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Entomology

A First Report of *Alternaria longipes* on Groundnut from Tamil Nadu, India

G S Giri[1] and **K Murugesan**[2] (1. Plant Quarantine and Fumigation Station, Ministry of Agriculture, Government of India, Chennai Airport, Chennai 600 027, Tamil Nadu, India; and 2. Centre for Advanced Studies in Botany, University of Madras, Life Sciences Building, Guindy Campus, Chennai 600 025, Tamil Nadu, India)

During a field trip in the 1996 postrainy season near Melmaruvathur, Maduranthagam taluk, Chengai M G R district, Tamil Nadu, groundnut (*Arachis hypogaea* L.) leaf samples showing symptoms similar to those caused by *Alternaria alternata* (Fr.) Keissler were collected from a 110-day-old crop. The leaf samples showing lesions were surface sterilized in the laboratory with 0.1 w/v sodium hypochlorite and rinsed several times with sterile distilled water. They were kept under three layers of moistened blotter paper in 100 × 25 mm petri dishes covered with both the sides using the International Seed Testing Association (ISTA) method (Neergaard 1979) and incubated under room temperature (28±2°C) for 6–8 days. The spores produced were observed under a binocular microscope for identification.

The leaf symptoms appeared as small, chlorotic, water-soaked lesions on the leaf surface, with a light brown center and dark, irregular margins. The spots, most of which appeared near the veins and veinlets near the lesions, later turned necrotic. During the advanced stages of infection, these water-soaked, necrotic lesions coalesced to form the blighted appearance of the leaf. In mature lesions, sporulation occurred on the adaxial surface of the leaf. The spores did not correspond to those of *Alternaria alternata* (Fr.) Keissler. Subsequently, they were identified as spores of *Alternaria longipes* (Ellis and Everh) Mason (IMI no. W 5210, IMI no. 371015), by Dr J C David of the International Mycological Institute, UK. This pathogen is reported on the leaves of tobacco (*Nicotina tabacum*) where it causes brown spot symptoms. This is the first report of the occurrence of *A. longipes* on the leaves of groundnut. However, its pathogenicity needs to be proved in groundnut.

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Groundnut Genotype Reaction to *Helicoverpa armigera* in India

Ramesh Arora, Sukhwinder Kaur, and **Mohinder Singh** (Department of Plant Breeding, Punjab Agricultural University, Ludhiana 141 004, Punjab, India)

The pod borer, *Helicoverpa armigera* (Hübner) is one of the most important crop pests in India, where it damages more than 100 species of cultivated plants (Dhaliwal and Arora 1993). It has been reported as a significant pest of groundnut crops in Andhra Pradesh, Karnataka, and Gujarat (Reddy and Ghewande 1986). In Punjab, groundnut is usually sown in the rainy season, but with the release of the spanish bunch variety SG 84 in 1986, its cultivation in the summer season (sown after the wheat harvest) has become very popular with growers. It has good yield potential when sown as a spring-season crop after potato at the end of February or in early March. Some farmers have obtained yields of 2.5–3.0 t ha^{-1} from the spring-sown crop in Ludhiana district.

Data on the incidence of *H. armigera* and the percentage of plants with damaged foliage recorded in Punjab in

Table 1. Incidence of *Helicoverpa armigera* on some groundnut genotypes in Punjab, 1993.

	Number of eggs and larvae per meter row				Plants with leaflet damage (%)				Leaflet		
	Observation I		Observation II								
Genotype	Eggs	Larvae	Eggs	Larvae	Observation I	Observation II	Pod yield (t ha^{-1})	Main shoot height (cm)	Length (cm)	Width (cm)	Color[1]
RHRG 93	5.50	4.00	6.00	12.50	79.2	91.7	1.06	44.6	6.17	2.96	LG
DH 42	3.75	6.50	5.00	16.00	83.3	80.8	0.78	43.3	5.86	2.94	LG
ICBS 86143	3.25	3.00	4.50	6.75	75.0	50.0	2.08	27.7	5.16	2.43	G
JCGS 88-2	5.75	5.75	9.00	11.75	100.0	100.0	0.85	49.3	6.53	3.24	LG
PBNC 8	4.50	4.25	5.75	11.00	87.5	80.8	0.90	34.2	5.71	2.97	LG
PBNG 18	4.25	6.25	5.75	7.25	87.5	65.4	0.98	38.6	5.79	3.14	LG
PBNG 26	3.75	6.00	5.50	12.00	95.0	95.8	1.04	36.7	5.94	2.95	LG
TG 27(B)	4.00	1.50	4.50	10.25	54.2	62.5	2.20	13.8	4.46	1.98	LG
SB XI	5.00	4.25	7.25	13.25	87.5	73.3	1.10	38.6	6.21	3.21	LG
ICGS 1	4.25	2.75	6.25	11.50	87.5	70.8	1.71	25.3	5.45	2.55	LG
ICGS 76	5.00	3.00	7.00	8.25	70.8	58.3	2.00	24.4	4.87	2.37	LG
SG 84	3.25	3.75	4.50	9.25	79.2	65.8	1.77	25.9	4.91	2.48	LG
CD (P<0.05)	NS	NS	NS	NS	12.9	27.0	0.32				

1. LG = light green; G = green.

1993 are presented in Table 1. Most of the larvae recorded during the first observation (27 May 1993) were in the early (1st or 2nd) instar stage with a few in the middle (3rd or 4th) instar stages. No late (5th or 6th) instar larvae were found. Initial instars fed on or near the growing shoot terminals by scraping the surface of the leaflets or the terminal area itself. Some of the middle instar larvae were found feeding on reproductive organs inside groundnut flowers. The differences among the entries in the number of eggs and larvae of *H. armigera* per meter of row length were not significant. However, there were significant differences between trial entries in the percentages of damaged plants. TG 27(E), that had the smallest main shoot of all the trial entries and dark green leaflets, showed the least damage (54.2%) while all the plants of JCGS 88-2, that has large, light green leaflets and main shoots, were damaged. It needs to be emphasized here that defoliation symptoms were due to the combined attack of all the defoliating pests that attack the crop but mainly *H. armigera*. Some of the plants showed the typical symptoms to attack by the leaf webber (*Anarsia epippias* Meyrick) even though no larvae of that pest were recorded at the time of observation.

Another observation recorded 9 days later (5 Jun 96) revealed no significant differences in the incidence of *H. armigera* where late-instar larvae were found feeding in the middle portion of the plants. The differences in the percentage of plants with damaged leaflets were again significant. ICSS 86143 was the least damaged (50.0%) but was on par with ICGS 76 (58.3%), TG 27(E) (62.5%), PBNG 18 (65.4%), SG 84 (65.8%), ICGS 1 (70.8%), and SB XI (73.3%). With the exception of PBNG 18, all the above varieties recorded significantly higher pod yields, ranging from 46% (SB XI) to 194% (TG 27)(E) than the most susceptible variety JCGS 88-2 (Table 1). In general, genotypes with short main shoots and dark green, comparatively smaller leaflets were found to be less damaged (e.g., TG 27(E), ICGS 76, ICBS 86413, ICGS 1, SG 84) than those with longer main shoots and larger, light green leaflets.

None of the entries, appeared to have a high degree of resistance to *H. armigera*. A similar but milder attack of *H. armigera* was recorded on the 1991 spring crop of groundnut in the Punjab where *H. armigera* has probably established itself as a regular pest of spring groundnut. Moreover, this crop is likely to help in the carry over of the pest during the peak summer months of May-June, that usually represent a lean period in pest production dynamics. This may ultimately result in higher incidences of the pest on rainy-season crops, particularly cotton, and it could be one of the reasons for the increasing outbreaks of *H. armigera* in the state during the last few years.

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Appropriate Time to Control Jassids (*Balclutha hortensis*) in Groundnut

B Subbarayudu (National Research Centre for Groundnut, I V Nagar Road, PB no. 5, Junagadh 362 005, Gujarat, India. Present address: Indian Lac Research Institute, Namkum, Ranchi 834 010, Bihar, India)

Of the various oilseed crops, groundnut (*Arachis hypogaea* L.) alone accounts for 45% of the oilseeds area and 55% of the total oilseed production in India. The jassid (*Balclutha hortensis* Pruthi) is a key insect pest of groundnut, and plays a significant role in limiting the crop yield. Feeding by the jassid causes yellowing of foliage, beginning at the top of the leaflet and spreading to other portions (V-shaped symptoms). Jassid injury is serious in Gujarat and in Tamil Nadu (Ghewande et al. 1987). Although jassid sampling on groundnut is being carried out by the sweep net method (Nandgopal 1991), no information is available on the appropriate time for sample collection. An experiment was conducted in the 1993 rainy season to determine the period of peak activity of this pest. This information will be useful in planning a successful pest management program.

The experiment was laid out at the farm attached to the National Research Centre for Groundnut, Junagadh, Gujarat. Groundnut (cv X 17-20) was sown with 45 cm interrow spacing and 10 cm intrarow spacing on 30 Sep 1993. Random samples of adult jassids and their eggs were collected five times at monthly intervals during the crop period. For comparison, adult jassid numbers were recorded for three and five sweep nets, and number of eggs per 10 and 20 leaves. The leaves were taken at random from the top, middle, and lower portions of the plant. The data were subjected to the 't' test (Table 1).

Except for the fifth sampling, the differences between five and three sweep nets were nonsignificant for adult jassid numbers. However, for the mean number of jassid eggs, the differences between 20 and 10 leaves were significant for all samplings except the third. In the fourth sampling, the mean population of adult jassids and their eggs was significantly higher than in the other samplings. The age of the crop was about 4 months at this stage. According to the above study, the sampling should be done around the fourth month after sowing, when the attack of the pest is likely to be at its maximum.

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Table 1. Mean number of jassid adults and eggs on groundnut during the 1993 rainy season, Junagadh, Gujarat, India.

	Mean number of adult jassids			Mean number of jassid eggs		
Sampling	5 sweep nets	3 sweep nets	t value[1]	20 leaves	10 leaves	t value[1]
1	16.2	10.2	3.6	6.2	2.2	5.5*
2	43.9	21.6	4.9	6.8	6.0	3.1*
3	21.7	7.6	6.7	7.4	3.3	5.7
4	65.3	52.2	2.5	11.8	2.7	11.2*
5	23.6	6.5	–7.5*	4.3	4.4	–0.3*

1. 't' calculated at 19 d.f. * indicates the 't' value significant at 5% level.

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Efficacy of Plant Extracts Against Tobacco Caterpillar Larvae in Groundnut

K Sahayaraj and **R Sekar** (Department of Botany, St. Joseph's College, Tiruchirapally 620 002, Tamil Nadu, India)

Utilization of naturally available plant products in an integrated pest management (IPM) system will be of great benefit to farmers in reducing large-scale use of highly toxic chemicals, and also the money spent on it. Laboratory and field experiments have shown that neem-based insecticides, azadirachtin (Koul 1985, Rao and Subramanian 1987) and margoside CK (AICORPO 1990), reduced *Spodoptera litura* Fabricius growth, and its damage on foliage in groundnut resulting in higher pod yields. Plant extracts from *Vitex negundo* Linn. and *Stachytarpheta urticifolia* (Salish) Sims. were also found to cause mortality to the third-instar larvae of *S. litura* in castor (Subadra Bai and Kandasamy 1985). The present study was undertaken to generate information on the control of *S. litura* with various plant products.

The leaves of *Azadiracta indica* A. Juss and *Vitex negundo* Linn., rind of *Citrus sinensis*, and rhizome of *Zingiber officinale* (10 g of each) were macerated individually in an all-glass mortar and pestle and extracted with small quantities of hot distilled water. The extract was passed through a muslin cloth and the final volume made up to 100 mL to get 10% extracts. Groundnut leaves were dipped in the different extracts to soak them thoroughly, and shade-dried for 15 min. The shoot ends were kept immersed in water to prevent the leaves from wilting. Ten last-instar *S. litura* larvae of uniform age and size were allowed to feed on these leaves for 24 h. The treatments were replicated thrice. After 24 h the larvae were removed from the treated leaves and released into plastic troughs containing nontreated fresh groundnut leaves. Mortality was recorded every 24 h for a period of 4 days. After 96 h the larvae mortality was the highest in *C. sinesis* treated leaves (90%) followed by *V. negundo* (83%), *A. indica* (80%), and *Z. officinale* (70%). Detailed experiments are necessary to confirm the findings and make use of these products for large-scale field application.

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Nematode Problems of Groundnut and their Management in Gujarat, India

B A Patel[1], **D J Patel**[1], **S B Sharma**[2], **H V Patel**[1], and **S K Patel**[1] (1. Department of Nematology, Gujarat Agricultural University, Anand, Gujarat, India; 2. Crop Protection Division, ICRISAT Asia Region, Patancheru 502 324, Andhra Pradesh, India)

In Gujarat state of India, groundnut is widely cultivated as a rainy-season crop in the Saurashtra region, and to some extent in the Sabarkantha, Banaskantha, and Panchmahals districts. It is grown as a summer crop in the Kaira and Vadodara districts. Diseases caused by nematodes significantly affect groundnut production. This report highlights the status of nematode problems of groundnut and options for their management in Gujarat.

The root-knot nematode, *Meloidogyne arenaria* is widely distributed in the groundnut-growing areas in Supedi, Sanala, Kathrota, Upleta, and Patanvav regions in Rajkot district, and Khadia and Dhoraji in Junagadh district of the Saurashtra region. *Meloidogyne javanica* infests groundnut fields in the Khalvada, Telnar, Betawada, Lalpur, Pariana Muvada, and Narsipur regions of Napadvanj mandal of Kaira district. A pathotype of *M. javanica* which reproduces on groundnut and produces severe galls is present in the Kapadvanj area (Patel et al. 1993). Root-knot nematode affected fields show stunting, reduced number of branches and internodes, burning of leaf margins, reduced leaf size, and yellowing of foliage. Other widespread pathogenic nematodes in groundnut fields are *Tylenchorhynchus mashhoodi, Pratylenchus coffeae, Rotylenchulus reniformis* and *Helicotylenchus* spp, but their importance as production constraints is not known.

Work done at the Gujarat Agricultural University indicates that the damage thresholds of *Meloidogyne* spp are 0.1–1.0 juveniles cm^{-3} soil at the time of sowing. Yield losses range between 10 and 23% due to *M. javanica*, and 13–50% due to *M. arenaria*. Application of carbofuran @ 2 kg ha^{-1} in *M. arenaria* or *M. javanica* infested soils reduces the root-knot disease by 16–96% and increases the pod yields by 15–53%. Carbofuran is more effective than phorate and phenamiphos. The presence of *M. arenaria* along with *Fusarium solani* advances wilting of groundnut plants (Patel et al. 1985), and reduces the number of *Rhizobium* nodules (Patel 1983). Seed treatments with 3–6% aldicarb sulfone or 6% carbofuran reduce *M. arenaria* damage (Patel et al. 1986). Organic cakes of castor, mustard, and neem (1000 kg ha^{-1} and above) significantly reduce the root-knot disease and increase pod and haulm yields; neem cake is most effective. Groundnut seed soaked for 12 h in phenamiphos, monocrotophos, phosalone or oxamyl (each @ 125, 250, and 500 ppm) inhibits the penetration of *M. arenaria* larvae into groundnut roots and increases the plant biomass. Phenamiphos @ 125 and 250 ppm is highly effective.

More than 1200 groundnut lines have been screened against root-knot nematodes in Gujarat and resistant sources have been identified (Table 1). These promising sources require further testing for confirmation of resistance before they can be used in breeding programs.

It is evident that root-knot nematodes are important constraints to groundnut production in Gujarat. Farmers and policy makers are not sufficiently aware of this problem in the state, and consequently the options available for nematode management are not commonly used. Awareness programs such as multilocational demonstrations of the advantages of nematode management, and guidance to farmers and extension staff with the help of radio, television, and videocassettes are needed.

Table 1. Groundnut lines identified as resistant to *Meloidogyne arenaria* or to *M. javanica* pathotype 2 in Gujarat, India.

	Groundnut line	
Species	Highly resistant	Resistant
Meloidogyne arenaria	None	A3, Abuarbaa, Ah 25, Ah 3328, Ah 4515, Ah 6902, Ah 6719, Ah 7188, Ah 7299, Ak 10-2, 55-437, C 83, C 149, EC 24118, Kigung, Khargaon 3, NC Ac 50.
Meloidogyne javanica	ICG 5341, ICG 6330	Apexy, B 1, C 162, C 166, Dangi, EC 85994, ICGs 411, 852, 859, 1268, 2248, 2496, 3053, 3104, 6323, 6826, 10047, JH 223, KG 61-22, PI 268594, PI 270787, S 7-2-1, S 7-24-3, U 4-7-3, No 923, No 523.

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Physiology

Growth and Partitioning Efficiency of Late Leaf Spot Resistant Genotypes

A G Patil, M V C Gowda, and B N Motagi
(Department of Genetics and Plant Breeding, University of Agricultural Sciences, Dharwad 580 005, Karnataka, India)

Late leaf spot caused by *Phaeoisariopsis personata* (Berk. and Curt.) is a major foliar disease of groundnut worldwide. The disease occurs regularly and can cause more than 50% loss in pod and haulm yields in the traditional tract of Karnataka, India (Hegde et al. 1995a). The disease can be controlled effectively by certain fungicides, but these are expensive and often not available. Cultivation of resistant varieties is therefore considered the best strategy. The available resistant germplasm is generally longer in duration compared with cultivated varieties. Limited crop growth period and a need for double cropping during the rainy season make them unsuitable for direct utilization (Hegde et al. 1995b). However, recently, an induced mutant combining high levels of resistance to late leaf spot, early maturity, high yield, and desirable pod and seed features has been identified (Patil et al. 1995). Late leaf spot resistance in groundnut is expressed either by resistance in initial infection, or reduction in the rate of disease development, or enhanced leaf production to compensate for leaf spot induced defoliation (Pixely et al. 1990).

The present study was conducted at the University of Agricultural Sciences, Dharwad, during the 1995 rainy season. Six selected genotypes—mutant 1-45, resistant germplasm (PI 259747, GBFDS 272, and VG 101), and susceptible controls (K 134 and JL 24)—were evaluated for growth and partitioning of dry matter to pods under unprotected conditions.

Each genotype was sown in six rows of 2.25 m length, with an interrow spacing of 30 cm and an intrarow spacing of 10 cm, with two replications. Disease development in each genotype was assessed at 80, 90, and 100 days after sowing (DAS), based on the remaining green leaf area (RGLA), calculated as a percentage using the standard area diagram (Hassan and Beute 1977). Leaf area index (LAI) was calculated according to Pixely et al. (1990) at 80, 90, and 100 DAS. The partitioning factor was computed for each genotype according to Duncan et al. (1978). Days to maturity and pod yield plant^{-1} were also recorded.

The susceptible controls were characterized by early maturity and higher rates of partitioning, but suffered severely due to disease leading to significant reduction in LAI over time (Table 1). As expected, resistant germplasm showed high levels of resistance and maintained higher LAI, but was characterized by late maturity and lower partitioning of assimilates to pods due to prolonged foliage growth. The association of resistance with late maturity in resistant genotypes was also reported by Knauft and Gorbet (1990) and Pixely et al. (1990). Mutant 1-45 combined favorable characters of both susceptible and resistant controls. It exhibited a high level of resistance as measured by RGLA, and maintained very high LAI even at harvest, besides maturing early with high rates of partitioning of daily assimilates to pods. This

Table 1. Growth and partitioning of selected genotypes under disease resistance to late leaf spot, growth, and productivity.

Genotype	Remaining green leaf area plant^{-1} (%)			Leaf area index			Partitioning factor (%)	Days to maturity	Pod yield plant^{-1} (g)
	80	90	100	80	90	100			
Mutant 1-45	80.1	75.1	75.4	3.6	3.1	3.3	68.2	103	14.8
JL 24	65.2	45.8	26.9	3.5	1.3	0.8	74.1	102	12.2
K 134	64.2	49.4	32.3	3.3	2.7	0.9	65.5	102	12.3
VG 101	57.9	48.2	35.4	2.9	1.8	1.6	46.0	112	13.1
PI 259747	72.7	60.6	63.8	4.3	2.9	2.2	48.6	112	17.0
GBFDS 272	80.4	65.6	57.8	3.6	2.2	2.3	41.6	125	18.7
Mean	70.1	57.5	48.0	3.5	2.3	1.8	57.3	–	14.7
SE	±0.5	±5.2	±0.6	±0.1	±0.1	±0.1	±2.2	±0.5	
$CD_{0.05}$	1.7	4.7	2.0	0.3	0.6	0.4	7.1	–	1.6
CV (%)	1.4	4.4	2.1	5.3	12.1	8.9	8.2	–	

indicates a possibility of combining late leaf spot resistance and desirable physiological growth attributes. Results showed that mutant 1-45 can be used effectively in breeding early-maturing and late leaf spot resistant varieties.

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Combining Ability for Nitrogen Nutrition in Erect Bunch Groundnut

D H Sukanya[1] and **M V C Gowda**[2] (1. Department of Genetics and Plant Breeding, University of Agricultural Sciences, Bangalore 560 065, Karnataka, India; and 2. Department of Genetics and Plant Breeding, University of Agricultural Sciences, Dharwad 580 005, Karnataka, India)

Productivity of erect bunch groundnut of subspecies *fastigiata* is often limited by nitrogen deficiency (Cox et al. 1982). However, considerable variation exists in the germplasm for biological nitrogen fixation (Nambiar et al. 1982) and response to applied nitrogen (Sukanya et al. 1995). Since groundnut is predominantly a self-fertilizing species with virtually no scope for commercial exploitation of hybrid vigor, the mopping up of the additive genetic variance is of major interest to breeders. The common approach of selecting parents on the basis of per se performance does not necessarily lead to the best results. The present investigation assesses the general combining ability (GCA) of 11 selected genotypes vis-a-vis their performance under two nitrogen levels.

The material included 9 diverse erect bunch genotypes selected by screening 97 germplasm lines under two levels of applied nitrogen: 0 kg ha^{-1} (N_0) and 225 kg ha^{-1} (N_1). While the genotypes Mani Blanco and S 206 were poor performers, EC 21032 and No. 276 showed superior performance at both nitrogen levels. Other genotypes were superior either at N_0 (Spanish 191-1, Short 1, and US 1) or N_1 (RS 113 and U 1-2-3) levels. A popular Indian variety, JL 24, and a high nitrogen fixing virginia (ssp *hypogaea*) genotype, NC Ac 2821, were also included. Forty-four crosses were produced following a partial diallel mating design (Kempthorne and Curnow 1961), with eight sample crosses per parent. The parents and F_1s were grown in a randomized block design with two replications separately with two levels of nitrogen. The experiment was conducted in sandy loam soil with pH 5.4 and EC 0.20 ds m^{-1}. The soil was low in available nitrogen (162 kg ha^{-1}), high in P_2O_5 (56 kg ha^{-1}), and moderate in potash (172 kg ha^{-1}). Each entry was grown in 5 rows of 2 m length, with an interrow spacing of 60 cm, and intrarow spacing of 20 cm. All recommended agronomic practices were followed during the entire cropping season. Three competitive plants were sampled in each plot to record observations. Total biomass (TDW) was obtained by adding dry root, stem, leaf, nodule, and pod masses. Similarly total nitrogen content (TNC) was obtained by adding the nitrogen content of root, leaf, shell, and seed at harvest. Nitrogen was estimated by the Kjeldahl method. Productivity was assessed through dry pod yield (PY).

The analysis of variance revealed the existence of substantial variability among parents and crosses for TDW, TNC, and PY. Mean squares due to general combining ability (GCA) and specific combining ability (SCA) were also significant indicating contribution of both additive and nonadditive effects. Parents No. 276, JL 24, EC 21032, and Short 1 were found to be good combiners for all the characters at both the nitrogen levels (Table 1). The per se performance of parents revealed that these good combiners, except Short 1, were superior under

Table 1. Mean values and general combining ability (GCA) effects of parents for different characters under two levels[1] of applied nitrogen.

	N_0						N_1					
	TDW[2] (g)		TNC (mg)		PY (g)		TDW (g)		TNC (mg)		PY (g)	
Parent	GCA	$\overline{X}$	GCA	$\overline{X}$	GCA	$\overline{X}$	GCA	$\overline{X}$	GCA	$\overline{X}$	GCA	$\overline{X}$
Mani Blanco	-14.0	76.5	-406.1	1754.8	-5.1	30.9	-0.04	79.7	-187.9	1920.3	-2.5	30.9
S 206	-11.2	79.3	-280.8	1445.7	-6.2	28.7	-21.9	71.0	-616.5	1455.7	-8.4	30.1
Spanish 191-1	0.9	74.3	68.8	1723.2	-0.5	32.0	-1.3	90.6	105.8	2091.6	0.7	37.5
Short 1	5.1	74.4	132.1	1891.8	1.8	32.6	13.5	94.8	251.1	2353.6	9.1	38.2
US 1	-1.7	75.6	-10.7	1719.0	2.2	30.8	-7.5	90.8	-170.8	1893.6	-3.1	37.3
RS 113	-3.8	89.4	-146.9	1985.1	-2.2	36.4	-3.4	76.2	14.1	1765.6	-1.6	28.9
U 1-2-3	-1.1	94.9	-20.3	2282.0	-0.2	38.0	-1.8	75.1	-37.0	1809.7	-1.4	29.0
EC 21032	10.2	100.3	107.8	2342.9	1.9	40.1	13.0	94.8	361.3	2145.2	3.5	39.5
No. 276	12.0	95.3	338.8	2030.2	5.8	40.2	1.6	86.6	52.0	1865.5	0.6	35.1
JL 24	5.8	93.5	271.7	2248.1	2.8	39.6	2.9	97.4	114.7	2623.6	2.4	42.8
NC Ac 2821	-2.1	95.9	-54.5	2384.7	-0.4	39.7	5.1	92.5	13.7	2685.3	0.8	43.2
SE	±9.7	±5.0	±262.8	±96.4	±4.3	±2.2	±9.6	±2.8	±26.3	±70.4	±5.8	±1.4
$CD_{0.05}$	19.6	15.9	530.1	303.7	8.7	6.8	19.3	8.8	529.7	222.0	11.1	4.4

1. N_0: zero applied N; N_1: 225 kg applied N ha^{-1}.
2. TDW: total biomass; TNC: total nitrogen content; PY: pod yield; $\overline{X}$: per se performance of the parent.

both the levels of nitrogen. The performance of genotypes under low soil N and applied N often reflects their nitrogen fixation potential and nitrogen utilization capacity (Mytton 1976), thus indicating the importance of both the criteria in selecting parents for hybridization. Though, in the present study, Short 1 showed poor N fixation and pod yield at low N, it was earlier shown to be highly responsive to applied N besides maintaining N fixation at high soil N (Sukanya et al. 1995). A high nitrogen fixer, NC Ac 2821, which is also superior at both the N levels, turned out to be a poor combiner especially under N_0. This genotype was earlier reported to be a good combiner (Nigam et al. 1985). The good combiners identified in this study could be useful parents for generating superior segregating material for further improvement.

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Most Probable Number Counts of Groundnut Rhizobia in Some Soils of Bangladesh

A K Podder[1], M A Sattar[1], and S K A Danso[2]
(1. Bangladesh Institute of Nuclear Agriculture, PO Box no. 4, Mymensingh 2200, Bangladesh; 2. International Atomic Energy Agency, Wagramerstrasse 5, PO Box 100, A 1400 Vienna, Austria)

Groundnut (*Arachis hypogaea* L.) is an important oilseed crop in Bangladesh occupying an area of about 20 000 ha. It covers 7% of the total area under oil crops and contributes nearly 9% of the total oilseed production (Gowda and Kaul 1982). In order to grow a legume successfully, it is necessary to have the relevant rhizobia in the soil. In certain soils, particularly of the tropical and subtropical regions, it is difficult for rhizobia/bradyrhizobia to survive because of unfavorable environmental conditions. The estimation of the number and distribution of rhizobia in soil is useful in predicting the likely response to rhizobial inoculation (Brockwell et al. 1988). The objective of this experiment was to assess the distribution of groundnut rhizobia in some soils of Bangladesh, and also the effect of soil depth and season.

Composite soil samples were collected from seven locations—Gangetic alluvium, Brahmaputra alluvium, Teesta silt, Barind tract, Madhupur tract, Saline tract, and Hill tract—at depths of 0–15 and 15–30 cm in the months of Jan/Feb, May/Jun and Sep/Oct. Physical and chemical analysis of soil (Table 1) were carried out by standard methods. To estimate the most probable number (MPN) of groundnut rhizobia, the serial (five-fold) dilution plant infection technique was followed using the groundnut cultivar Dhaka 1 as a trap-host.

The MPN count tended to be high in the Gangetic and Brahmaputra alluvium soils, intermediate in the Teesta silt, Hilly tract, Barind tract, and Madhupur tract, and consistently very low in the Saline tract (Table 2). Wilson (1930) reported that the number of rhizobia in field soils varied depending on soil type, crop cultivation, fertilizer application, cropping history, exchangeable calcium, soil reaction, etc. In soils of the semi-arid tropics, Kumar Rao and Dart (1981) made similar observations. They reported that Alfisols contained more rhizobia than Vertisols. On the other hand, it has been reported that *Rhizobium* was stimulated to a greater extent in the rhizosphere of legumes than in the rhizosphere of a nonlegume.

The MPN count was higher in the topsoils (0–15 cm) and relatively low in subsurface soils (depth 15–30 cm) (data not presented). The population density of groundnut

Table 1. Physical and chemical properties of soils (0–30 cm depth) collected from seven locations in Bangladesh.

Soil tract	Total nitrogen (%)	Organic carbon (%)	Carbon/ nitrogen ratio	Available phos- phorus (ppm)	Ex- change- able po- tassium (meq%)	Cation exchange capacity (meq%)	Ex- change- able calcium (meq%)	pH (water)	Texture
Gangetic alluvium	0.062	0.70	11.29	6.6	0.43	30.4	27.7	7.4	Clay loam
Brahmaputra alluvium	0.071	0.60	8.45	8.4	0.07	12.3	8.3	6.8	Loam
Teesta silt	0.072	0.57	7.91	11.4	0.35	11.3	2.0	6.7	Clay loam
Barind tract	0.053	0.33	6.22	5.9	0.34	12.6	7.3	6.8	Sandy clay loam
Madhupur tract	0.065	0.76	11.69	6.3	0.19	13.1	2.8	5.4	Sandy clay loam
Saline tract	0.050	0.50	10.00	10.4	0.55	16.2	6.3	7.9	Clay loam
Hill tract	0.101	0.78	7.72	11.0	0.08	8.4	1.1	5.9	Sandy clay loam

Table 2. Most probable number (MPN) counts of groundnut rhizobia in the 0–15 cm soil horizon collected from seven tracts in three different seasons in Bangladesh.

Soil tract	Season Jan/ Feb	May/ Jun	Sep/ Oct	Mean
Gangetic alluvium	8146	11295	6788	8743
Brahmaputra alluvium	31046	43448	25450	33314
Teesta silt	3065	3923	2097	3028
Barind tract	429	622	210	420
Madhupur tract	258	184	184	208
Saline tract	48	24	34	35
Hill tract	800	1178	817	931
Mean	6256	8667	5082	-

SE: Month (M) = 436.8; soil tract (S) = 667.2; M × S = 1155.7.

rhizobia in the subsoil was remarkably high (17 939 g^{-1} soil) in the Brahmaputra alluvium in the month of May/Jun. The density fell sharply with Gangetic alluvium (5089 g^{-1} soil), and drastically with Teesta silt (1322), Hill tract (434), and Madhupur tract (68). The Saline tract contained the lowest number (6) of groundnut rhizobia.

There was a wide variation in the groundnut rhizobial count depending on soil tract and season. This could be due to the variation in soil properties, agroecological differentiation, and cropping history. Chatel and Parker (1973) observed that the population of rhizobia increased during the growing season and then declined. In 1984, Pandher et al. also reported that the rhizobial population in soil varied with type of soil and cropping pattern. Response to *Rhizobium* inoculation can be expected in soils where the native rhizobial populations are low (e.g., Saline tract).

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Variation in Canopy Apparent Photosynthesis in Groundnut

Jinmin Fu, Yongshan Wan, Fang Su, Gengling Zhang (Agronomy Department, Shandong Agricultural University, Taian, Shandong Province 271018, China)

Experiments with two groundnut (*Arachis hypogaea* L.) cultivars Haihua 1 and Luhua 11 were conducted with three replications on the experimental farm of Shandong Agricultural University in 1994. The entries were sown on 17 May 1994. On clear days during the groundnut growing season, the canopy apparent photosynthetic rate (CAP) was directly measured according to Garrity et al. (1984), using a GGD–07 infrared CO_2 analyzer. It was observed that the leaf area index (LAI), CAP, and canopy respiratory rate (CRR) peaked at 82, 90, and 90–95 days after sowing (DAS). LAI was closely related to CAP before 82 DAS, and not later. LAI and CRR increased at a similar rate before 50 DAS. From 50 to 82 DAS, LAI increased faster than CRR. From 82 to 98 DAS, LAI declined gradually and CRR increased rapidly; later, both LAI and CRR dropped simultaneously.

Three kinds of relationships existed between CAP and CRR—increasing before 50 DAS, decreasing after 98 DAS, and not regular from 50 to 98 DAS. At all stages, CRR varied in a single-peak curve in a day. However, at the seedling stage, CAP in Haihua 1 changed in a double-peak curve in a day, and in Luhua 11 in a slanting-peak curve. After 50 DAS, CAP in both cultivars varied in a single curve, with its maximum value at 1200, and negative value before 0600–0700 and after 1730–1900 in a day.

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Production and Management

Effect of Sowing Pattern and Tillage System on Groundnut Grown after Lowland Rice in Indonesia

T Adisarwanto (Research Institute for Legume and Tuber Crops, RILET, PO Box 66, Malang, Indonesia)

In Indonesia, 35% of the groundnut crop is grown in lowland rice fields in rice-rice-groundnut, or rice-groundnut-other legume cropping systems.

At present most farmers dibble groundnut seeds using a wooden stick at irregular spacings resulting in varying populations of 265 000–275 000 plants ha^{-1}). The productivity of these groundnut crops ranges from 0.7 to 2 t ha^{-1}.

Previous experiments have shown that in light soils combinations of no tillage and rice stubble as mulch (Suyamto et al. 1989), no tillage and hilling-up (Saleh et al. 1993), and tillage before sowing (Adisarwanto 1992) result in increased pod yields.

A field experiment was conducted in an Associate Latosol-Regosol soil during the dry season from Jul to Oct 1994 to determine an optimum sowing pattern and tillage system for groundnut grown after lowland rice. The following sowing patterns were included in the trial:

a. single rows spaced at 20 cm, with 20 cm plant-to-plant spacing within a row.
b. single rows spaced at 40 cm, with 10 cm plant-to-plant spacing within a row.
c. double rows with 20 cm interrow and intrarow spacings, each pair 40 cm apart, and
d. triple rows with 20 cm interrow and intrarow spacings, each triplet 40 cm apart.

Table 1. Effect of sowing pattern and tillage system on performance of groundnut in rice fallows, Indonesia.

Treatment	Plant height (cm)	Number of pods plant^{-1}		100-seed mass (g)	Pod yield (t ha^{-1})	Biomass yield (t ha^{-1})	Harvest index (%)
		Full	Empty				
Sowing pattern							
a. Single row (20 × 20 cm)	39.7[a,1]	12.1	1.2	60.3	2.98[a]	17.8	24.8[a]
b. Single row (40 × 10 cm)	38.3[a]	12.2	1.6	61.3	2.29[b]	15.7	22.7[ab]
c. Double rows	35.2[b]	13.0	1.5	61.9	2.24[b]	15.9	21.8[b]
d. Triple rows	37.1[b]	12.6	1.6	59.5	2.13[b]	16.2	20.9b
LSD (P<0.01)	3.09	ns[2]	ns	ns	0.53	ns	2.96
CV (%)	7.83	18.57	57.17	15.23	13.56	8.98	
Tillage							
Strip	37.8	12.6	1.5	61.1	2.37	15.6	23.3
Complete	37.4	12.4	1.6	60.4	2.46	17.3	21.8
LSD (P<0.01)	ns	ns	ns	ns	ns	ns	ns
CV (%)	7.83	18.57	57.17	5.24	15.23	13.56	0.98

1. Means in the same column bearing an identical letter do not differ significantly (P<0.01).
2. ns = nonsignificant.

Two tillage systems, strip tillage (in strips only along the sowing rows) and complete tillage (full tillage of the whole field) were also included in the trial.

The results showed that strip tillage was not significantly different from complete tillage for pod yield and yield components (Table 1). Strip tillage is a less expensive method of land preparation than complete tillage in lowland rice fields. Plants in single rows with 20 × 20 cm spacings had better plant heights, pod yields, and harvest index than those grown in other patterns (Table 1). The data indicate that on medium soil types groundnut grown after lowland rice, strip tillage, and dibbling seed at regular plant spacings of 20 × 20 cm would maximize groundnut pod yields. These results need further confirmation as they are based on a single year's data. Further tillage × sowing pattern interactions also need to be studied.

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Comparison of an Improved Package with Farmers' Groundnut Production Practices in Southern Vietnam

Nguyen Thi Lien Hoa, Nguyen Bao Cuong, and **Phan Lieu** (Oil Plant Institute of Vietnam, 171-175 Ham Nghi Street, Ho Chi Minh City, Vietnam)

Among the annual oilseed crops in Vietnam, groundnut is the most important with an area of about 0.25 million ha in 1995. The demand for groundnut is on the increase because of oil extraction and export requirements. The eastern region of southern Vietnam has the largest groundnut area in the country; however, the average yields of groundnut are low in this region because of the following factors (Phan Lieu et al. 1996):

- Lack of high-yielding and agronomically suitable varieties for different regions: farmers mostly use mixed local varieties such as LY, Giay, Moket. These varieties have deteriorated over time due to lack of proper seed maintenance.
- Lack of appropriate production technology: farmers are habituated to use coconut shell ash (1.5–3.0 t ha^{-1}) with inorganic fertilizers. The use of coconut shell ash increases the cost of production.
- Lack of effective insect pest and disease management technology: farmers often try to control insect pests and diseases with chemicals at periodic intervals by giving 5–10 sprays for a 90-day crop.

With the results obtained from varietal, nutrition, and plant protection studies, a high-yield package of production technology was developed and evaluated on large areas in comparison with farmers' practices in Trang Bang and Cu Chi districts during the 1993/94 and 1994/95 winter-spring seasons. In this model, we used the improved variety LY (VD 1), fertilizers as an alternate to coconut shell ash (artificial coconut shell ash, ACA), and fungicide for seed treatment and control of early and late leaf spots.

At the time of harvest, with the assistance of Ho Chi Minh City and Tay Ninh province authorities, we organized Farmers' Days right on the field, and invited experienced farmers to evaluate the efficiency of the package. On an average, the improved package gave 25% higher pod yield than the farmers' package (2310 kg ha^{-1}). The average shelling turnover and sound mature seed were relatively greater in the variety VD 1 than in the mixed local varieties at four locations (Table 1). Economic anal-

Table 1. A comparison of the improved package with the farmers' package of groundnut production, southern Vietnam.

Production package	Location	Area (m^2)	Pod yield (kg ha^{-1})	Shelling turnover (%)	Sound mature seed (%)
Improved	Cu Chi 1	550	2950	76.3	97.6
	Cu Chi 2	500	2760	76.7	89.4
	Cu Chi 3	500	2910	77.3	89.1
	Trang Bang	1150	2950	79.6	97.4
Average			2890	77.5	93.4
Farmers'	Cu Chi 1	550	2410	76.2	96.8
	Cu Chi 2	500	2380	74.7	84.3
	Cu Chi 3	500	2450	74.3	86.4
	Trang Bang	950	1980	78.2	97.0
Average			2310	75.9	91.1

Table 2. Average input costs (Vietnam Dong, VND[1]) in the improved package of practices compared with the farmers' package for 1 ha of groundnut cultivation, southern Vietnam.

Input	Improved package		Farmers' package	
Land preparation	489 500	(8%)[2]	489 500	(7%)[2]
Seed and sowing	1 136 000	(19%)	1 274 500	(19%)
Fertilizers	1 313 575	(22%)	2 015 625	(31%)
Plant protection (insecticides, fungicides)	883 650	(15%)	887 300	(13%)
Weeding	599 875	.(10%)	589 875	(9%)
Irrigation	338 250	(6%)	338 250	(6%)
Harvesting	1 167 063	(20%)	1 004 263	(15%)
Total	5 927 913		6 599 313	

1. Vietnam Dong (1 US$ = 11 000 VND).
2. Percentage of total input cost.

ysis of the production package showed that the input cost was 10% less in the improved package than in the farmers' package (Table 2). The fertilizer cost was 31% of the total input cost in the farmers' package where coconut shell ash was used, compared with 22% in the improved package where coconut shell ash was replaced with the alternate mixture of fertilizers. The production cost of 1 kg groundnut was reduced by 29% with the improved package (pod yield 2890 kg ha^{-1}; input cost VND 5 927 913) compared with the farmers' package (pod yield 2310 kg ha^{-1}; input cost VND 6 599 313) (1 US$ = 11 000 Vietnam Dong, VND).

An integrated pest and disease management package is also under investigation with the active participation of ICRISAT, OPI, and Institute of Agricultural Sciences, Ho Chi Minh City. We hope to reduce the cost of groundnut production further when the improved package of production technology will be combined with a suitable package of integrated pest and disease management.

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Effect of Improved Production Technology in Groundnut in India

N K Prabhakaran, R Madhiyazhagan, C S Sridharan, and **R Venkitaswamy** (Agricultural Research Station, Tamil Nadu Agricultural University, Aliyarnagar 642 101, Tamil Nadu, India)

Fifteen on-farm trials (Front Line Demonstrations) were conducted during the postrainy season/summer 1995/96 in the Pollachi Tract, Coimbatore district, Tamil Nadu, India, under the aegis of the National Research Centre for Groundnut, Junagadh, Gujarat, and the Directorate of Oilseeds Research, Hyderabad, Andhra Pradesh. The objective of these trials was to demonstrate the beneficial effects on groundnut of improved production technologies: a seed rate of 125 kg ha^{-1}, seed treatment with carbendazim, a fertilizer dose of 17:34:54 kg NPK ha^{-1}, basal application of micro nutrient mixture at the rate of 12 kg ha^{-1}, and split application of gypsum (basal and topdressing at the pegging stage) at the rate of 200 kg ha^{-1} each time. Improved production technology was compared with the farmers' method in an area of 0.4 ha each. The farmers' method included a seed rate of 100 kg ha^{-1}, a fertilizer dose of 10:10:10 kg NPK ha^{-1}, and topdressing of gypsum at the rate of 200 kg ha^{-1} at the pegging stage. All other practices were the same.

The results of the study indicated that the improved production technologies gave higher yield in all the 15 locations, and recorded a mean yield of 2.1 t ha^{-1} which was 24% higher than that obtained with farmers' practices. The additional cost incurred in the improved package was Rs 1353 ha^{-1} (US$ 38) compared to an increased income of Rs 5160 ha^{-1} (US$ 145). The cost-benefit ratio using the improved technologies was 1.72 while that using farmers' practices was 1.48 (Table 1). The results clearly bring out the beneficial effect of improved production technology in enhancing groundnut yield and net returns.

Table 1. Yield and economics of groundnut in Front Line Demonstrations, (average of 15 trials), Agricultural Research Station, Aliyarnagar, Tamil Nadu, India, postrainy season/summer 1995/96.

Cultivation method	Yield (t ha^{-1})	Cost of cultivation (Rs ha^{-1})	Net return (Rs ha^{-1})	Cost benefit ratio
Improved	2.1	10048	17328	1.72
Farmers' practice	1.7	8835	13090	1.48

1. 1 US$ = Rs 35.

Alternative Fertilizer to Coconut Shell Ash for Groundnut Production in Vietnam

Nguyen Thi Lien Hoa, Phan Lieu, and **Nguyen Bao Cuong** (Oil Plant Institute of Vietnam, 171-175 Ham Nghi Street, Ho Chi Minh City, Vietnam)

Coconut shell ash is the most common form of fertilizer used in groundnut cultivation in the eastern region of southern Vietnam. Farmers often use 3 t of coconut shell ash combined with 30 kg N, 30 kg P_2O_5, and 15 kg K_2O ha^{-1} (basic fertilizers) for increased groundnut production. However, in recent years, with increasing groundnut area, coconut shell ash has become a scarce commodity, thus affecting groundnut production. This study was therefore planned to identify new material that could replace coconut shell ash.

Table 1. Chemical compositiion of the so-called 'Coco ash' and real coconut shell ash.

		Macronutrient (%)							Micronutrient (ppm)			
Sample	pH	Phosphorus (P_2O_5)	Potassium (K_2O)	Sodium (Na_2O)	Calcium (CaO)	Magnesium (MgO)	Chlorine (Cl^-)	Sulfur (SO_4^{-2})	Molybdenum (Mo)	Manganese (Mn)	Zinc (Zn)	Boron (Bo)
'Coco ash'												
1	10.2	2.77	5.70	7.92	6.29	5.31	6.5	2.43	8	1520	178	137
2	9.5	2.65	7.14	9.37	7.94	4.71	10.0	2.49	16	863	101	132
3	9.1	1.97	4.37	2.57	6.28	2.17	2.6	1.51	16	1067	140	63
4	8.6	1.68	3.51	2.15	8.71	2.45	1.5	1.11	20	1451	103	70
5	-	1.10	2.83	-	3.16	1.90	-	-	3	720	152	27
6	-	1.12	1.89	-	5.20	1.35	-	-	5	731	412	22
7	10.2	3.02	9.45	3.81	4.47	4.31	5.0	3.15	7	1620	270	135
8	9.2	2.21	4.41	3.45	16.0	2.68	2.2	2.04	17	1414	218	119
9	9.4	2.93	7.11	1.53	17.1	2.96	1.7	2.02	18	1475	198	119
10	8.8	2.20	3.65	1.83	24.2	2.59	1.3	1.31	17	1403	215	71
11	9.8	3.04	2.34	-	2.53	1.66	-	-	15	-	-	62
Average	9.4	2.24	4.76	4.08	9.26	2.91	3.9	1.79	16	1228	199	87
SE	±0.55	±0.71	±2.34	±2.95	±6.86	±1.30	±3.1	±0.90	±8	±348	±92	±43
CV (%)	6	32	49	72	74	44	80	50	52	28	46	49
Real coconut shell ash												
1	11.0	2.56	22.9	4.7	11.30	3.91	12.0	4.33	6	378	216	247
2	11.0	2.16	21.4	2.7	4.92	1.41	10.0	2.65	13	194	153	141
3	10.9	2.73	12.9	5.9	6.70	5.88	8.4	2.61	15	612	208	247
4	10.6	3.45	19.5	7.7	5.14	5.50	15.0	1.69	15	336	233	213
Average	10.7	2.73	19.2	5.3	7.02	4.18	11.0	2.82	12	380	203	212
SE	±0.28	±0.54	±4.41	±2.1	±2.18	±2.03	±2.8	±1.10	±4.3	±174	±35	±50
CV (%)	3	20	23	40	42	48	24	39	35	46	17	24

Table 2. Effect of macro- and micronutrients in coconut shell ash on groundnut yield.

	Pod yield				
Treatment	t ha^{-1}	Percentage of control	Shelling turnover (%)	Sound mature seed (%)	100-seed mass (g)
No fertilizer (control)	2.53	100	77.27	94.17	43
Basic fertilizers[1] + coconut shell ash[2]	3.53	139	77.95	95.09	47
Basic fertilizers + P	2.95	116	77.57	94.83	44
Basic fertilizers + K	3.43	135	77.84	93.74	45
Basic fertilizers + Ca	2.76	109	77.25	95.24	45
Basic fertilizers + Mg	2.86	113	76.87	97.15	44
Basic fertilizers + B, Mo	2.95	116	78.19	96.20	46
Basic fertilizers + P, K	3.40	134	76.87	95.75	44
Basic fertilizers + P, K, Ca	3.41	135	77.70	95.59	45
Basic fertilizers + P, K, Ca, Mg	3.19	126	78.30	95.51	44
Basic fertilizers + P, K, Ca, Mg, B, Mo	3.49	138	78.43	96.18	46
Basic fertilizers + P, K, Ca, Mg, B, Mo + peat	3.39	134	76.66	95.27	45
SE	±125		±0.48	±0.65	±0.74
CV (%)	8				

1. Basic fertilizers used by farmers: 30 kg N, 30 kg P_2O_5, 15 kg K_2O ha^{-1}.; 2. Coconut shell ash @ 3 t ha^{-1}.

Table 3. Economics of artificial coconut shell ash (ACA) application in groundnut in southern Vietnam (mean of winter-spring crop seasons 1993/94, 1994/95, and 1995/96).

Treatment	Pod yield ($kg\ ha^{-1}$)	Input cost (VND)[1]	Total income (VND)	Profit (VND)	Production cost of 1 kg of groundnut VND	(%)	Fertilizer cost VND	(%)
Farmers' fertilizer[2]	3360	7143600	13991100	6847500	2161	100	1834667	100
ACAs[3]								
ACA2	3400	6509400	14168200	7646133	1955	90	1164567	65
ACA4	3550	6616567	14473300	8186100	1900	88	1232567	68
ACA6	3580	6715000	14752700	8223967	1909	88	1321100	73
ACA8	3520	6768100	14662500	7885500	1960	91	1389100	77
SE	±50	±43310	±260804	±187324	±23		±33 691	
CV (%)	2.54							

1. Vietnam Dong (1 US$ = 11 000 VND).
2. Farmer's fertilizer: 30 kg N + 30 kg P_2O_5 + 15 kg K_2O + 3000 kg 'Coco ash' ha^{-1}.
3. Artificial coconut shell ash (ACA) ha^{-1}

ACA2: 30 kg N + 300 kg lime + 5 kg borax + 60 kg P_2O_5 + 80 kg K_2O ha^{-1}.
ACA4: 30 kg N + 300 kg lime + 5 kg borax + 60 kg P_2O_5 + 100 kg K_2O ha^{-1}.
ACA6: 30 kg N + 300 kg lime + 5 kg borax + 90 kg P_2O_5 + 80 kg K_2O ha^{-1}.
ACA8: 30 kg N + 300 kg lime + 5 kg borax + 90 kg P_2O_5 + 100 kg K_2O ha^{-1}.

The chemical composition of real coconut shell ash was compared with that of the so-called 'Coco ash' often sold in the market. Coconut shell ash is a very complex material consisting of macronutrients (potassium in the largest quantity, followed by phosphorus, calcium, and magnesium), and several micronutrients. The chemical composition of coconut shell ash greatly fluctuates, especially that of 'Coco ash' (Table 1).

Substituing coconut shell ash with P (or Ca or Mg or Mo) and B resulted in significantly lower groundnut pod yield. However, substituting coconut shell ash by K or all the compositions that included K gave a pod yield comparable with that of the coconut ash treatment. Among the various elements in ash, K plays the most effective role in improving groundnut yield (Table 2).

Based on the above results, a new series of fertilizers, named ACAs (artificial coconut shell ash) were compared as alternatives to coconut shell ash. The ACAs were tested in three winter-spring crop seasons (1992/93, 1993/94, and 1994/95) with good results (Nguyen Thi Lien Hoa et al. 1995). For the 1995/96 winter-spring season, the selected ACAs were tested at four locations. Although at every location the response of groundnut yield to fertilizer varied due to differences in cultivation practices and in native soil fertility, the pod yield with ACAs at all four locations was always comparable with the yield obtained with coconut shell ash.

Economic analysis of ACAs in three winter-spring crop seasons (1993/94, 1994/95, and 1995/96) revealed that the input cost of ACAs was 23–35% less than that of coconut shell ash. The replacement of coconut shell ash with ACAs reduced the production cost of 1 kg of groundnut by 9–12%. (Table 3).

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Exploiting the Production Potential of Groundnut by Improved Nutrient Management in the Lower Bhavani Project Area, Tamil Nadu, India

K Ponnuswamy, V K Balakrishnan, and **P Santhi,**
Department of Agronomy, Agricultural Research Station, Tamil Nadu Agricultural University, Bhavanisagar 638 451, Tamil Nadu, India)

Groundnut is one of the important oilseed crops of the Periyar district of Tamil Nadu, India. In the Lower Bhavani Project (LBP) area in this region, nearly 81 000 ha of irrigated groundnut is being cultivated, in addition

Table 1. Effect of fertilizer application on yield and profitability of groundnut in the Periyar district of Tamil Nadu, India.

Treatment	Pods plant^{-1}	Dry pod yield (kg ha^{-1})	Shelling percentage	Fertilizer cost (Rs ha^{-1})	Gross income (Rs ha^{-1})	Net income (Rs ha^{-1})
T_1	10	1541.7	64.2	1178.12[1]	15417	9238.88
T_2	10	1541.7	62.6	1453.16	15417	8963.84
T_3	10	1433.3	68.1	1178.12	14333	8154.88
T_4	9	1158.3	64.4	879.13	11583	5703.87
T_5	11	1625.0	70.3	1481.17	16250	9768.83
T_6	11	1741.7	71.0	1481.17	17417	10935.83
T_7	11	2058.3	69.5	1742.79	20583	13840.21
T_8	11	2383.3	72.4	1586.15	23833	17246.85
$CD_{0.05}$	NS	455.2	NS	-	-	-

1. 1 US$ = Rs 35.

to about 20 000 ha of rainfed groundnut. Nutrient application can increase the growth and yield of groundnut. This research note reports the results of a study to improve the production potential of groundnut by nutrient management. The economics of fertilizer application was also studied for the benefit of farmers in the LBP area.

A field experiment was conducted in red sandy loam soil at the Agricultural Research Station, Bhavanisagar, in the 1992 rainy season. The soil was low in available nitrogen (N) (125 kg ha^{-1}), medium in available phosphorus (P) (20 kg ha^{-1}), and potassium (K) (155 kg ha^{-1}) with a pH of 7.1. The following treatments were applied in a randomized block design with 3 replications:

- T_1 Recommended dose of N, P, and K (17.5; 35: 52.5 kg ha^{-1}; all basal)
- T_2 Recommended dose of N, plus 125% recommended dose of P and K (all basal)
- T_3 Recommended dose of N, P, and K (N and P basal, and K in two equal split doses—as basal, and 40 days after sowing (DAS))
- T_4 75% recommended dose of N, P, and K (all basal)
- T_5 125% recommended dose of N, P, and K (all basal)
- T_6 125% recommended dose of N, P, and K (N and P basal, and K in two equal split doses—as basal, and 40 DAS)
- T_7 125% recommended dose of N, and 150% recommended dose of P and K (all basal)
- T_8 125% recommended dose of N and P, and 150% recommended K (N and P basal, and K in two equal split doses—as basal and 40 DAS).

Gypsum (200 kg ha^{-1}) was applied to all treatments at the time of sowing, and again 40 days after sowing for better rooting and peg formation.

Treatments had no significant influence on days to 50% flowering, on growth parameters like plant height, number of branches plant^{-1}, and on number of nodules and effective nodules plant^{-1}. Groundnut pod yield was however, significantly affected by the treatments. Application of N, P, K at 22:44:79 kg ha^{-1} (T_8) gave the highest dry pod yield of 2383 kg ha^{-1}. A similar pod yield (2058 kg ha^{-1}) was obtained by the application of N, P, K at 22:52:79 kg ha^{-1} (T_7). The increase in pod yield in response to N and P application has been reported by Balasubramanian et al. (1988). Treatment 5, where the N and P levels were identical to those in T_8, gave a significantly lower yield presumably due to the lower K application rate. The role played by potassium in higher doses as a catalyst in carbohydrate metabolism and in many physiological activities in plants might be the reason for yield increase in groundnut (Masthan et al. 1990). The fertilizer treatments had no significant effect on shelling percentage.

The application of fertilizer to groundnut would result in farmers earning additional income. The net profit increased with the increasing dose of fertilizer application, and the highest net profit was obtained with T_8, the application of N,P, and K at 22:44:79 kg ha^{-1} (Table 1). A similar response of groundnut to fertilizer application, has been reported by Maliwal et al. (1988), and Chitkaladevi and Ramakrishna Reddy (1991).

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Evaluation of Vermicompost in Groundnut Production, Maharashtra, India

S S Dhane, S B Dodake, and **S N Jadhav** (Regional Agricultural Research Station, Karjat, Maharashtra 410 201, India)

Groundnut (*Arachis hypogaea* L.) is a major oilseed crop in the Konkan region of Maharashtra, India. It is well adapted for irrigated cultivation in the rice fallows of this region. The judicious combination of organic and inorganic fertilizers is gaining wider acceptance in maintaining the soil fertility for sustainable groundnut production. The beneficial effects of farmyard manure (FYM) and boron on the pod yield of groundnut have been reported by several workers (Survase et al. 1986, Patil and Shinde 1986, and Dhane et al. 1995). However, due to the lack of sufficient quantities of FYM, the use of vermicompost as an alternative is increasing. The present study was undertaken to compare the use of vermicompost and FYM in groundnut production.

The field experiment was conducted in a randomized block design during the 1995 postrainy season at the Regional Agricultural Research Station, Karjat, Raigad district, Maharashtra. There were seven different treatment combinations of organic and inorganic fertilizers (Table 1).

Each treatment was replicated four times. The soil of the experimental site was medium black loamy in texture, neutral in reaction with 1% organic carbon, containing 181 kg ha^{-1} available N, (assessed by the alkaline permanganate method), 27 kg ha^{-1} available P_2O_5 (Olsen's method) and 306 kg ha^{-1} exchangeable potassium. The semi-spreading 120-day duration groundnut variety, Konkan Gaurav, was sown, at 30 × 15 cm spacing with 2 seeds hill^{-1}, on 20 Jan 1996. The plot size was 5 × 4 m. The crop was irrigated 7 times at 12-day intervals and harvested on 16 May 1996. The inorganic nitrogen was applied as urea, phosphorus as single superphosphate, and boron as borax.

Table 1. Integrated effect of farmyard manure (FYM), vermicompost, and inorganic fertilizers on dry pod yield of groundnut.

Treatment	Mean dry pod yield (t ha^{-1})
25 kg N + 50 kg P_2O_5 ha^{-1}	3.06
1.5 t vermicompost + 25 kg N + 50 kg P_2O_5 ha^{-1}	4.47
1.5 t vermicompost + 25 kg N + 50 kg P_2O_5 ha^{-1} + 0.5 kg B ha^{-1}	4.25
1.5 t vermicompost + 25 kg N + 50 kg P_2O_5 ha^{-1} + 1.0 kg B ha^{-1}	4.06
5 t FYM + 25 kg N + 50 kg P_2O_5 ha^{-1}	4.56
5 t FYM + 25 kg N + 50 kg P_2O_5 ha^{-1} + 0.5 kg B ha^{-1}	4.68
5 t FYM + 25 kg N + 50 kg P_2O_5 ha^{-1} + 1.0 kg B ha^{-1}	4.37
$CD_{0.05}$	0.66

The integrated use of FYM at 5 t ha^{-1} or vermicompost at 1.5 t ha^{-1} with nitrogen (25 kg N ha^{-1}), phosphorus (50 kg P_2O_5 ha^{-1}) and boron (0.5 or 1.0 kg B ha^{-1}) produced significantly superior dry pod yields to those that received applications of nitrogen and phosphorus alone (Table 1). The effects of treatments containing FYM and vermicompost indicate that vermicompost would be an alternative to FYM. In the presence of organic sources, i.e., FYM and vermicompost, the beneficial effect of boron application either at the rate of 0.5 kg B or 1 kg B ha^{-1} was not significant.

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Evaluation of Weed Management Practices in Groundnut, Tamil Nadu, India

N K Prabhakaran, R Madhiyazhagan, C S Sridharan, and **R Venkitusamy** (Agricultural Research Station, Tamil Nadu Agricultural University, Aliyarnagar, Tamil Nadu, India)

A field experiment was conducted during the 1995 rainy season at the Agricultural Research Station, Tamil Nadu Agricultural University, Aliyarnagar, Tamil Nadu, India, to find a suitable weed-management practice for groundnut for this tract. Two preemergence herbicides, pendimethalin (at the rate of 1.0 kg ha^{-1}) and metolachlor (at the rate of 1.0 kg ha^{-1}), alone and in combination with intercultivation (IC) and hand weeding (HW) at different times, were compared. The treatment combinations are described in Table 1. The experiment was conducted in a randomized block design with three replications. Groundnut cv VRI 2 was grown as a test crop at an interrow spacing of 30 cm, and intrarow spacing of 10 cm. The experimental soil was sandy loam in texture.

During the investigation, observations on weed flora, weed population, weed dry-matter production were assessed, and pod yield was recorded. The net return was worked out. The results are summarized in Table 1.

Weed flora. Weeds associated with groundnut in the experimental field were *Boerhaavia diffusa, Trianthema portulacastrum, Eclipta alba, Amaranthus viridus, Parthenium histerophorus, Gynandropsis pentaphylla, Cyperus rotundus, Cynodon dactylon, Panicum repens*, and *Dactyloctenium aegyptium*. Grass weeds, constituted 51% of the total weed population. Among the grass weeds *Cynodon dactylon* was predominant. *Trianthema portulacastrum* was predominant among broad-leaved

Table 1. Effect of weed control treatments on total weed population, dry-matter production (45 DAS), pod yield, and net return, Aliyarnagar, Tamil Nadu, India, rainy season 1995.

Treatment	Total weed population (weeds m^{-2})	Weed dry matter (kg ha^{-1})	Pod yield (kg ha^{-1})	Net return (Rs ha^{-1})[1]
T_1 = Preemergence pendimethalin (Stomp® 30% EC) @ 1.0 kg ha^{-1}	86.8	970	1174	8483
T_2 = Preemergence metolachlor (Dual® 50% EC) @ 1.0 kg ha^{-1}	111.6	1143	1054	7305
T_3 = T1 + intercultivations (IC) at 30 and 45 DAS	66.0	893	1361	10013
T_4 = T2+IC at 30 and 45 DAS	74.8	793	1229	8090
T_5 = T3+1 hand weeding (HW) at 30 DAS	43.2	487	1360	9588
T_6 = T4+1 HW at 30 DAS	45.5	497	1353	9380
T_7 = IC at 20 and 45 DAS	65.1	587	1138	6350
T_8 = Unweeded control	127.6	1723	760	3480
T_9 = Weed-free control (3 ICs at 15, 30 and 45 DAS, and 2 HW at 20 and 50 DAS)	59.7	383	1434	10385
SE	±8.5	±67	±117	±471
$CD_{0.05}$	17.9	142	248	993

1. 1 US$ = Rs 35.

weeds, and *Cyperus rotunda* was predominant among sedges.

Weed population. Total weed population was the highest (127.6 weeds m^{-2}) in the unweeded control plot. Pre-emergence application of 1.0 kg ha^{-1} pendimethalin with two ICs and one HW recorded the lowest weed population (43.2 weeds m^{-2}). At the early stages of observation, there was significant reduction in weed population under the treatments receiving herbicides. Among the two herbicides, pendimethalin was superior to metolachlor in reducing the total weed population.

Weed dry-matter production. The weed-free control had the least weed dry-matter production. However, this treatment was comparable with the treatments (T_5 and T_6) receiving herbicides supplemented with ICs and HW. All weed-control treatments had significantly greater pod yield than that of the nonweeded control. Pod yield in many treatments (T_3, T_4, T_5, and T_6) was not significantly different from that of the weed-free control (1434 kg ha^{-1}), which was the highest.

Net return. The weed-free control recorded the highest net return followed by pendimethalin (at the rate of 1.0 kg ha^{-1}) with two ICs.

The weed-free control (3 intercultivations at 15, 30, 45 DAS, and 2 hand weedings at 20 and 50 DAS) or pre-emergence application of pendimethalin at the rate of 1.0 kg ha^{-1} with two ICs at 30 and 45 DAS results in high groundnut pod yield and net return.

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Manual Weed Control in Rainfed Groundnut in Western Sudan

A K Osman and **E M Elamin** (El Obeid Agricultural Research Station, PO Box 429, El Obeid, Sudan)

Water is the major production constraint affecting the productivity of groundnut in the semi-arid Western Sudan. Weeds consume the limited water resource and considerably reduce the available moisture if not effectively eliminated. Small-scale farmers avoid the use of costly inputs, hence the use of herbicides is not feasible in the near future. The objective of this experiment was to determine the best time and frequency of manual weeding to increase productivity and economic returns.

The experiment was conducted in the 1989 and 1990 rainy seasons under rainfed conditions at the El Obeid Research Station, North Kordofan, Sudan. The soil is sandy (93%), low in organic matter and cation exchange capacity. The total rainfall received was 171 mm in 1989, and 361 mm in 1990. The long-term average is 350 mm. Five weeding treatments were applied:

- Clean weeded control (five weedings starting from crop establishment to the pod formation stage)
- Two weedings (one at crop establishment, and a second at the late flowering stage)
- Local practice (one early weeding, and a second at the early flowering stage)
- Delayed weeding (one at the late flowering stage, and a second at the pod formation stage)
- Weedy control

Weeding was done with a flat-bladed sweep push hoe (locally called *geria*).

Treatments were arranged in a randomized complete block design with three replications. A spanish groundnut variety, Barberton, was sown at the rate of 2 seeds $hill^{-1}$, with 60 cm interrow spacing and 20 cm intrarow spacing. In both years, the crop was sown in mid July and harvested at the end of October.

The dominant weeds observed were *Alysicarpus glumaceus*, *Cenchrus setigerus*, *Sesamum alatum*, *Fragrostis aspera*, *Zornia gluchidiata*, *Aristida cassia*, and *Cescikia* species.

Table 1. Effect of weeding treatments on pod yield, haulm yield, and shelling percentage, North Kordofan, Sudan, 1989 and 1990 rainy seasons.

Weeding treatment	Pod yield (t ha^{-1})	Haulm yield (t ha^{-1})	Shelling percentage
Clean weeded control	0.76	1.14	73
Two weedings	0.60	0.89	71
Local practice	0.69	0.89	66
Delayed weeding	0.55	0.85	69
Weedy control	0.28	0.62	69
Mean	0.58	0.88	70
SE	±0.062	±0.133	±1.2

The effect of the different weeding treatments is given in Table 1. Pod yields were significantly ($P = 0.01$) affected by the weeding treatments. Higher pod yields were obtained with the clean weeded control, followed by the farmers' local practice and two weedings. The weedy control resulted in a reduction in pod yield of 63% and 60%, compared with the clean weeded control and local practice. Although differences among haulm yields were not significant ($P = 0.05$), the trend was similar to that of pod yield. The highest shelling percentage was recorded with the clean weeded control.

Economic analysis

A benefit/cost analysis was made by comparing the farmers' practice with the improved weed management treatments. The objective was to confirm whether the farmer could make adequate profit to justify additional costs due to improved weeding. The average farm gate price of 130 Sudanese pounds (LS) (1 US$ = LS 12) per *kantar* (45 kg) was used to calculate the benefit/cost of the improved weeding methods. The clean weeded control gave 74 kg higher yield over the usual farmer practice. The other three weeding practices resulted in no yield increase over the farmers' practice. The benefit/cost ratio calculated for the clean weeded control was 1.05. This indicates that every Sudanese pound paid for additional weeding (over farmers' practice) produced a profit margin of only 5 plasters (1 LS = 100 plasters). This marginal profit per pound invested in weeding is far below the opportunity cost of capital (over LS 60), making the four weedings worthless and hence, not recommended. Under the current production and marketing (low price) environments of groundnut, the farmers' practice of weeding appears to be the best.

Food Quality

Fatty Acid Composition of Developing Groundnut Seed, Shandong, China

Wan Yongshan[1], **Fu Jinmin**[1], **Li Xiangdong**[1], **Tan Zhong**[2], and **Fan Hui**[3] (1. Department of Agronomy, Shandong Agricultural University, Taian, Shandong 271018, China; 2. Centric Laboratory, Shandong Agricultural University, Taian, Shandong 271018, China; and 3. Linyi City Agricultural Research Institute, Linyi, Shandong 276002, China)

Three groundnut cultivars—Haihua 1, Shuangji 2, and Hua 17—were cultivated in 1990. Pods were sampled at 7–10 day intervals from the initial podding stage. After air drying and hulling, the dry mass and fatty acid composition of seed were determined.

The results showed that the oleic/linoleic acid ratios, which correlated positively with dry seed mass, were lowest at the early pod stage, increased gradually with the development of pods and seed, and reached a stable maximum at near maturity. Oleic acid (18:1) and linoleic acid (18:2) constituted about 65% of the fatty acid composition in groundnut oil at the initial podding stage and 80% at maturity. During pod and seed development, the oleic acid content increased while the linoleic acid content decreased. From seed formation to maturity, palmitic acid (16:0) and eicosenoic acid (20:1) decreased gradually. However, there was no regular variation in stearic acid (18:0), arachidic acid (20:0) and behenic acid (22:0) contents. The development of these characteristics was similar across cultivars, seeding times, and sowing patterns.

Fatty Acid Composition of some Groundnut Germplasm Lines in Guangdong, Southern China

Liang Xuanqiang, Liao Xiaomei, and **Li Lizong,** (Crops Research Institute, Guangdong Academy of Agricultural Sciences, Wushan 510640, Guangzhou, China)

Groundnut is the second largest crop and the sole oilseed crop in Guangdong, China. More than 70% of the crop is crushed for oil. The market demands groundnut with high oil content and good storability, and meeting these demands is an important objective at the Crops Research Institute (CRI).

Thirty groundnut germplasm lines (16 accessions from ICRISAT, and the remaining 14 from China) were grown at the CRI, Guangzhou in the 1989 autumn, 1990 spring, and 1990 autumn seasons. Fatty acid composition of the harvested seed was determined by liquid chromatography. The results showed that genotypic differences in fatty acid composition were larger than differences due to the seasons. Fatty acid compositions (mean over 3 seasons) are shown in Table 1.

There was considerable variability in fatty acid composition among the different genotypes. Mean content (range in parentheses) of different fatty acids were as follows:

Palmitic 10.7% (7.2–12.5)
Stearic 2.73% (1.8–3.7)
Arachidic 1.73% (1.19–2.44)

Table 1. Fatty acid composition of 30 groundnut germplasm lines grown in Guangzhou, China.

Germplasm line	Fatty acid (%)[1]							
	Palmitic	Stearic	Arachidic	Behenic	Eicosenoic	Oleic (O)	Linoleic (L)	O:L ratio
CS 18	10.79	2.81	1.84	2.80	0.95	55.00	25.81	2.13
CS 22	9.66	2.27	1.52	3.55	1.51	63.28	18.20	3.47
CS 25	11.40	2.72	1.66	2.83	0.79	52.67	27.92	1.88
CS 26	8.92	2.43	1.96	3.25	1.48	64.64	17.32	3.73
CS 27	10.03	1.53	1.44	3.79	1.75	62.95	18.54	3.39
CS 30	10.78	3.26	1.70	2.80	0.99	53.54	26.93	1.98
CS 33	9.63	3.71	1.99	2.75	1.28	59.28	21.36	2.77
CS 36	10.13	2.13	1.53	3.63	1.43	63.79	17.37	3.67
CS 41	8.73	2.82	2.26	3.87	1.45	60.87	20.02	3.04
CS 46	10.68	3.60	1.79	2.83	0.76	58.34	22.01	2.65
CS 50	10.38	3.07	1.57	2.70	0.98	53.85	27.45	1.96
CS 55	8.90	3.11	2.25	4.31	1.56	59.48	20.37	2.91
ICG 3225	10.33	2.59	1.70	3.16	1.03	50.05	31.14	1.60
ICG 4562	11.22	2.33	1.50	2.38	0.95	48.38	33.34	1.45
ICGS 85	11.60	1.80	1.28	3.21	1.17	43.67	37.27	1.17
ICG 93	11.96	1.90	1.19	3.55	1.19	45.94	34.27	1.34
Siyouhong 4	7.16	1.96	1.48	3.01	1.44	74.04	10.91	6.78
551 Zatian	10.23	2.40	1.94	2.54	0.97	51.50	30.43	1.69
Baishai	11.92	3.70	2.32	1.20	1.79	42.07	37.00	1.13
Yue You 177	11.27	3.03	1.51	2.18	0.98	48.65	32.37	1.50
Yue You 196	11.18	2.48	1.22	2.06	0.72	49.43	32.92	1.50
Huaxianzhu	12.33	2.97	1.48	3.33	0.85	47.33	31.72	1.49
Taishanzu	12.49	2.79	1.75	2.60	0.92	43.50	35.95	1.21
Zhushaihong	11.33	2.82	2.15	3.55	1.29	45.24	33.63	1.34
Shentengxi	11.80	2.47	1.53	2.45	0.84	47.75	33.16	1.43
Chetengzhong	11.87	3.34	1.89	2.53	0.71	46.87	32.79	1.42
Goubidou	11.47	2.89	1.73	2.55	1.02	48.91	31.42	1.55
Fuhuadundili	11.19	2.88	1.64	2.51	0.86	51.50	29.41	1.75
Sihesihua	10.65	2.68	1.66	2.51	0.94	52.42	29.15	1.79
Daizhudou 1	10.90	3.07	2.44	2.57	1.05	48.70	31.25	1.55
Mean	10.70	2.72	1.73	2.83	1.12	53.12	27.71	2.17

1. Mean of three seasons.

Behenic 2.83% (1.2–3.8)
Eicosenoic 1.12% (0.71–1.79).
Oleic 53.1% (42.1–74.0).
Linoleic 27.71% (10.9–37.3).

The oleic:linoleic (O:L) ratio ranged from 1.1 to 6.8, with a mean of 2.7.

The O:L ratio is commonly used as an index of storability of groundnut oil and its products. The O:L ratio of the local landrace Siyouhong 4 was 6.8, higher than any other accession. Siyouhong 4 has been used as a high O:L ratio parent to develop high O:L ratio cultivars.

Effect of Potassium Nutrition and Type of Storage Container on Seed Quality of Stored Groundnut Pods

A K Patra, S K Tripathy, R C Samui, and **M K Nanda** (Department of Agronomy, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur 741 252, West Bengal, India)

Potassium plays an important role in groundnut seed storage life since it activates respiratory enzymes, ATP-ase, and others, in the biosynthesis of seed. Potassium (K) deficiency in plants accelerates seed deterioration, and long-term storage under humid conditions reduces seed viability. The present study was conducted to determine the effect of K and type of storage container on the viability of groundnut (*Arachis hypogaea* L.) seed under the humid climatic conditions of West Bengal state in India.

Groundnut cultivar JL 24 was grown at University Farm, Kalyani, West Bengal, during the 1992 and 1993 rainy seasons with two K treatments—0 and 50 kg K_2O ha^{-1} as soil application. Pods from both the treatments, with a seed moisture content of 7% were stored in bulk (4 kg) in three types of containers—gunny bag (300 gauge) (A), plastic silo (B), and a polythene-lined gunny bag containing 25 g anhydrous calcium chloride ($CaCl_2$) in a small plastic jar with several perforations on its upper half and placed upright inside the bag (C). Seed viability was evaluated by the tetrazolium test. Water soluble sugar in seed was analyzed by the phenol-sulfuric acid method. The moist blotter method recommended by the International Seed Testing Association (ISTA) was to isolate fungi associated with seeds.

Soil application of 50 kg K_2O ha^{-1} increased K concentration in seed (0.93% without K and 1.27% with K). Pods from the K-fertilized crop had higher seed viability than pods from the crop grown without K (Table 1). Potassium appeared to prevent possible seed deterioration due to mold infection (Table 2). High K concentration in seed reduced the water absorbing capacity and water soluble sugar content in seed (Table 3) which might have favorably influenced the seed viability during storage. Low water soluble sugar content in seed from the K-fertilized crop indicated a greater cell membrane integrity in seeds.

The plastic silo and the polythene-lined gunny bag with $CaCl_2$ both showed higher seed viability than the

Table 1. Effect of potassium and type of storage container on groundnut seed viability (%) (mean of 1992 and 1993).

	120 DAS[1]	180 DAS	240 DAS	300 DAS	360 DAS
Potassium (kg K_2O ha^{-1})					
0	83	61	38	25	16
50	85	70	50	40	33
Storage container[2] (mean over K levels)					
A	77	48	5	0	0
B	85	66	55	41	30
C	90	83	72	56	44

1. DAS = days after storage.
2. A = gunny bag, B = plastic silo, C = polythene-lined gunny bag with a plastic jar containing anhydrous calcium chloride.

Table 2. Effect of potassium application to crop and type of storage container on the number (%) of fungi-affected seeds after 360 days of storage (mean of 1992 and 1993).

	Aspergillus niger	*A. flavus*	*Penicillium* spp	*Rhizopus* spp
Potassium (kg K_2O ha^{-1})				
0	40.3	21.3	23.7	26.7
50	33.7	13.3	16.7	23.3
Storage container[1] (mean over K levels)				
A	46.5	25.0	34.5	33.5
B	37.5	16.5	18.0	26.5
C	27.0	10.5	8.0	15.0

1. A = gunny bag, B = plastic silo, C = polythene-lined gunny bag with a plastic jar containing anhydrous calcium chloride.

Table 3. Effect of potassium and type of storage container on moisture content and sugar content of groundnut seed (mean of 1992 and 1993).

	Moisture content (%)[1]			Sugar content (mg $seed^{-1}$)		
	120 DAS[2]	240 DAS	360 DAS	120 DAS	240 DAS	360 DAS
Potassium (kg K_2O ha^{-1})						
0	7.9	9.1	9.5	0.20	0.22	0.25
50	7.6	8.5	9.0	0.16	0.28	0.32
Storage container[3] (mean over K levels)						
A	8.1	10.0	10.6	0.22	0.30	0.34
B	7.9	8.9	9.4	0.18	0.27	0.30
C	7.3	7.5	7.7	0.14	0.18	0.21

1. Initial seed moisture content was 7%, and sugar content was about 0.07 mg $seed^{-1}$ at the time of storage.
2. DAS = days after storage.
3. A = gunny bag, B = plastic silo, C = polythene-lined gunny bag with a plastic jar containing anhydrous calcium chloride.

ordinary gunny bag (Table 1). They were impervious to moisture and must have protected the seeds from spoilage. Anhydrous $CaCl_2$ is hygroscopic and it absorbed excess moisture from the pods.

It can be concluded that groundnut pods from plants well supplied with K can be stored either in plastic silos or in polythene-lined gunny bags with $CaCl_2$ for prolonged seed viability.

Acknowledgment. The authors are grateful to the Adaptive Research Council, Government of West Bengal, India, for financial support.

New ICRISAT Publications

Copies of titles are available on request from:

Distribution Unit
IMEP, International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)
Patancheru 502 324, Andhra Pradesh, India

or other sources as indicated.

LDC = less developed country. Highly developed countries (HDCs) include Australia, Canada, European countries, Iran, Iraq, Japan, Kuwait, Libya, New Zealand, Saudi Arabia, South Africa, and USA. All prices include postage.

International *Arachis* Newsletter No. 15 (Supplement). 26 pp. ISSN 1010-5824. Single copies free.

A special supplement to IAN No. 15 on high-yield technology for groundnut in China was issued in 1995. Copies have been sent to all IAN recipients. Further copies are available from ICRISAT and Shandong Peanut Research Institute, Laixi, Shandong Province 266601, China.

Please inform your colleagues who might like to make use of them.

Peanut clump virus disease. A 4-page illustrated leaflet in English and Hindi for farmers and extension workers. Briefly explains the symptoms, causal agent, host range, and control of the disease.

ICRISAT Plant Material Descriptions. 4 pp. Single copies free.

- Groundnut variety ICGV 86325. 1995. Plant Material Description no. 62. ISBN 92-9066-322-7. Order code PME 062.

  Gives a brief description of this high-yielding, medium-duration, virginia bunch groundnut variety, tolerant of peanut bud necrosis and peanut mottle virus diseases, released in 1994 for rainy-season cultivation in India.

- Groundnut elite germplasm ICGV 86699. Plant Material Description no. 65. 1996. ISBN 92-9066-339-1. Order code PME 065.

  Gives a brief description of the high-yielding, interspecific derivative with multiple resistance/tolerance to diseases and insect pests.

- Groundnut elite germplasm ICGV 86165. Plant Material Description no. 67. 1996. ISBN 92-9066-341-3. Order code PME 067.

  Gives a brief description of the high-yielding, interspecific derivative resistant to rust and late leaf spot.

- Groundnut elite germplasm ICGV 86143. Plant Material Description no. 68. 1996. ISBN 92-9066-342-1. Order code PME 068.

  Gives a brief description of the high-yielding, spanish variety, released as BSR 1 for cultivation in the Western Zone of Tamil Nadu, India.

- Groundnut elite germplasm ICGVs 86155, 86156, 86158, 87378, and 87921. Plant Material Description no. 69. 1996. ISBN 92-9066-343-X. Order code PME 069.

  Gives a brief description of the high-yielding, spanish groundnut varieties with 4-week postmaturity fresh seed dormancy.

Waliyar, F. (ed.) 1996. Summary proceedings of the Fourth Regional Groundnut Meeting for Western and Central Africa, 29 Nov to 2 Dec 1994, ICRISAT Sahelian Center, Niamey, Niger. 144 pp. ISBN 92-9066-345-6. Order code CPE/F 102. Price US$ 10.80 (LDC), US$ 32.40 (HDC), and Rs 330.00 (India).

Representatives from Benin, Burkina Faso, Central African Republic, Chad, Congo, Côte d'Ivoire, France, Ghana, Guinea, India, Madagascar, Mali, Niger, Nigeria, Senegal, Sierra Leone, Togo, and USA attended this Meeting organized as part of the NARS/ICRISAT consultation for effective collaboration, and co-sponsored by ICRISAT, the Conférence des responsables de la recherche agronomique africains (CORAF), and Peanut Collaborative Research Support Program (Peanut CRSP).

The proceedings contain summaries of papers on agronomy, breeding, and crop protection, and recommendations to improve and stabilize groundnut production in the region.

Reddy, D.V.R., and **Gowda, C.L.L.** (eds.) 1996. Groundnut virus diseases in the Asia-Pacific Region: summary and recommendations of the Fourth Meeting of the International Working Group, 12–14 Mar 1995, Khon Kaen University, Thailand. 44 pp. ISBN 92-9066-338-3. Order code CPE 101. Price US$4.42 (LDC), $11.02 (HDC), and Rs 108.00 (India).

Virus diseases cause economically significant losses to groundnut crops. The Fourth Meeting of the International Workshop Group on Groundnut Viruses in the Asia-Pacific Region was organized by ICRISAT in cooperation with Khon Kaen University, Thailand, Peanut Collaborative Research Support Program (Peanut CRSP), USA, the Samuel Roberts Nobel Foundation, USA, the Belgian Administration for Development Cooperation, the Australian Centre for International Agricultural Research, the Directorate General for International Cooperation of the Ministry of Foreign Affairs, The Netherlands, and the Overseas Development Administration, UK. The Meeting was held to develop strategies for the management of groundnut virus diseases in Asia. This publication contains summaries of the papers presented at the Meeting. The first two sessions deal with genome organization of economically important groundnut viruses, and strategies for producing transgenic groundnuts with resistance to virus diseases. The third and fourth sessions cover country-specific situations for the management of groundnut viruses in Bangladesh, China, India, Indonesia, Myanmar, Nepal, Pakistan, and Vietnam. Specific recommendations for collaborative research on groundnut viruses in the Asia-Pacific Region are listed.

Reddy, D.V.R., Lenné, J.M., Delfosse, P., and **Subrahmanyam, P.** (eds.) (In press.) Groundnut virus diseases in Africa: summary proceedings of a Working Group Meeting, 18–19 Mar 1996, Plant Protection Research Institute, Pretoria, South Africa. ISMN 92-9066-358-8. Order code CPE 109.

The International Working Group Meeting on groundnut viruses in Africa reviewed progress made on the detection, identification, characterization, and management of groundnut viruses in Africa, with special emphasis on rosette and clump viruses. Country representatives summarized the status of research on groundnut viruses in their countries. In order to accomplish integrated management of rosette and clump virus diseases, it was agreed that consolidated efforts should be made to understand their epidemiology. Among the important aspects discussed were the provision of diagnostic aids and training in the identification and detection of viruses for the national agricultural research systems in Africa, and strengthening of laboratory facilities.

Scientists from Burkina Faso, Kenya, Malawi, Nigeria, South Africa, and Zimbabwe in Africa, and from Belgium, Germany, UK, and USA attended the meeting, which was the first gathering of so many plant virologists in South Africa.

Gowda, C.L.L., Nigam, S.N., Johansen, C. and **Renard, C.** (eds.) 1996. Achieving high groundnut yields: proceedings of an International Workshop, 25–29 Aug 1995, Laixi City, Shandong, China. ISBN 92-9066-350-2. Order code CPE 105.

An international workshop was held at the Shandong Peanut Research Institute, Laixi City, China, to review and document available technologies to achieve high groundnut yields, observe methods that have been developed and adopted in Shandong Province, and develop plans to achieve similar yields in other countries in Asia and elsewhere.

Representatives from 13 provinces of China, India, Korea, Myanmar, the Philippines, Thailand, Vietnam, and Zimbabwe, and ICRISAT attended the meeting and toured areas of Shandong to see the technologies in practice.

Papers on all aspects of groundnut production are included, with additional abstracts, and summaries of Working Group discussions. All preliminary papers, abstracts, and group discussions are presented in English and Chinese.

Mehan, V.K., and **Gowda, C.L.L.** (eds.) (In press.) Aflatoxin contamination problems in groundnut in Asia: proceedings of the First Asia Working Group Meeting, 27–29 May 1996, Ministry of Agriculture and Rural Development, Hanoi, Vietnam. ISBN 92-9066-360-X. Order code CPE 110.

The current status of research on aflatoxin contamination problems in groundnut in Asia is reviewed. Particular emphasis is given to recent advances in aflatoxin management technologies including genetic resistance to *Aspergillus flavus* infection and aflatoxin production, and analytical and immunochemical methods for the analysis of aflatoxins. The publication includes country papers summarizing the status of the groundnut aflatoxin problem in Bangladesh, China, India, Malaysia, the Philippines, Thailand, and Vietnam. Recommendations are made for collaborative research, and the need to interest potential donors in promoting the Group's activities is stressed.

Gowda, C.L.L., and **Ramakrishna, A.** (eds.) 1996. Collaborative research in Asia: needs and opportunities. Summary proceedings of the CLAN Country Coordinators' Steering Committee Meeting, 4–6 Dec 1995, ICRISAT Asia Center, India. 128 pp. ISBN 92-9066-346-4. Order code CPE 103. Price US$ 9.60 (LDC), US$ 28.80 (HDC), Rs 294.00 (India).

This publication reports the deliberations of the Steering Committee Meeting of the Cereals and Legumes Asia Network (CLAN). The CLAN Country Coordinators reviewed the activities of the network of 1993–95, and identified the needs and opportunities for future collaborative research and technology exchange. The role of ICRISAT's research projects and research support programs was sketched and discussed, as were potential contributions from regional and international institutions.

The recommendations of the meeting include enhanced cooperation and linkages among member countries for research and technology involving sorghum, pearl millet, chickpea, pigeonpea, and groundnut, and related natural resource management in the production systems where these crops are grown.

Cooper, M., and **Hammer, G.L.** (eds.) 1996. Plant adaptation and crop improvement. 652 pp. ISBN 0-85199-108-4.

[Published by CAB International in association with the International Rice Research Institute (IRRI), Philippines, and the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), India. Copies available from IRRI, PO Box 933, Manila 1099, Philippines.]

This book has been developed from a series of papers presented at an international workshop held at ICRISAT Asia Center, Hyderabad, India, 28 Nov to 2 Dec 1994. The book contains chapters which consider; i) theoretical and applied aspects of analyzing plant adaptation in multi-environment experiments, ii) how information on plant adaptation can be used in plant breeding programs, iii) selection for plant adaptation, iv) genotype by environment (GxE) interactions in plant breeding, v) methodologies for interpreting the causes of GxE interactions, vi) case studies on how to accommodate the effects of GxE interactions, vii) research strategies for understanding GxE interactions and differences in plant adaptation, and other topics related to crop improvement.

There is a particular focus on the opportunities for increasing the efficiency of crop improvement by understanding the basis of variation for plant adaptation in agricultural production systems. Crop improvement strategies based on combinations of the statistical modeling methodologies used by plant breeders and the crop modeling methodologies used by crop physiologists/agronomists are developed and case studies discussed. The book captures much of the experience of scientists from around the world (e.g. in Australia and centres such as IRRI, ICRISAT, and CIMMYT) who have worked on the challenging problem of achieving crop improvement in variable crop production systems. It represents a major synthesis for workers in plant breeding, crop physiology, and agronomy.

Laryea, K.B., and **Katyal, J.C.** (eds.) (In press.) Measuring soil processes in agricultural research. Technical Manual no. 3. ISBN 92-9066-359-6. Order code TME 003.

Soil and crop management strategies (e.g., tillage, bunding, cropping intensity, and crop sequencing) are location- and season-specific in the way they affect soil processes and resource utilization by crops. Research findings on these effects therefore need to be modeled if they are to be extrapolated to other locations with similar soils and climatic conditions. This manual presents practical methods for assessing management effects on such soil processes as water infiltration, and erosion by water, and on water, air, and nutrient use by crops. It covers the basic elements of soil physical characterization and deals principally with the role of soil structure on water infiltration and percolation (and, as a consequence, on water balance in the soil profile), on heat flow (and therefore on the soil thermal regime), on aeration, and on the mobility of roots and soil microorganisms.

The authors discuss the agronomic and engineering practices that affect soil processes; and the effects of such strategies as contour cultivation, organic and inorganic amendments, watershed management, and soil surface manipulations are emphasized.

Under headings for equipment, principle, procedure, and calculations, methods are described for measuring: water infiltration into soil (ponded infiltrometers, disc permeameters for determining in-situ hydraulic properties, and rainfall simulation); runoff and erosion (H-type flumes, weirs, water-level recorders, stilling wells, tipping buckets, multi-slot devisors, sediment samplers, and tilting flumes); gravimetric water content and water potential (tensiometry and/or pressure plates neutron probes); volumetric water content and time-domain reflectometry); soil structural stability (wet-sieving, use of moisture characteristics, and penetration resistance). The use of PERFECT software in simulation modeling is described in detail.

Baidu-Forson, J., Bantilan, M.C.S., Debrah, S.K., and **Rohrbach, D.D.** 1996. Partners in impact assessment: summary proceedings of an ICRISAT/NARS Workshop on Methods and Joint Impact Targets in Western and Central Africa, 3–5 May 1995, Sadoré, Niger, and 9, 11–12 May 1995, Samanko, Mali. 116 pp. ISBN 92-9066-354-5. Order code CPE/F 107. Price US$ 8.70 (LDC), US$ 26.10 (HDC), and Rs 266.00 (India).

Regional workshops were held at Sadoré, Niger and at Samanko, Mali, to evaluate the joint impact of ICRISAT and National Agricultural Research Systems (NARS) in Western and Central Africa. Twenty-one scientists from ICRISAT and the national programs in Cameroon, Chad, and Niger participated in the workshop at Sadoré. The Samanko workshop was attended by 18 scientists from ICRISAT, NARS collaborators in Burkina Faso and Mali, Institut du Sahel (INSAH), and the West and Central Africa Sorghum Research Network (WCASRN). National program representatives identified specific jointly-developed technologies that should be targeted for impact assessment. Methodological approaches for measuring welfare benefits to consumers and producers were discussed and illustrated with case studies. Minimum dataset requirements were outlined and protocols for case studies on technologies targeted by NARS partners were developed.

Publications in French, Portuguese, and Spanish

The title 'Screening methods and sources of resistance to rust and late leaf spot of groundnut', previously published in English, has been translated into French, Portuguese, and Spanish.

- La rouille et la cercosporiose tardive de l'arachide: méthodes de criblage et sources de résistance. Bulletin d'information n° 47. 24 pp. ISBN 92-9066-000-0. Code de commande IBF 047. Price US$ 3.83 (LDC), US$ 7.83 (HDC), Rs 65.60 (India).
- Roya y mancha foliar tardía de maní: métodos de aislación y fuentes de resistencia. Boletín informativo núm. 47. 24 pp. ISBN 92-9066-330-8. Código de orden IBS 047. Price US$ 3.83 (LDC), US$ 7.83 (HDC), Rs 65.60 (India).
- Ferrugem e mancha foliar tardia do amendoim: métodos da avaliação e fontes da resistência. Boletim informativo n° 47. 24 pp. ISBN 92-9066-331-6. Codigó de ordenar IBP 047. Price US$ 3.83 (LDC), US$ 7.83 (HDC), Rs 65.60 (India).

Videos

To spray or not to spray .... 1996. Order code VCE 008. English/VHS-PAL/16 min. Price US$10.00 (HDC/LDC), Rs 350.00 (India).

The Green Revolution seemed successful in the 1960s and the 1970s, when the productivity of food crops increased dramatically, largely as a result of the intensive use of inputs, such as fertilizers and pesticides.

However, during the last 20 years, insect pests have become a major problem for many farmers in tropical and subtropical regions. Initially susceptible to insecticides, many of these insects have developed resistance to the chemicals. Farmers spray more often, resistance intensifies, the natural enemies of the pests are killed, and the problem intensifies - this is the *insecticide treadmill.*

Integrated pest management (IPM) procedures help farmers to minimize crop losses without or with limited use of pesticides. Scientists from the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), together with Indian national program scientists and farmers, have developed IPM procedures for groundnut. Natural predators of the insect pests, helped by modified cultural techniques, are now the control agents. Using these procedures, farmers can control more than 90% of pest occurrences without insecticides.

Also available in Telugu (*Ladde purugu joru, rythula bejaru*).

Show me, tell me, explain me .... 1996. Order code VCE 007. English/VHS-PAL/16 min. US$10.00 (HDC/LDC), Rs 350.00 (India).

Presents ICRISAT's participatory work with NGOs and farmers in India's largest pearl millet growing state, Rajasthan. In it, farmers, NGO workers, and scientists discuss techniques for selecting varieties. The video is available in both English and Hindi (*Mujhe samjhaiye*), and was produced by Ulrich Roth, a freelance videographer based in Germany.

Agreement on ICRISAT Germplasm Exchange

ICRISAT signed an agreement with the United Nations Food and Agriculture Organization (FAO) on 26 Oct 1994, placing germplasm collections maintained by ICRISAT under the auspices of the FAO, as part of the International Network of *ex situ* collections provided for in Article 7 of the International Undertaking on Plant Genetic Resources, to be held in trust by ICRISAT. The materials covered by the Agreement are listed as 'designated germplasm'.

ICRISAT has traditionally adhered to a policy of unrestricted availability of germplasm held in its genebanks. In the interest of keeping this material available for future research and utilization, ICRISAT has undertaken, under Article 3(b) of the Agreement with FAO, not to claim legal ownership over 'designated germplasm', or to seek any intellectual property rights over that germplasm or related information. To ensure continued free availability of that germplasm, ICRISAT has also agreed to pass on these obligations to all future recipients of 'designated germplasm'.

Accordingly, no 'designated germplasm' will be released in future unless the recipient signs a Standard Germplasm Order Form reproduced overleaf.

Rules for future exchange of germplasm for food and agriculture are currently being debated in the FAO Commission on Plant Genetic Resources in coordination with the Conference of the Parties to the Convention on Biological Diversity. ICRISAT and the Consultative Group on International Agricultural Research (CGIAR) are actively participating in this debate to ensure that any future regime will facilitate exchange and utilization of this precious global resource, and the fair and equitable sharing of the benefits derived from the commercial or other utilization of the germplasm.

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ICRISAT

Standard Germplasm Order Form

I/we order the following material:

Insofar as this material is "designated germplasm" under the 26 Oct 1994 Agreement between ICRISAT and the Food and Agriculture Organization of the United Nations (FAO) placing collections of plant germplasm under the auspices of FAO[1],

I/we agree

- not to claim ownership over the material received, nor to seek intellectual property rights over that germplasm or related information.
- to ensure that any subsequent person or institution to whom I/we make samples of the germplasm available, is bound by the same provision.

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Address ______________________________

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Shipping address (if different from the above) ______________________________

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Authorized signature ______________________________

1. "Designated germplasm" will be indicated by an asterisk (*) on the Shipment Notice.

About ICRISAT

The semi-arid tropics (SAT) encompasses parts of 48 developing countries including most of India, parts of southeast Asia, a swathe across sub-Saharan Africa, much of southern and eastern Africa, and parts of Latin America. Many of these countries are among the poorest in the world. Approximately one-sixth of the world's population lives in the SAT, which is typified by unpredictable weather, limited and erratic rainfall, and nutrient-poor soils.

ICRISAT's mandate crops are sorghum, pearl millet, finger millet, chickpea, pigeonpea, and groundnut; these six crops are vital to life for the ever-increasing populations of the semi-arid tropics. ICRISAT's mission is to conduct research which can lead to enhanced sustainable production of these crops and to improved management of the limited natural resources of the SAT. ICRISAT communicates information on technologies as they are developed through workshops, networks, training, library services, and publishing.

ICRISAT was established in 1972. It is one of 16 nonprofit, research and training centers funded through the Consultative Group on International Agricultural Research (CGIAR). The CGIAR is an informal association of approximately 50 public and private sector donors; it is co-sponsored by the Food and Agriculture Organization of the United Nations (FAO), the United Nations Development Programme (UNDP), the United Nations Environment Programme (UNEP), and the World Bank.

Editor

S N Nigam

ICRISAT

International Crops Research Institute for the Semi-Arid Tropics
Patancheru 502 324, Andhra Pradesh, India

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