ISSN 1010-5824

International Arachis Newsletter

Prepared by

Legumes Program

ICRISAT

Patancheru, Andhra Pradesh 502 324, India

GROUNDNUT, PEANUT, MANÍ, ARACHIDE, AMENDOIM, MUNGPHALI.

No. 10 November 1991

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

International Arachis Newsletter

Publishing Objectives

The International Arachis Newsletter is issued twice a year (in May and November) by the Legumes Program, ICRISAT, in cooperation with the Peanut Collaborative Research Support Program, USA (Supported by USAID Grant No.DAN-4048-G-SS-2065-00). It is intended as a communication link for workers throughout the world who are interested in the research and development of groundnut, *Arachis hypogaea*, or peanut, and its wild relatives. The Newsletter is therefore a vehicle for the publication of brief statements of advances in scientific research that have current-awareness value to peer scientists, particularly those working in developing countries. Contributions to the Newsletter are selected for their news interest as well as their scientific content, in the expectation that the work reported may be further developed and formally published later in refereed journals. It is thus assumed that Newsletter contributions will not be cited unless no alternative reference is available.

Style and Form for Contributions

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

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

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

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

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

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

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

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

CONTENTS

News and Views

Reports

Research Reports

News and Views

Editorial

We have timed the release of this 10th issue of the newsletter to coincide with the Second International Groundnut Workshop which is being hosted by ICRISAT and scheduled to be held from 25 to 30 Nov 1991 at ICRISAT Center. The workshop will address global issues concerning groundnut research, trade, and production. We expect about 190 representatives from the scientific and industrial sectors of 53 countries to participate in the workshop, besides ICRISAT staff. The program will cover worldwide trends in trade and commerce, research directions, successes and constraints, adoption of research findings by farmers, and changes in constraint patterns. Possible topics include modeling and its applications, processing of seeds and byproducts, implementation of Integrated Pest Management (IPM), Geographical Information System (GIS) applications, Cell Biology applications, and socioeconomic aspects. Concurrent sessions on various disciplines such as breeding and cytogenetics, pathology, entomology, etc., are also planned, where specialists get together to review progress and problems. Donor reports and poster sessions are also included. Papers from the workshop will be published by ICRISAT in 1992.

The problem of afiatoxin which was first recognized following outbreaks of Turkey 'X' disease in the United Kingdom in 1960, is now recognized worldwide as a serious human and livestock hazard, more so in the developing than in the developed world. The Tropical Products Institute, London, played a leading role in the extraction, purification, and identification of the toxins, and in the development of biological and physico-chemical methods to identify and quantify toxins in groundnut and other commodities. This laid the foundation for the rapidly expanding research on aflatoxin worldwide. Although much information on aflatoxins in groundnut is available, it is widely scattered in research journals, progress reports, etc., and is inaccessible to several researchers. Our pathologists have therefore collated information on groundnut aflatoxins and prepared an annotated bibliography, a set of 10 diskettes containing the database, and a users' manual, which are available for researchers on a ~~o~~st basis (please see section on announcements).

This issue includes a report on global trends in groundnut area, production, and productivity based on FAO data for 23 years. During this period, although a decreasing trend in global area was noticed, there was an increasing trend in groundnut production because of enhanced productivity in different continents, except Africa. The highest positive trend in production was noticed for Asia followed by North and Central America, while Africa and South America showed negative production trends. North and Central America registered the highest productivity trend coefficient of 41.0 kg ha^{-1} $year^{-1}$.

Most of the other articles in this issue deal with insects and diseases, including aflatoxins.

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

We wish our readers best seasonal greetings and a good turkey-feast, free of aflatoxins of course!

L.J. Reddy
Editor

Letters to the Editor

Dear Editor:

I am working on the relationship between root physiology/turnover, infection by fungal, soil-borne diseases and the establishment of potential biocontrol agents. My experiments have so far been laboratory based. I would therefore be interested in firsthand information from the field about problems groundnut growers encounter, which might be attributed to fungal diseases, for e.g., establishment problems, damping-off, patchiness, root and pod rot. I would also be interested in experiences with seed treatment, rotational or cultural control, or differential susceptibilities of different cultivars. I would appreciate if any of your readers could help me with their experiences in the field.

Yours sincerely

Ulrike Krauss
Microbiology
School of Agriculture
West Mains Road
EDINBURGH EH9 3JG
UK

ICRISAT Pathologist, D.H. Smith, replies:

Some of the information that you need is available in a book entitled "Peanut Science and Technology", published by the American Peanut Research and Education Society, 376 Agricultural Hall, Oklahoma State University, Stillwater, OK 74078, USA. A "Compendium of Peanut Diseases" is available from the American Phytopathological Society, Saint Paul, MN 55121, USA. A new book on "Peanut Health Management" will soon be published by the American Phytopathological Society. Some current information on biocontrol agents, seedling diseases, root rot, pod rot, etc., has been published in international journals. A considerable amount of the world literature on groundnut diseases is cited in the "Review of Plant Pathology", published monthly by CAB International, Wallingford, OX10 8DE, UK.

Thank you for your interest in the International Arachis Newsletter. Perhaps some of the scientists who are recipients of this newsletter can send you reprints of relevant publications.

Dear Editor:

In our area (coastal belt of Kutch district in Gujarat State, India), because of receding ground water levels and accumulation of soluble salts of sodium and carbonates in soil, growing groundnut is becoming more and more difficult. Farmers do try to use $FeS0_4$ and $MgS0_4$ to overcome chlorosis, but a satisfying crop still eludes them. A remote possibility of some groundnut variety which has some inbred resistance to/tolerance of salinity, can help our farmers a lot. We have heard of some progress in this line by tissue culture breeding, but it needs your authentication.
Looking forward to your comments,

Yours sincerely,

Vijay Shah
Nu Tech Farm
Rayan
Kutch District
Gujarat 370 465
India

ICRISAT Physiologist, V.M. Ramraj, replies:

We recognize that the productivity of groundnuts grown on saline-alkaline soils is reduced by salinity stress and possible micronutrient deficiencies, especially iron. Both management and genetic options exist for the alleviation of salinity-alkalinity stress. Reclamation of saline-alkaline soils through the use of gypsum and leaching of sodium salts is possible but use of salt-tolerant and iron-efficient cultivars may be more attractive for farmers. Sources of resistances to salinity stress are yet to be identified and confirmed, although the variety GG 2 is reported to be relatively more tolerant of salinity stress. However, inheritance of salt resistance, a trait selected in cell or tissue cultures of groundnut have not been reported.

News from ICRISAT Center

News about ICRISAT Groundnut Scientists and Research Fellows

Dr D.C. Sastri, Cell Biologist, left ICRISAT upon his appointment as Research Director of a Seed Company, V.A. Thomas & Co., in Cochin, India.

Dr J.P. Moss, Principal Cell Biologist, returned to ICRISAT Center after completion of his 6-month sabbatical leave in UK, during which he worked on a collaborative project at the Scottish Crops Research Institute, Dundee.

Dr K.K. Sharma, joined the Legumes Cell Biology Unit on 30 Sep 1991 as International Associate Scientist.

Dr Osmund D. Mwandemele, Geneticist and Plant Breeder, Department of Agronomy, Egertan University, Njoro, Kenya, successfully completed his 2 months senior fellowship in the Groundnut Breeding Unit.

Mr B. Soekarno Sosroprawiro, Malang Research Institute for Food Crops (MARIF), Indonesia, joined the Groundnut Breeding Unit on 13 Aug 1991 as Research Fellow for 3 months.

Mr Nguyen Dang Khoa, Institute of Agricultural Sciences, South Vietnam, joined the Groundnut Breeding Unit on 26 Aug 1991 as In-service Trainee for 6 months.

Recent ICRISAT Publications

ICRISAT (International Crops Research Institute for the Semi-Arid Tropics). 1991. Groundnut virus diseases in Africa. Patancheru, A.P. 502 324, India: ICRISAT.

ICRISAT (International Crops Research Institute for the Semi-Arid Tropics). 1991. Groundnut variety ICGV 87121 (ICGS 5). Plant Material Description no. 28. (Supplied gratis.)

ICRISAT (International Crops Research Institute for the Semi-Arid Tropics). 1991. Groundnut elite germplasm ICGV 87157 [ICG(FDRS) 4]. Plant Material Description no. 29. (Supplied gratis.)

ICRISAT (International Crops Research Institute for the Semi-Arid Tropics). 1991. Groundnut variety ICGV 87160 [ICG(FDRS) 10]. Plant Material Description no. 30. (Supplied gratis.)

ICRISAT (International Crops Research Institute for the Semi-Arid Tropics). 1990. Crop Improvement in India: ICRISAT Cultivars (Sorghum, Pearl Millet, Chickpea, Pigeonpea, and Groundnut). (Public Awareness Series.) Patancheru, A.P. 502 324, India: ICRISAT. (Supplied gratis.)

ICRISAT (International Crops Research Institute for the Semi-Arid Tropics). 1991. Conserving Germplasm for the Semi-Arid Tropics. (Public Awareness Series.) Patancheru, A.P. 502 324, India: ICRISAT. (Supplied gratis.)

ICRISAT (International Crops Research Institute for the Semi-Arid Tropics). 1991. Uses of Tropical Grain Legumes: Proceedings of a Consultants Meeting, 27-30 Mar 1989, ICRISAT Center, India. Patancheru, A.P. 502 324, India: ICRISAT.

News from Peanut CRSP (Collaborative Research Support Program)

Meetings. The Technical Committee met on 19 Apr 1991 at Griffin, Georgia. Present were: Olin Smith, Texas A&M University (Chairman); Manjeet Chinnan, University of Georgia; Tom Isleib, North Carolina State University; Bharat Singh, Alabama A & Mand David Cummins, Program Director and ex officio member. Barbara Donehoo, Management Entity Secretary, assisted with the meeting. Primary business was the finalization of budgets and workplans for 1991-92, which included recommendation on the use of the budget increase.

The Board of Directors met at North Carolina State University (NCSU) on 23-24 May 1991. Present were: Dudley Smith, Texas A&M University (Chairman); Louis Boyd University of Georgia; Onuma Okezie Alabama A&M University; Johnny Wynne, North Carolina State University; Bob Schaffert, AID Project Manager and ex officio member; and David Cummins, Program Director and ex officio member. The recommendations of the Technical Committee were reviewed and a Plan of Work and Budget for 1991-92 approved. Highlights of the meeting were a visit to the departments at NCSU which are involved in the Peanut CRSP and an overview of the research by the investigators Tom Isleib, Tom Stalker, and Art Weissinger in the Crop Science Department; Rick Brandenburg and Mary Barbercheck in the Entomology Department; and Marvin Beute, Barbara Shew, and Larry Grand (Department Head) in the Pathology Department. The group had an informative and enjoyable breakfast meeting with the NCSU administrators including Dr Durward Bateman, Dean of the School of Agricultural and Life Sciences; Dr Ron Kuhr, Associate Dean for Research; Dr Jim Harper, Head of the Entomology Department, Dr Johnny Wynne, Head of the Crop Science Department (also Board Member); and Dr Bob Gay, Fiscal Officer for the School.

The Peanut CRSP and the host country principal investigators and co-principal investigators who were attending the American Peanut Research Education Society meeting, participated in a meeting on 12 Jul 1991 in San Antonio, Texas. Also participating were the Board of Directors, External Evaluation Panel, and visitors from ICRISAT and Institut de recherches pour les huiles et oléagineux (IRHO).

Travels. Robert Lynch of the University of Georgia Insect Management project traveled to Burkina Faso and Niger, 22 Jun–2 Jul 1991, to review research data and plans for 1991 field research, and to plan coordination of research with other CRSP research in Burkina Faso and with the ICRISAT Sahelian Center.

Manjeet Chinnan and Tal Oz-Ari of the Postharvest Project were in Kingston, Jamaica, 23 Jun–3 Jul 1991, regarding progress of research and data collection. Preliminary plans were made for the Postharvest Workshop to be held in Jamaica in June 1992.

David Cummins, Program Director and Dudley Smith, Chairman, Board of Directors, Texas A&M University visited Peanut CRSP Postharvest Project sites in Belize and Jamaica from 28 Sep to 4 Oct 1991.

Graduate Students Receive Awards. Therese Malundo and Rocelle Clavero, two M.S. graduate students from the Philippines on the University of Georgia Food Technology project, were among those receiving awards at the 1991 Annual Meeting of the Institute of Food Technologists (IFT) in Dallas, Texas, in June. Ms Malundo won the Rose Marie Pangborn Graduate Paper Award (Sensory Evaluation Division) and Ms Clavero won the third place in the John C. Ayres Graduate Student Award competition (Food Microbiology Division) for the papers presented. Ms Clavero also won the Student Scientists Award from the Food Science and Human Nutrition Section of the Southern Association of Agricultural Scientists at its annual meeting in Fort Worth, Texas.

Awards

D.H. Smith Receives Wilson Service Award

D.H. Smith, Principal Plant Pathologist (Legumes), ICRISAT, was awarded the first Coyt T. Wilson Distinguished Service Award. This award is given in recognition to members of the American Peanut Research and Education Society (APRES), who have freely given of their time and contributed outstanding service to the organization.

D.H. Smith has served APRES to a degree that few other members can match. He was Executive Secretary-Treasurer for 10 years. He has also served as President-Elect, President, and Past-President and has held a number of committee assignments.

Chinese Award for Collaborative Research on Groundnut Viruses

An award for "Development in Science and Technology" was recently given to the Oil Crops Research Institute, Chinese Academy of Agricultural Sciences, China, for their contribution to the identification of peanut viruses and determination of their distribution in China during 1990, a research which ICRISAT had supported. In a letter communicating this information to D.V.R. Reddy, Principal Plant Virologist, Legumes Program, Dr Xu Zeyong, Associate Professor, Oil Crops Research Institute, says, "I think this achievement is also contributed by cooperative research supported by ICRISAT, particularly with your guidance and great help."

ICRISAT Groundnut Work Recognized in Pakistan

ICRISAT has received special recognition for its contribution to the Barani Agricultural Research and Development (BARD) Project at the BARD Concluding Ceremonies and Open House in Islamabad, Pakistan, on 2 May 1991. The Asian Grain Legumes Network (AGLN) Coordinator D.G. Faris, representing ICRISAT, was presented with a special certificate of appreciation. Since 1983, ICRISAT has supplied to BARD's breeding program, groundnut germplasm and equipment to cultivate and process the crop. BARD has released the variety BARD 699, a composite of two ICRISAT lines.

Announcements

Information on Groundnut Cultivars in Various Parts of the World

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

Principal Groundnut Breeder
ICRISAT Center
Patancheru
Andhra Pradesh 502 324
India

Southern Regional Information Exchange Group on Peanut Molecular Biology

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

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

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

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

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

Mehan, V.K., McDonald, D., Haravu, L.J., and **Jayanthi, S.** 1991. The Groundnut Aflatoxin Problem - Review and Literature Database. Patancheru, A.P. 502 324, India: International Crops Research Institute for the Semi-Arid Tropics. 388 pp.

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

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

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

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

Workshop on Integrated Pest Management and Insecticide Resistance Management in Asian Grain Legume Crops

J.A. Wightman (ICRISAT Center)

Some 40 delegates representing the major legume-growing countries of Asia, the agrochemicals industry, and international research and policy organizations met in Chiang Mai, Thailand, to discuss the integrated management of grain legume pests in Asia and the related topic of insecticide resistance management from 19 to 22 Mar 1991. The meeting was sponsored by the International Development Research Centre (IDRC), Ciba-Geigy (Thailand) Ltd., and ICRISAT, as an activity of the Asian Grain Legumes Network (AGLN).

The workshop was divided into two 2-day meetings. The first meeting dealt with integrated pest management (IPM) *per se*, and the second with insecticide resistance management (IRM), recognizing that IRM is a facet of IPM.

The **Objectives** of the workshop were to:

- determine the need and the strength of support for network activity among legume entomologists in Asia, and if the need was demonstrated, then to:
- highlight priority areas (research topics and key insect pests),
- examine the feasibility of increasing the interaction between public sector researchers and the agrochemical industry,
- determine the extent and intensity of insecticide resistance in the farming systems that include grain legumes, and
- to discuss policies which would prevent insecticide resistance in legume crops reaching the grave levels found in other commodities.

Recommendations Leading to the Formation of a Subnetwork Dedicated to the Integrated Control of Insect Pests of Grain Legumes in Asia

1. It was recommended that a network should be formed, under the aegis of the Asian Vegetable Research and Development Center (AVRDC), FAO, and ICRISAT (AGLN) to promote:
   a) the exchange of information on grain legume pests. Specific mention was made of the need to communicate information on the results of pest surveys carried out by members of national programs;
   b) the exchange of natural control agents, including pathogens and germplasm, and breeders' material with insect resistance in its profile;
   c) human resource development by the interchange of trainees and organization of specialist training courses;
   d) the development and application of biotechnological techniques specifically oriented to the needs of IPM schemes.
   e) rational insecticide management; and
   f) taxonomic support for the identification of insect pests and their natural enemies, ideally through a Regional Center.

2. It was recommended that attention should be focussed on specific problems through the medium of working groups consisting of specialists from the National Programs, the private sector, and where accessible, from international institutes in the region and from institutes on other continents.

The Working Groups highlighted in discussion, in priority order of topics, are:

Pesticide management	(1)
Agromyzid flies	(2=)
Storage pests	(2=)
Insecticide application	(4)
Helicoverpa	(5)
Maruca	(6)
Virus vectors	(7)
Soil insects	(8=)
Pod borers	(8=)
Defoliators	(10)
Thrips	(11)
Heteroptera	(12)
Insect pathogens (see note below)	

(Note: The exploitation of insect pathogens was noted to be of highest priority by researchers but the ranking of this topic was depressed because it is currently less important to the private sector than the other topics although research is ongoing)

3. The need to monitor the effectiveness of IPM in economic and socioeconomic terms was stressed, and specific recommendations were made to:
   a) hold a workshop in the near future, to compile all available baseline data on the relationships between pest density and yield loss for grain legume crops;
   b) to initiate studies on the effectiveness and farmer perceptions of IPM in grain legume crops;
   c) analyze the impact of the policy environment in the advancement of IPM.

4. Technology exchange and information transfer should be facilitated by:
   a) newsletter(s)
   b) meetings of Working Groups
   c) constructing an IPM database
   d) investigating the possibility of organizing an International Grain Legumes Workshop in 1993/94 by ICRISAT in India
   e) procuring support for intercountry study tours.

5. The membership of the network should be widened to increase the pool of experience available within the network and to attract donor support.

6. Attempts should be made to have contacts with other networks having common interests.

7. A Steering Committee administered by AGLN and based at ICRISAT Center should be formed to promote the activities of this subnetwork. It should be chaired by an ICRISAT Legumes Entomologist and include representatives from AGLN countries or their nominees if the representatives are not plant protection specialists. The private sector, AVRDC, FAO, and other Non Governmental Organizations (NGOs) should be represented on this steering committee.

Recommendations on Insecticide Resistance Management in Asian Grain Legumes

1. The group recognized the importance of IRM as a component of the integrated management of legume pests and intends to link IRM with the proposed IPM network through the pesticide management working group. It also recognized that many of the insect pests of legumes live on other crops and stressed the importance of the coordination of IRM activities on the basis of insect species and across farming systems (as opposed to the existing emphasis on crops and commodities).

2. The group emphasized the need to accumulate baseline data about key or high-risk pests with respect to their resistance to different classes of insecticides, wherever possible before resistance was detected or suspected. Initial research projects should focus on:

   Maruca
   Spodoptera
   Helicoverpa
   Aphids, jassids, and white flies
   and insect pests of local relevance

3. There is a need to increase the number and quality of test laboratories and training courses to obtain the required baseline data. Training should be imparted by resource personnel from private and public sectors.

4. Monitoring techniques should be identified, standardized, and developed or refined where necessary.

5. IRM/IPM strategies should be formulated on the basis of site specific, baseline susceptibility and resistance data and on the results of resistance.

6. There is a need for the continuous evaluation of IRM strategies.

7. Every effort should be made to ensure the full participation of policymakers, researchers, industry and farmers to guarantee the success of IPM/IRM programs.

8. The Asian Grain Legumes IRM Network should establish linkages with the donor community, International Organization for Pesticide Resistance Management (IOPERM), Insecticide Resistance Action Council (IRAC), FAO and other international bodies to sustain work on IRM.

Global Trends in Area, Production, and Productivity of Groundnut

A. Krishnan and **V.S. Ramachandran**
(University of Agricultural Sciences, Bangalore, India)

A comparison of groundnut coverage and production in different countries of the world was carried out earlier using data up to 1974 (Krishnan and Rao 1979). The objective of this note is to make an international comparison with respect to different continents as well as countries using data up to 1987.

Table 1 shows the mean area, production, and productivity of groundnut in different continents and for the world. This table is based on data from 1963 to 1987 as published in the FAO production yearbooks. The trend equations and CV values are also given. The main features revealed by this table are as follows:

1. Mean area, production, and productivity of groundnut in different continents of the world.
   a) Area: Out of the total area of 19.1 million hectares in the world, Asia contributed 11.1 (57.8%) and Africa 6.5 (34.1%) million ha. Both these continents account for 91.9% of the total area under groundnut in the world. Each of the North, Central and South American continents have only 3.8% of the total area.
   b) Production: The total production in the world was 18.3 million t with the contribution of 10.6 million t (58.1%) from Asia and 5.0 million t (27.1%) from Africa. Thus these two continents together account for 85.2% of the total production. The contribution to the global production by North and Central America was 9.0% and by South America 5.2%. The differences in percentage contribution values of production from those of area are because of low productivity in the African continent and comparatively higher productivity in the two American continents.
   c) Productivity: The mean groundnut productivity in the world was 958 kg ha^{-1}. Highest productivity is noticed in the North and Central American continents (2194 kg ha^{-1}) followed by Europe (2065 kg ha^{-1}), South America (1332 kg ha^{-1}) and Australia (1179 kg ha^{-1}). However, the area under groundnut in Australia was only 34 000 ha and in Europe 11 000 ha, both together contributing only 0.24% of the total global area. The least productivity of 761 kg ha^{-1} was recorded in Africa. Asia, having

Table 1. Mean area, production, and productivity of groundnut in different continents of the world[1].

Continent	Area (A) Mean ('000 ha)	Area CV (%)	Production (P) Mean ('000 t)	Production CV (%)	Productivity (Y) Mean (kg ha^{-1})	Productivity CV (%)
Asia	11054	5.2	10627	17.9	957	13.9
	(A=10283.4 + 59.30 ha)[2]		(P=7679.0 + 226.79 t)		(Y=759.8 + 15.17 t)	
Africa	6518	8.7	4958	12.3	761	8.5
	(A=7342.3 – 63.44 ha)		(P=5718.6 – 58.50 t)		(Y=780.6 – 1.51 t)	
North and Central America	747	4.3	1646	20.4	2194	17.8
	(A=711.7 + 2.71 ha)		(P=1174.8 + 36.26 t)		(Y=1659.7 + 41.13 t)	
South America	743	13.8	956	24.6	1332	18.7
	(A=1078.0 – 25.79 ha)		(P=1241.4 – 21.97 t)		(Y=1016.9 + 24.21 t)	
Australia	34	22.1	41	33.1	1179	20.1
	(A=24.9 + 0.72 ha)		(P=26.25 + 1.15 t)		(Y=1036.8 + 10.95 t)	
Europe	11	12.7	23	11.7	2065	8.7
	(A=11.8 + 0.04 ha)		(P=22.2 + 0.07 t)		(Y=1884.6 + 13.86 t)	
World	19107	3.0	18287	9.1	958	10.2
	(A=19466 – 26.72 ha)		(P=15787.7 + 192.25 t)		(Y=807.9 + 11.52 t)	

1. Source: FAO production year books (1963 to 1987), volumes 18 to 41, Rome, Italy.
2. Figures in parentheses refer to trend equation as a percentage of continent average to the world average.

57.8% of the total global area under groundnut, had a mean productivity of 957 kg ha^{-1}.

2. Interannual variability of area, production, and productivity of groundnut in different continents of the world.
   a) Area: CV value for the world was low, being only 3%. Except India, North and Central Americas, all other continents had high interannual variability in area under groundnut. The highest CV value was in South America (31.8%) followed by Australia (22.1%).
   b) Production: For all the continents, interannual variability in production was much higher than that of area, probably because of yearly fluctuations and due to changes in the productivity. For Asia the CV was 17.9% which was higher than that for Africa which is 12.3%. The continents having CV values exceeding 20% were Australia, North, Central, and South America.
   c) Productivity: The least interannual variability was for Africa (8.5%), which was lower than that for Asia (13.9%). CV values ranged from 17.8 to 20.1% for Australia and the two American continents.

3. Trends in area, production, and productivity of groundnut in continents.
   a) Area: During the study period, there was an increasing trend in the area under groundnut cultivation in Asia with a trend coefficient of 59 300 ha a^{-1}, in North and Central America with a trend coefficient of 2710 ha a^{-1} and in Australia with a trend coefficient of 720 ha a^{-1}. Africa revealed a decreasing trend with a coefficient of 63 440 ha a^{-1} as did South America with a coefficient of 25 790 ha a^{-1}. The causes for this negative trend require careful examination. Europe indicates practically no trend. In view of large decreases in area under groundnut in African and South American continents, there was a decreasing trend in the world area, with a coefficient of 26 720 ha a^{-1}.
   b) Production: In spite of the decreasing trend in the area coverage of groundnut, there was an increasing trend in groundnut production during 1963 to 1987 with a positive coefficient of 0.19 million t a^{-1} because of enhanced productivity trends in different continents. The highest positive trend coefficient of 0.23 million t a^{-1} was noticed for Asia followed by 0.04 million t a^{-1} for North and Cen-

Table 2. The mean area, production and productivity of groundnut in 15 major groundnut-producing countries of the world.

Country	Area ('000 ha)	Production ('000 t)	Productivity (kg ha^{-1})	Productivity rank
India	7172.2	5581.1	772.6	11
China	2468.4	3198.2	1478.9	2
Senegal	1027.4	849.8	826.2	9
Nigeria	964.8	853.4	879.1	7
Sudan	637.2	555.8	857.1	8
USA	593.1	1515.5	2549.3	1
Myanmar	576.9	468.4	806.8	10
Zaire	497.5	344.7	691.4	12
Indonesia	447.0	622.0	1373.0	4
Brazil	396.1	526.6	1371.7	5
Cameroon	290.4	128.2	478.2	15
Argentina	277.7	358.1	1384.2	3
South Africa	275.4	261.2	930.2	6
Malawi	244.5	165.9	672.9	13
Niger	234.7	132.7	532.4	14
Total	16103.3	15561.6	Mean 1040.3	
Percentage of mean global value	84.3	85.1	108.6	

tral America. Decreasing trends in production were recorded for Africa with a negative trend coefficient of 0.06 million t a^{-1} and for South America with a negative trend coefficient of 0.02 million t a^{-1}. The positive trend coefficients for Australia and Europe were extremely low.

c) Productivity: For the world as a whole, there was a moderate increasing trend with a coefficient of 11.52 kg ha^{-1} a^{-1}. The highest positive trend coefficient was with respect to North and Central America (41.13 kg ha^{-1} a^{-1}). This was followed by South America (24.21 kg ha^{-1} a^{-1}) and Asia (15.17 kg ha^{-1} a^{-1}). Australia and Europe also had positive trend coefficients exceeding 10 kg ha^{-1} a^{-1}. In North and Central America and in Europe, very high productivity was seen in the initial years. These continents maintained their increasing trends during the study period also. The only continent which indicated a slightly decreasing trend in groundnut productivity was Africa with a coefficient of -1.51 kg ha^{-1} a^{-1}.

4. Analysis of data in major groundnut-producing countries.

The mean area, production and productivity of groundnut in 15 major groundnut-producing countries of the world are shown in Table 2.

These data are based on FAO statistics from 1965 to 1987 and countries with mean area of 0.2 million ha and above have been included. Fifteen countries indicated above accounted for 84.3% of the total global area and 85.1% of the total global production. India topped in area (7.17 million ha) and production (5.58 million t). But it ranked only 11th in productivity. India's productivity was only 772.6 kg ha^{-1} compared with the global average of 958 kg ha^{-1} and an average of 1040.3 kg ha^{-1} for the 15 countries mentioned above. The highest productivity of 2549.3 kg ha^{-1} was recorded for USA followed by China, Argentina, Indonesia, and Brazil. All these countries had productivity exceeding 1000 kg ha^{-1}. Though USA ranked sixth in terms of area, it ranked third in terms of production on account of its higher productivity.

Reference

Krishnan, A., and **Murali Mohan Rao, E.V.** 1979. Analysis of trends and stability in production of groundnut in India and an agro-climatic study of its productivity. Technical Monograph 1/79. Centre for advanced research in Agro-meteorology, University of Agricultural Sciences, Bangalore, India. 66 pp.

"TAG 24" - A New Early Maturing and High-Yielding Groundnut Variety for Vidarbha Region of Maharashtra State, India

G.R. Fulzele, D.G. Weginwar, and S.N. Deshmukh (Oilseeds Research Unit, Punjabrao Krishi Vidyapeeth, Akola, Maharashtra 444 104, India)

Groundnut (*Arachis hypogaea* L.) is one of the major oilseed crops grown in Maharashtra state. The area under groundnut in Maharashtra is 0.66 million ha in the rainy season and 0.26 million ha in the postrainy season. Vidarbha region of Maharashtra State contributes about 0.11 million ha in rainy season and 25 000 ha in postrainy season with a production of 77 000 t in the rainy season and 28 000 t in the postrainy season.

A new genotype of groundnut TAG 24 (Trombay-Akola-Groundnut-24) was developed by Punjabrao Krishi Vidyapeeth, Akola in collaboration with the Bhabha Atomic Research Centre, Trombay. This is a cross derivative of TGS 2 (TG 18A × M 13) × TGE 1 (Tall mutant × TG 9). Multilocational trials were conducted at four locations during the rainy and postrainy seasons of 1987, 1988, and 1989 in the Vidarbha region. This genotype gave excellent pod yield compared to the controls JL 24 and J 11, during the rainy season and over SB XI and UF 70103 during the postrainy season. It recorded 23.91% higher pod yield over the best control JL 24 during the rainy season, and in the postrainy season, it established its superiority over the best control UF 70103, by recording 50.5% higher pod yield (Tables 1 and 2).

In the Vidarbha region, two varieties—JL 24 and SB XI were recommended and grown during the rainy season, while varieties SB XI and UF 70103 were grown during the postrainy season. At present SB XI is the only variety that can be grown in both the seasons but its yield levels have been found to be stagnant. There was therefore a need to replace this variety by some suitable variety in both the seasons, which would have higher productivity levels than JL 24 in the rainy season, higher than UF 70103 in the postrainy season, and higher than

Table 1. Pod yields of TAG 24 and other control groundnut varieties in multilocational trials in the Vidarbha region of Maharashtra, India, rainy season 1987–89.

		Pod yield (kg ha^{-1})				
Year	Location	TAG 24	JL 24	SB XI	SE	CV (%)
1987	Akola	1054	741	660	± 80.2	10.2
	Achalpur	1713	1484	1519	±173.6	14.5
	Amravati	1099	546	531	±100.7	15.0
	Nagpur	2487	1363	1142	±125.1	11.9
1988	Akola	1264	1268	1015	±103.1	17.4
	Achalpur	525	596	510	± 47.7	7.7
	Amravati	1697	1465	1092	±149.9	21.0
	Nagpur	1864	1892	1164	±198.3	24.9
1989	Akola	769	703	724	± 63.8	16.3
	Achalpur[1]	1058	767	585	± 98.3	31.4
	Amravati	639	525	743	± 78.6	22.4
	Nagpur[1]	867	680	943	±230.0	34.0
	Mean	1311	1058	910		
	Increase (%)		(23.91)[2]	(44.06)		

1. Not considered in calculating mean pod yields because of higher cv percentage.
2. Figures in parentheses refer to percentage of yield increase of TAG 24.

Table 2. Pod yields of TAG 24 and other control groundnut varieties in multilocational trials in the Vidarbha region of Maharashtra, India, postrainy seasons 1987/88–1989/90.

Year	Location	Pod yield (kg ha^{-1})					
		TAG 24	UF 70103	SB XI	ICGS 11	SE	CV (%)
1987/88	Akola	2569	1097	2109	2137	±261.0	13.2
	Achalpur	2269	2196	2018	2563	±217.8	11.5
	Amravati	1554	1222	1156	1449	±236.9	9.0
	Nagpur	4661	2938	2890	2642	±377.7	12.6
1988/89	Akola	2956	1655	1408	2352	±198.4	19.3
	Achalpur	1433	1523	2025	1344	±173.6	20.0
	Nagpur[1]	2771	2462	1513	2912	±278.4	24.0
	Amgaon[1]	4911	4227	4543	5510	±600.7	27.3
1989/90	Akola	2078	761	579	1149	± 96.8	15.9
	Achalpur	1186	816	899	965	± 37.4	13.0
	Nagpur	3729	2709	1847	4280	±219.8	12.9
	Amgaon[1]	3231	3386	3816	4136	±954.2	21.3
	Mean	2493	1657	1659	2098		
	Increase (%)		(50.45)[2]	(50.27)	(18.83)		

1. Not considered in calculating mean pod yields because of higher cv percentage.
2. Figures in parentheses refer to the percentage of yield increase of TAG 24.

SB XI in both the seasons. The new variety, TAG 24, had 50.8% oil content as against 49.2% of JL 24 and SB XI. It matured in about 100 - 105 days during the rainy season, and in 112 - 117 days during the postrainy season, which is comparable to 90 days maturity period of JL 24 in the rainy season and 130 days maturity period of SB XI in the postrainy season. TAG 24 had a shelling percentage of 69.5, and medium-sized seed (100-seed mass 35 to 39 g). The plant type was very dwarf (15 - 20 cm in height) and responded well to higher plant densities. Higher pod yield, moderate shelling, high oil, moderate resistance to bud necrosis disease and early maturity in summer, dwarf structure and adaptability to both rainy and postrainy seasons are the major advantages of TAG 24.

This variety will replace all the three existing varieties. An additional advantage of having the same variety for both the seasons is that it simplifies the seed multiplication program and eliminates the necessity of having to store seed for 1 year.

Evaluation of Broadbeds and Furrows (BBF) for Summer Groundnut in Rice Fallows of Northern Telangana, Andhra Pradesh, India

V. Praveen Rao, A. Gangakishan, and **M. Devender Reddy** (Regional Agricultural Research Station, A.P. Agricultural University, Jagtial, Andhra Pradesh 505 327, India)

In the northern Telangana region of Andhra Pradesh, India, the agroecosystem is deteriorating because of the continuing rice-rice culture. Summer groundnut is therefore increasingly being promoted in the command areas of medium and major irrigation projects in this region. This commercially viable and potentially profitable oilseed crop fits well into the rice-groundnut crop rotation.

In the northern Telangana region, rice is normally sown late in the rainy season because of the late release of canal water, which results in late harvesting of the crop (Nov-Dec). Because of this, land preparation and sowing of summer groundnut can be done only in January. The soils under rice fallows are Vertisols and Alfisols, with subsoil clay pan normally having low infiltration rates, and thus get waterlogged. Amin et al. (1989) reported that the broadbed-and-furrow (BBF) technology was useful both for rainfed and irrigated groundnuts. A study was taken up to evaluate the BBF in comparison with the control, flatbed (check basin), for groundnut in rice fallows.

The experiment was conducted in 1990 on a Vertisol. The chemical analysis of the experimental site showed 112 kg N, 12 kg P_2O_5, and 260 kg of K_2O ha^{-1} with a pH of 7.7. The hydrological properties revealed that the moisture held at field capacity (0.03 MPa) was 0.39 cm^3 and wilting point (1.5 MPa) 0.20 cm^3. A uniform dose of 20 kg of N as urea; 60 kg P_2O_5 as single super phosphate, and 20 kg K_2O ha^{-1} as muriate of potash were applied to all the plots. The N was given in two equal splits, i.e., as basal and at 20 days after sowing, while the entire P_2O_5 and K_2O were given as basal applications. Groundnut cultivars, Kadiri 3 and ICGS 11 were grown under both the flatbed and BBF systems in a randomized block design with 10 replications. The crop was sown on 20 Jan 1990, after treating the seed with Dithane-M45 at the rate of 3 g kg^{-1} of seed, at 30 × 10 cm spacing on both BBF and flatbeds. In the case of BBF, gypsum was applied at the rate of 500 kg ha^{-1} during peg formation at the base of the plants. Other recommended agronomic practices and plant protection measures were followed uniformly in both the treatments. The crop was harvested on 29 May 1990. The data on important yield parameters and yield are given in Table 1.

The data in Table 1 suggested that ICGS 11 performed better on BBF, while Kadiri 3 performed better on flatbed. In addition to greater pod yield, ICGS 11 recorded higher shelling percentage and 100-seed mass when grown on BBF. These results indicate that ICGS 11 should be taken on BBF with gypsum application to realize its high yield potential.

Reference

Amin, P.W., Jain, K.C., Kumar Rao, J.V.D.K., and **Pawar, C.S.** 1989. ICRISAT's experience in the introduction of improved groundnut technology in India. Pages 61-65 *in* Summary Proceedings of the Regional Legumes Network Coordinators Meeting, 20-24 Nov 1989, ICRISAT, Hyderabad, India. Patancheru, A.P. 502 324, India: International Crops Research Institute for the Semi-Arid Tropics.

Influence of Composite *Rhizobium* Seed Inoculation on Nodulation and Yield of Groundnut Cultivar JL 24

J. Prabakaran and **K. Sivasubramaniam**
(National Pulses Research Centre, Vamban, Pudukottai, Tamil Nadu 622 303, India)

Use of composite strains of *Rhizobium* for legume seed inoculation has been found economically prospective for soybean, French bean (Das and Bhaduri 1975), and other legumes (Raut et al. 1980). The underlying principle is that at least one of the many strains used in composite culture might establish well and provide effective nodulation. The composite culture has the advantage of being able to be used to inoculate different crops and also achieve a suitable interaction depending on the prevailing edaphic conditions.

A field experiment was conducted in the acid lateritic (pH 5.8) soils of Vamban, Tamil Nadu, India, using three natively developed rhizobial strains—VPR 1, VGR 1, VCP 1, and their composites, along with nitrogen control (70 mg kg^{-1}) and noninoculate control. A plot size of 4 × 3 m^2 and a spacing of 45 × 15 cm^2 was adopted to grow

Table 1. Effect of broadbed-and-furrow (BBF) and flatbed sowing on yield-contributing characters and yield of groundnut, Jagtial, A.P., India, summer 1989.

	Flatbed		BBF		
Character	ICGS 11	Kadiri 3	ICGS 11	Kadiri 3	SE
Dry matter $plant^{-1}$ (g)	57.8	58.5	49.8	55.6	± 4.37
Number of pods $plant^{-1}$	35.0	33.0	44.0	32.0	± 2.06
Shelling (%)	65.6	65.9	71.7	64.7	± 0.72
100-seed mass	40.9	37.5	43.2	37.0	± 0.68
Dry pod yield (t ha^{-1})	2.9	3.9	4.8	3.6	± 0.17

Table 1. Nodulation characteristics and yield of groundnut cultivar JL 24 as influenced by composite cultures of *Rhizobium*, Vamban, Tamil Nadu, rainy season 1988.

Culture/ Treatment	Nodule number $plant^{-1}$ 60 DAS	Nodule mass (mg) $plant^{-1}$ 60 DAS	Pod yield (kg ha^{-1})
VPR 1	46	91	1395
VGR 1	42	86	1230
VCP 1	34	62	1180
Composite culture	64	136	1510
Nitrogen control	23	45	1348
Control	20	33	995
SE	±2.64	± 4.67	± 53.11

the groundnut cultivar JL 24. A common basal fertilizer dose of $N_0P_{50}K_{15}$ kg ha^{-1} was applied evenly. Inoculation with *Rhizobium* using 10^7 cells g^{-1} of peat base inoculates was made in all the treatments except in controls. The plots were replicated four times.

Ten plants were pulled out at 60 days after sowing (DAS) and nodule number and mass $plant^{-1}$ were assessed. The yield of the respective treatments was assessed after harvest.

A large variation was found in the nodule number $plant^{-1}$ (Table 1). Seeds inoculated with composite cultures possessed the highest nodule numbers and were statistically significant at 5% probability level followed by the local strains VPR 1 and VGR 1. Composite culture did influence the nodule mass, as revealed by the highest value of 136 mg recorded by the seeds treated with composite strains. The composite culture also resulted in the highest pod yields followed by the local strain, VPR 1.

References

Das, S.N., and **Bhaduri, P.N.** 1975. Host *Rhizobium* interaction between *Phaseolus vulgaris* L. and *Rhizobium phaseoli*. Proceedings of the Indian National Science Academy, Part B, 40:554-561.

Raut, R.S., **Ghonsikar, C.P.**, and **Musande, V.G.** 1980. Effect of composite cultures of *Rhizobium* on important legumes grown in Marathwada region. Pages 19-21 *in* Aspects of biological nitrogen fixation: proceedings of the Third Southern Regional Conference on Microbial Inoculants in Crop Production, 1-2 April 1977, Dharwad, India. UAS Technical Series no. 28. Bangalore, Karnataka, India: University of Agricultural Sciences.

Survey on the Occurrence of *Aspergillus* Contamination of Groundnut Seeds in Eastern Province, Zambia

J. Kannaiyan and **S. Sithanantham** (Food Legumes Research Team, Msekera Regional Research Station, PO Box 510089, Chipata, Zambia)

In Zambia, a limited occurrence of afiatoxin was observed in groundnut seeds. This was attributed to *Aspergillus flavus* contamination of seeds in field/storage (Kannaiyan et al. 1989). *A. flavus* contamination has also been known to affect the viability of seeds, and to lead to stunting of the young seedlings (aflaroot). In the Eastern Province, the major groundnut-producing area of the country, farmers get their seed mainly from their own crop of the previous season, from neighbors, or from local markets (Sithanantham et al. 1987). The present survey was undertaken to assess the occurrence of contamination by *A. flavus* in seeds being used by the farmers in the province and the associated losses.

During Oct-Nov 1987 (just before sowing in December), we traveled in five districts in the Eastern Province and collected samples of seeds kept by farmers for sowing. We collected at least 200 seeds each from 20 farmers, with 3–6 farmers representing each district, in Chadiza, Chipata North, Chipata South, Katete, and Lundazi districts. From each sample, we subjected 100 seeds to a blotter test (on moist filter paper in petri dishes) to record seed germinability and the percentage of seeds contaminated by *A. flavus*. We sowed the other 100 seeds from each sample in the field at Msekera during December 1987, and recorded the percentage of plants germinated and the seed yield of the plot. For comparison, seed samples of three cultivars, MGS 2, Makulu Red, Chalimbana from the research station, were also included in these observations.

The results (Table 1) showed that the range in *A. flavus* contamination in farmers' seed samples was from 4 to

Table 1. Seed contamination by *Aspergillus,* germinability and field performance of farmers' groundnut seeds collected in the Eastern Province, Zambia, 1987/88.

District/Source	Laboratory test[1]		Field test[2]	
	Seeds infected with *Aspergillus* (%)	Seeds germinated (%)	Plants emerged (%)	Seed yield plot^{-1} (g)
Chipata South				
Kalichero	30	76	21.3	23.4
Kalichero	26	67	6.3	16.0
Sikito	13	83	10.0	22.6
Sikito	16	66	16.3	29.4
Sikito	15	86	22.5	25.4
Mean	20	75.6	15.3	23.4
Chipata North				
Chinyaku	56	68	21.3	24.1
Maei Mutoti	55	66	3.8	7.5
Mainja	4	78	20.0	59.6
Mainja	26	78	11.3	32.0
Simioni	27	80	37.5	50.1
Simioni	38	78	18.8	47.0
Mean	34.3	74.7	18.8	36.7
Katete				
Chilembo	85	14	2.5	1.4
Muwanje	83	19	7.5	11.8
Muwanje	80	24	5.0	8.1
Muwanje	87	14	5.0	7.1
Mean	83.8	17.8	5.0	7.1
Chadiza				
Champhanje	89	22	3.8	2.5
Kasiye	68	11	11.3	21.6
Kasiye	51	34	15.0	33.7
Mean	69.3	22.3	10.0	19.3
Lundazi				
Chanks	16	86	2.5	8.9
Chanks	17	85	11.3	45.0
Chanks	16	83	18.8	74.2
Mean	16.3	84.7	10.9	42.7
Msekera (Controls)				
MGS 2	26	68	26.3	134.7
Makulu Red	10	98	40.0	141.4
Chalimbana	14	84	30.0	73.6
Mean	16.7	83.3	32.1	116.6
SE	-	-	±4.29	±11.79
Overall mean	39.50	61.17	15.10	37.25
CV (%)	-	-	40.2	44.8

1. At 10 seeds plate^{-1}; 10 plates sample^{-1}; five replications.
2. At 40 seeds plot^{-1}; two replications; plot size 1 row x 4 m; spacing 75 cm x 10 cm; sown on 5 Jan 1988; harvested on 27 May1988.

89%, the average for districts being 84% for Katete, 69% for Chadiza, 34% for Chipata North, 20% for Chipata South, and 16% for Lundazi, as against 17% for seeds from the research station. The laboratory estimates of mean seed germinability for the five respective districts were 18, 22, 75, 76, and 85% compared to 83% for seeds from the research station. Apparently, the extent of seed contamination tended to negatively influence the seed germinability.

In the field germination test, however, the germinability of the seeds from the five districts ranged from 5 to 19% as against 32% for the research station seeds. The mean seed yield plot^{-1} ranged from 7 to 43 g in the five districts, as against the mean plot yield of 116 g for the research station seeds.

These results showed that the seed contamination during the season was distinctly high in two districts—Katete and Chadiza—which consequently resulted in lower viability of seeds and seed yields of the resulting crop. The likely reasons for the higher seed contamination in the two districts need to be examined.

There was a significant negative correlation between *A. flavus* contamination and the percentage of germinability in the field ($r = 0.92^{**}$). This shows that the extent of seed contamination by the fungus had a direct adverse effect on seed germinability, which in turn can substantially affect the plant stand.

References

Kannaiyan, J., Sandhu, R.S., and **Phiri, A.L.** 1989. Aflatoxin and *Aspergillus flavus* contamination problems of groundnuts in Zambia. Pages 65-70 *in* Aflatoxin contamination of groundnut: Proceedings of the International Workshop, 6-9 Oct 1987, ICRISAT Center, India. Patancheru, A.P. 502 324, India: International Crops Research Institute for the Semi-Arid Tropics.

Sithanantham, S., Lungu, T., and **Kannaiyan, J.** 1987. Survey on farmers practices and perceptions and relating to storage losses in grain legumes and groundnut, Eastern Province, Zambia: Msekera Regional Research Station, Chipata. (Limited distribution).

Preharvest *Aspergillus flavus* Infection of Apical and Basal Seed in Pods of Groundnut Genotypes

V.K. Mehan[1], **A. Ba**[2], **N. Ramakrishna**[1], and **D. McDonald**[1] (1. ICRISAT Center; 2. ISRA, Kaolack, Senegal)

Under fluctuating drought stress conditions, *Aspergillus flavus* Link ex Fries invades groundnut pods during their development in the soil, possibly by direct penetration through nondamaged shells (Diener et al. 1987). *A. flavus* colonization of groundnut flowers and aerial pegs may lead to systemic seed infection (Pettit et al. 1986; Pitt 1989). These different 'entry and infection pathways' may, to some degree, influence which seeds in multiseeded pods are infected by the fungus. This prompted us to examine preharvest fungal infection in relation to seed position within the pod. This paper reports the frequencies of fungal infection of apical (distal, near the beak) and basal (proximal, near the peg) seed within pods of groundnut genotypes grown in different environments.

Field trials were conducted at two locations (Nioro and Bambey) in Senegal during the 1988 rainy season, and at ICRISAT Center, Patancheru, India, during the 1990 rainy and 1990/91 postrainy seasons. In each location/season, sets of two genotypes were grown in randomized block designs with four or five replications. Standard cultural practices were used to grow these genotypes at each location. Trials in the rainy season were rainfed, while in the postrainy season the trial was irrigated but drought stress was imposed 90 days after sowing by withholding irrigation. Twenty-five plants were selected at random from each plot at harvest and nondamaged mature pods were picked for hand-shelling. One-hundred apical and 100 basal seeds from the same pods were examined for fungal infection using the methods according to Mehan et al. (1986).

A. flavus infection levels were higher in basal seeds than in apical seeds at both locations in Senegal (Fig. 1a). Significant differences in infection between seed positions occurred only in genotypes GH 119-20 (in Nioro) and EC 76446(292) (in Bambey). Levels of seed infection by *A. flavus* were much higher in Bambey than in Nioro. It was attributed to severity of drought stress during pod development and maturity. Only 1.4 mm of rainfall was received at Bambey compared with 158 mm of rainfall at Nioro in the last 40 days before harvest.

In the 1990 rainy season trial at ICRISAT Center, preharvest seed infection levels were low (<2%), hence, no data are given. These low levels of infection were attrib-

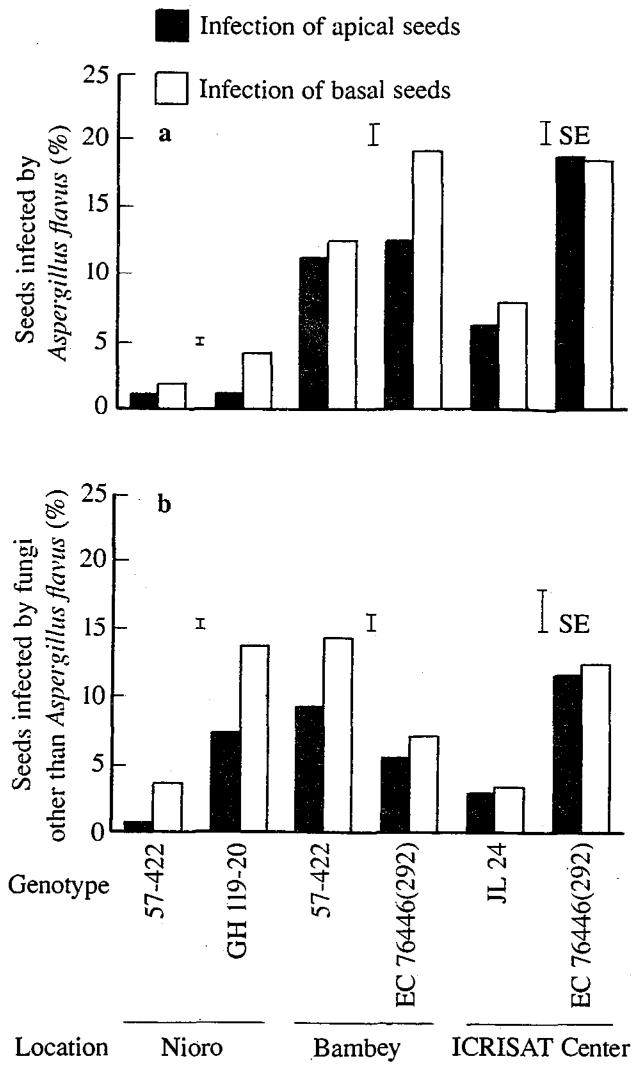

Figure 1. Infection of apical and basal seeds in pods of groundnut genotypes grown at Nioro and Bambey in Senegal (in the 1988 rainy season) and at ICRISAT Center in India (in the 1990/91 postrainy season) by *Aspergillus flavus* (a) and by fungi other than *A. flavus* (b). Standard error (SE) of difference for comparisons between and within genotypes are given separately for each location.

uted to high and well-distributed rainfall in the season. In the 1990/91 postrainy season, no significant differences in *A. flavus* infection were noted for any genotype with respect to seed position (Fig. 1a).

These results indicate that fungal infection of apical and basal seed within groundnut pods could vary with environmental conditions and genotypes. For example, at both locations in Senegal, the genotype 57-422 showed little difference for *A. flavus* infection of apical and basal seeds. At Bambey, there were conspicuous differences with EC 76446(292) for *A. flavus* infection of apical and basal seeds but not at ICRISAT Center. At both locations in Senegal, infection with fungi other than *A. flavus* was significantly higher in basal seeds than in apical seeds irrespective of genotypes, but these differences were only small in both genotypes grown at ICRISAT Center in the 1990/91 postrainy season (Fig. 1b).

Under drought-stress conditions, some cultivars could show similar levels of infection in both apical and basal seeds, while some others with weak areas towards the pod-tip could show more infection in the apical seed. For instance, much higher levels of *A. flavus* were observed in apical seeds of EC 76446(292) and NC Ac 17090 in Anantapur (a severe drought-prone area in Andhra Pradesh, India) in the 1986 rainy season (V.K. Mehan, ICRISAT, interpersonal communication). Pods of both of these genotypes have prominent beaks with weak areas in the shells below the beak and this could predispose the apical seeds to fungal invasion. Further studies are needed to differentiate shell reaction to fungi at specific points on the pod surface, and to assess if apical and basal seeds of different genotypes differ innately in their responses to fungal invasion.

References

Diener, U.L., Cole, R.J., Sanders, T.H., Payne, G.A., Lee, L.S., and **Klich, M.A.** 1987. Epidemiology of aflatoxin formation by *Aspergillus flavus*. Annual Review of Phytopathology 25:249–270.

Mehan, V.K., McDonald, D., Ramakrishna, N., and **Williams, J.H.** 1986. Effects of genotype and date of harvest on infection of peanut seed by *Aspergillus flavus* and subsequent contamination with aflatoxin. Peanut Science 13:46–50.

Pettit, R.E., Martin, C.L., and **Smith, O.D.** 1986. Incidence of *Aspergillus flavus* and *Aspergillus niger* in peanut pegs, immature pods and kernels. Proceedings of American Peanut Research and Education Society 18:64.

Pitt, J.I. 1989. Field studies on *Aspergillus flavus* and aflatoxins in Australian groundnuts. Pages 223-235 *in* Aflatoxin contamination of groundnut: proceedings of the International Workshop, 6-9 Oct 1987, ICRISAT Center, India. Patancheru, A.P. 502 324, India: International Crops Research Institute for the Semi-Arid Tropics.

Frequency of Occurrence of *Aspergillus flavus* and *Aspergillus niger* in Developing Groundnut from Flowering to Harvest

C.M. Usha[1], K.L. Patkar[1], H. Shekar Shetty[1], and J. Lacey[2] (1. Department of Studies in Applied Botany, University of Mysore, Manasagangotri, Mysore, Karnataka 570 006, India; 2. Agricultural and Food Research Council (AFRC), Institute of Arable Crops Research, Rothamsted Experimental Station, Harpenden, Hertfordshire, UK).

Aflatoxin is a major constraint to the production of high-quality groundnuts (*Arachis hypogaea* L.) in tropical and subtropical countries. It is necessary to identify the growth stages at which groundnut is susceptible to invasion by *Aspergillus flavus* if remedial measures to prevent infection are to be successfully applied. *Aspergillus flavus* is ubiquitous as a soil fungus with plenty of opportunity to infect groundnut pegs after they reach the soil. There is some evidence that pegs may be infected with *A. flavus* even before penetration into the soil (Howell 1970; Pitt et al. 1991). *Aspergillus niger* can also infect groundnut and can interact with *A. flavus* and prevent aflatoxin formation (Hill et al. 1987). It is therefore necessary to know the pattern of colonization of these two species in groundnut.

Groundnut crops were raised following normal agronomic practices. Growth stages of groundnut were defined using a key slightly modified from that of Kranz and Pucci (1963; Table 1). Incidence of *A. flavus* and *A. niger* was assessed by weekly sampling from flowering (GS 1) to harvest (GS 13) in three crops of cultivar TMV 2 from September to December 1990. Fungal colonization of flowers or pegs (1.5 cm) was assessed until GS 4 and of shells and seeds from GS 5. Samples were surface sterilized with 2% sodium hypochlorite for 2 minutes and then plated on DG 18 agar (Hocking and Pitt 1980) and incubated for 7 days at 27°C. At harvest aflatoxin B_1 (AFB_1) in the seeds was assayed by ELISA using monoclonal antibodies for AFB_1 (Ramakrishna et al. 1990). Both *A. flavus* and *A. niger* were present in surface-sterilized groundnut as early as GS 1 and increased to GS 3 with *A. niger* more frequently isolated than *A. flavus*. However, the incidence of both the fungi decreased after GS 3 when *A. flavus* became more common in seeds than in shells with the reverse true of *A. niger*. The incidence of *A. flavus* on both seed and shell was inversely proportional to that of *A. niger*. The water content at GS 7 was 63.7% and this gradually decreased towards pod maturation. The fields were irrigated 5 days before harvest causing seed water content to increase slightly, while incidence of *A. flavus* decreased temporarily from 39.3 to 20.0% and that of *A. niger* increased from 37.3 to 60.6%.

Table 1. Developmental stages of groundnut pods.

Stage of development	Description	Approximate period from sowing (days)
1	Flowering	40– 45
2	Start of gynophore elongation	46– 50
3	Before gynophore penetrates soil	51– 55
4	After gynophore penetrates soil, end swells to size of a match head	55– 60
5	Ovary nearly horizontal	60– 65
6	Pod enlarging, division between seeds visible externally	66– 70
7	Formation of two clear sections and nervature progressing	71– 75
8	First empty space appears between seeds and shell	76– 80
9	Lignification starting at heel end, pith becoming elder-like, oldest nuts fully grown	81– 85
10	Lignification progressing, empty spaces appearing between seeds and shells	86– 90
11	Seeds fully developed but testa still pink	90– 95
12	Fully matured seeds	96–100
13	Plants at harvest	101–105

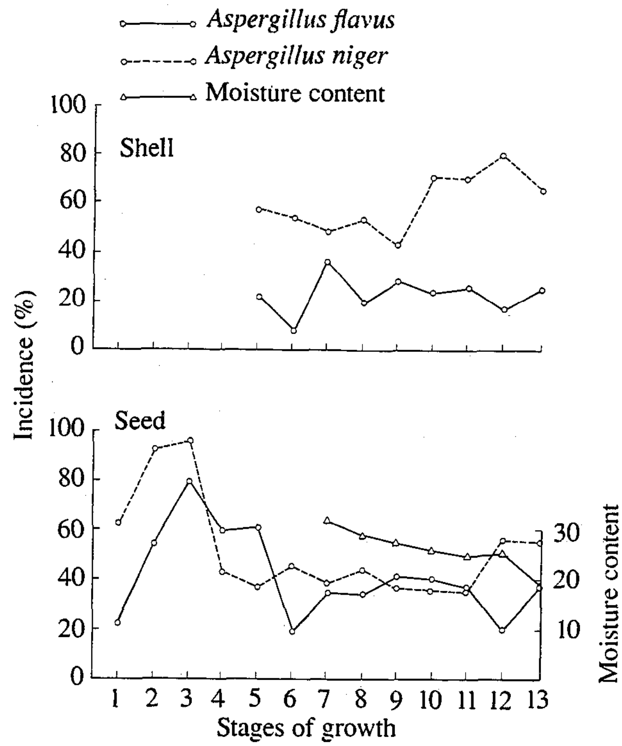

Figure 1. Incidence of *Aspergillus flavus*, *Aspergillus niger*, and moisture content of developing groundnut.

At harvest, *A. flavus* had again increased and samples contained 60 μg AFB_1 g^{-1}. *A. flavus*, as a soil fungus, has easy access to groundnut pegs after they enter the soil. However, 80% of the pegs were infected by *A. flavus* and 90% by *A. niger* before they touched the soil, suggesting that either the fungi grow systemically in the plant (Pitt et al. 1991) or that infection occurs through flower or peg from airborne or splash-borne inoculum. A critical study of the epidemiology of infection by *A. flavus* is needed. Incidence of *A. flavus* and *A. niger* on groundnuts showed an inverse relationship which was possibly related to seed water content. As the water content of the seed decreased, incidence of *A. flavus* increased and that of the other fungi, including *A. niger*, decreased. (See Fig. 1) At harvest, seeds contained 60 μg AFB_1 g^{-1}, with 40% *A. flavus* incidence and 50% *A. niger* incidence. This indicated that the presence of *A. niger* alone may not prevent the formation of AFB_1 by *A. flavus*. Hill et al. (1987) suggested that a ratio of *A. niger* : *A. flavus* propagules of greater than 1:9 was necessary to inhibit AFB_1 formation but the relative numbers were not determined in this study.

References

Hill, R.A., Blankenship, P.D., and **Sanders, T.H.** 1987. Effects of soil moisture and temperature on preharvest invasion of peanuts by the *Aspergillus flavus* group and subsequent aflatoxin development. Applied and Environmental Microbiology 45:628–633.

Hocking, A.D., and **Pitt, J.I.** 1980. Dichloran glycerol medium for enumeration of xerophilic fungi from low moisture foods. Applied and Environmental Microbiology 39:488–492.

Howell, R.W. 1970. Mycotoxin research in oil seeds. *In* Toxic Microorganisms: Mycotoxins, Botulism. Pages 61–66 *in* Proceedings of the first U.S.-Japan Conference on Toxic Micro-organisms: Mycotoxins [and] Botulism, 1968, Honolulu, Hawaii, USA (Herzberg, M., ed.). Washington, D.C., USA: US-Japan Cooperative Program in Natural Resources, and US Department of the Interior.

Kranz, J., and **Pucci, E.** 1963. Studies on soil borne rots of groundnut (*Arachis hypogaea* L.). Phytopath. Z. 47:101–112.

Pitt, J.I., Dyer, S.K., and **McCammon, S.** 1991. Systemic invasion of developing peanut plants by *Aspergillus flavus*. Letters in Applied Microbiology 13:16–20.

Ramakrishna, N., Lacey, J., Candlish, A.A.G., Smith, J.E., and **Goodbrand, I.A.** 1990. Monoclonal antibody-based enzyme linked immunosorbent assay for aflatoxin B_1, T-2 toxin, and ochratoxin A in barley. Journal of Association of Official Analytical Chemists 73:71–76.

Modified Atmosphere and Propionic Acid Treatment to Prevent Storage Fungi in Groundnut

K.L. Patkar[1], **C.M. Usha**[1], **H. Shekar Shetty**[1], **N. Paster**[2], and **J. Lacey**[3] (1. Department of Studies in Applied Botany, University of Mysore, Manasagangotri, Mysore, Karnataka 570 006, India; 2. Department of Stored Products, Agricultural Research Organization, The Volvani Centre, PO Box 6, Bet Dagan 50250, Israel; 3. Agricultural and Food Research Council (AFRC), Institute of Arable Crops Research, Rothamsted Experimental Station, Harpenden, Hertfordshire, UK)

Groundnut (*Arachis hypogaea* L.) is commonly colonized by storage fungi, especially *Aspergillus* and *Penicillium* spp during storage at high relative humidity and temperature. Many of these fungi produce large amounts of mycotoxins which affect the quality of stored grains. We attempted to prevent fungal growth by controlling environmental factors and by applying chemicals to inhibit fungal growth. Modified atmosphere (MA) storage of grains is a promising method to prevent fungal growth because it eliminates the use of chemicals. Propionic acid (PA) has been frequently used to prevent fungal growth in stored grains. We studied the changes in mycoflora of groundnut stored in MA and PA or with both together.

The MA system was similar to that described by Navarro and Donahaye (1972) and CO_2:O_2:N_2 were used in the proportion 20:20:60. The gas mixture was humidified to 90% RH by passing it through gas washing bottles containing salt solutions of the desired RH. PA was added to seeds to 0.2% (w/w). Ambient air treatment was stored in desiccators adjusted to 90% RH using saturated barium chloride solution. Samples were taken at 15-day intervals to determine the mycoflora. The mycoflora was analyzed by plating surface-sterilized seeds on malt extract salt agar medium and incubating the seeds for 7 days at 27°C. Visible molding was also recorded and classified with a 0 - 3 scale (0 = no molds, 1 = < 25% moldy seeds, 2 = 25 - 50% moldy seeds, 3 = > 50% moldy seeds).

Visible molding of nontreated samples kept in ambient air was found after only 15 days of storage and seeds were completely colonized by 30 days. Visible molding appeared in PA-treated samples after 30 days of storage (category 1) and complete colonization occurred by 60 days. Seeds stored in MA showed only a few moldy seeds at the end of the experiment while no visible molding was recorded in the combined MA+PA treatment. The percentage of infected seeds increased with increase in the period of storage except in the combined PA+MA treatment where it decreased (Table 1).

A. flavus incidence decreased during storage in all treatments but especially in the combined PA+MA treatment. *A. niger* increased in samples under MA after an initial decrease, but decreased in other samples. In nontreated seeds, the incidence of *Penicillium* spp increased during storage but decreased with MA. In PA and PA+MA treatments, *Penicillium* increased only towards the end of the experiment. During storage, *Eurotium* spp increased in incidence from 1.3 to 34% in nontreated seeds (Table 2).

Thus, although the percentage of infected seeds in MA increased during storage after initial decrease, visible molding was not seen until 60 days of storage at 90% RH. However, in ambient air, with or without PA treatment, seeds were completely moldy within 60 days. In the combined PA and MA treatment, visible molding was never seen and the percentage of infected seeds also decreased during storage. *A. flavus* and *A. niger* decreased during the storage period but *Penicillium* spp increased towards the end except in samples stored in MA. The study on the effect of MA on mycotoxin production and quality of groundnut is in progress.

Table 1. Visible molding and percentage of infected seeds of groundnut treated with propionic acid and modified atmosphere.

Storage period	Control		PA[1]		MA[2]		PA+MA	
(days)	VB[3]	PIS[4]	VB	PIS	VB	PIS	VB	PIS
0	0	100	0	68	0	100	0	64
15	2	100	0	100	0	64	0	52
30	3	100	1	100	0	72	0	58
60	3	100	3	100	0	100	0	28
90	3	100	3	100	1	100	0	30

1. PA = 0.2% propionic acid.
2. MA = Modified atmosphere of CO_2/O_2 : 20/20.
3. VB = Visible molding.
4. PIS = Percentage of infected seeds.

Table 2. Percentage of incidence of major storage fungi in groundnut treated with modified atmosphere, propionic acid and a combination of both.

Treatment	Storage period (days)	Incidence of fungi (%)		
		A. flavus	*A. niger*	*Penicillium* spp
Control	0	52	100	16
	15	46	40	48
	30	42	16	74
	60	40	10	74
	90	34	8	72
PA[1]	0	28	28	14
	15	8	16	66
	30	6	8	20
	60	10	0	28
	90	10	0	44
MA[2]	0	52	100	16
	15	36	64	6
	30	22	72	2
	60	20	100	0
	90	14	100	0
PA + MA	0	28	28	14
	15	16	36	8
	30	16	14	18
	60	8	16	14
	90	2	12	28

1. PA = Propionic acid at 0.2%.
2. MA = Modified atmosphere of CO_2/O_2:20/20.

Reference

Navarro, S., and **Donahaye, E.** 1972. An apparatus for studying the effect of controlled low pressure and composition of atmospheric gasses on insects. Journal of Stored Products Research 8:223–226.

Inhibitory Effect of Sorghum and Pearl Millet Pollen on Urediniospore Germination and Germtube Growth of Groundnut Rust

P.M. Reddy, D.H. Smith, and **D. McDonald** (ICRISAT Center)

Rust, caused by *Puccinia arachidis* Speg., is an economically important disease of groundnut (*Arachis hypogaea* L.) Rust can reduce pod yield by over 50% in susceptible cultivars (Subrahmanyam and McDonald 1983). Incidence and severity of the disease were lower in groundnut intercropped with sorghum and pearl millet than in sole crop groundnut. Deposition of sorghum and pearl millet pollen was observed on the leaves of intercropped groundnut. A laboratory study was conducted to examine the influence of the pollen on urediniospore germination and germtube growth of groundnut rust.

Urediniospores from infected groundnut leaves and fresh pollen from sorghum and pearl millet were collected and suspended independently in distilled water. The spores and pollen concentrations were adjusted to 10^5 mL^{-1} using a haemocytometer. Pearl millet and sorghum pollen suspensions were separately mixed with rust spore suspension in equal volumes, and 2–3 drops of these mixtures were placed on clean glass slides. Drops of the urediniospore suspension mixed with an equal volume of water served as control. Four replications were maintained for each treatment. The slides were placed in petri dishes lined with moist filter paper and incubated in the dark at 25°C for 4 h in a percival incubator. A drop of formaldehyde was added to each drop of the suspension on the slides to prevent further spore germination and germtube growth. Two-hundred spores were examined from each slide to estimate the percentage of germination, and 20 germtubes were measured to estimate the germtube length in each replication. The experiment was repeated twice and the pooled data were analyzed.

Urediniospore germination and germtube lengths were significantly lower in the presence of pollen (Table 1). Spore germination was 46% in the sorghum-pollen-urediniospore mixture, 57% in the pearl millet-pollen-urediniospore mixture and 76% in urediniospore-water suspension. Germtube length was 76.8um in the sorghum-pollen-urediniospore mixture, 84µm in the pearl millet-pollen-urediniospore mixture, and 121.5µm in the urediniospore-water suspension. Inhibitory effect of sorghum pollen on rust urediniospore germination and germtube growth was higher than that of pearl millet pollen.

Table 1. Inhibitory effect of sorghum and pearl millet pollen on urediniospore germination and germtube length of groundnut rust.

Treatment	Urediniospore germination[1] (%)	Germtube length[1] (μ)
Sorghum-pollen-urediniospore mixture	45.4	76.9
Pearl millet-pollen-urediniospore mixture	57.3	84.2
Urediniospore distilled water suspension	76.4	121.6
SE (pooled)	±1.7	± 0.26
CV (%) (pooled)	5.8	5.1

1. Mean of three tests with four replications.

The inhibitory effect of sorghum and pearl millet pollen could contribute to the reduced rust severity in intercropped groundnut.

Reference

Subrahmanyam, P., and **McDonald, D.** 1983. Rust disease of groundnut. Information Bulletin no. 13. Patancheru, A.P. 502 324, India: International Crops Research Institute for the Semi-Arid Tropics. 16 pp.

Screening Groundnut Genotypes for Resistance to Streak Necrosis Disease in Zambia

J. Kannaiyan, H.C. Haciwa, and **B. Syamasonta** (Msekera Regional Research Station, PO Box 510089, Chipata, Zambia)

Groundnut streak necrosis disease (GSND) is potentially an important disease in the eastern Province of Zambia (Kannaiyan 1990a). Bock (1989) had reported the occurrence of GSND in Malawi and Tanzania. The disease could cause yield reduction up to 80% (Kannaiyan 1990b). During the 1990/91 rainy season, the disease was also found in Central (Kabwe) and southern (Mochipapa) provinces in Zambia.

A severe outbreak of GSND was recorded at Kabwe Regional Research Station on three advanced groundnut yield trials: long season virginia (8 entries), confectionery long season virginia (10 entries), and SADCC/ICRISAT virginia (25 entries) trials. These trials were sown in mid-December 1990 in plots with four ridges of 4-m length with a spacing of 75 cm between ridges and 10 cm within ridges. There were four replications in each trial. Fertilizer 'D' compound (10N, 20P, 10K) was applied as basal at 150 kg ha^{-1}, but no pesticide was applied. The trials were hand weeded and reridged twice. The severity of GSND was scored on a 1–9 scale (1 = no disease, 3 = 1–10% GSND, 5 = 11–25% GSND, 7 = 26–50% GSND, and 9 = above 50% GSND) at 14 weeks after emergence and the mean scores were used for comparison between genotypes.

The GSND severity was significantly low in 6/6/5, Makulu Red, 6/6/7, and 1/27 (long season virginia); 8/8/12, 8/8/2, 8/8/19 and 16/10/11 (confectionery long season virginia); and in ICGV-SM 88710, 88711, 88734, 88709, 87798, 86741, 86761, 86737, 86760, 86759, and ICGM 749 (SADCC/ICRISAT virginia) compared to the susceptible controls 8/8/1, 15/10/12, and MGS 2 and local controls—MGS 4 and MGS 2 in the respective trials (Table 1). Of these, five genotypes, 6/6/5, ICGV-SM 88710, 88711, 88734, and 88709 showed distinctly low scores (3.0 and below) and are considered to be field resistant. The popular cultivar Makulu Red showed a 3.3 score to GSND compared to 8.3 score of MGS 2 and 6.0 score of MGS 4, the two recently released high-yielding varieties.

Many of the GSND field-resistant genotypes (6/6/5, 6/6/7, 1/27, 8/8/12, 8/8/2, and 16/10/11) also showed good yield potential in the multilocational tests across the country (B. Syamasonta, Msekera Regional Research Station) interpersonal communication. Since this is only a preliminary observation, it is important to confirm the resistance in these lines in further field and laboratory tests.

Acknowledgments. The authors thank the staff at Kabwe Regional Research Station, Central Province, for their liberal assistance in this study.

Table 1. List of genotypes field resistant to streak necrosis disease from three advanced groundnut yield trials (AGYT) at Kabwe Regional Research Station in 1990/91.

Trial/Genotype	Streak necrosis severity[2]
AGYT (Long-season virginia)[1]	
6/6/5	2.8
Makulu Red	3.3
6/6/7	3.5
1/2/7	4.3
Controls	
8/8/1 (Susceptible)	6.5
MGS 4 (Local genotype)	6.0
SE	±0.3
Trial mean (8 entries)	4.8
CV (%)	14.0
AGYT (Confectionery long-season virginia)[1]	
8/8/12	4.0
8/8/2	4.8
8/8/19	5.5
16/10/11	5.5
Controls	
15/10/12 (Susceptible)	7.5
MGS 2 (Local genotype)	7.0
SE	±0.5
Trial mean (10 entries)	6.1
CV (%)	15.2
AGYT (SADCC/ICRISAT virginia)[1]	
ICGV-SM 88710	3.0
ICGV-SM 88711	3.0
ICGV-SM 88734	3.0
ICGV-SM 88709	3.3
ICGV-SM 87798	3.5
ICGV-SM 86741	4.0
ICGV-SM 86761	4.0
ICGM 749	4.0
ICGV-SM 86737	4.8
ICGV-SM 86760	4.8
ICGV-SM 86759	5.9
Controls	
MGS 2 (Susceptible)	8.3
SE	±0.4
Trial mean (25 entries)	5.3
CV (%)	16.8

1. Mean of four replications.
2. Based on a 1–9 scale where 1 = no disease and 9 = above 50% disease.

References

Bock, K.R. 1989. ICRISAT Regional Groundnut Pathology Program: a review of research progress during 1985-87 with special reference to groundnut streak necrosis disease. Pages 13-20 *in* Proceedings of the Third Regional Groundnut Workshop for Southern Africa, 13-18 Mar 1988, Lilongwe, Malawi. Patancheru, A.P. 502 324, India: International Crops Research Institute for the Semi-Arid Tropics.

Kannaiyan, J. 1990a. Survey of groundnut disease in the Eastern Province, Zambia. International Arachis Newsletter 7:12–13.

Kannaiyan, J. 1990b. Groundnut viral diseases in Zambia. International Arachis Newsletter 7:10–12.

Identification of Field Resistance to Tomato Spotted Wilt Virus in Groundnuts

J.W. Demski[1], R. Pittmann[2], J. Todd[3], and **A. Culbreath[3]** (1. University of Georgia, Georgia Station, Griffin, GA 30223-1797, USA; 2. USDA/ARS, Plant Introduction Station, Griffin, GA, USA; and 3. Coastal Plain Station, Tifton, GA 31794, USA)

A groundnut disease named bud necrosis was reported in India in 1968 and the causal agent was later identified as tomato spotted wilt virus (TSWV). This virus was first reported naturally infecting groundnuts in USA in 1974.

Although TSWV was not detected in surveys conducted in 1983 in Georgia, since 1985 it has consistently been observed there. In 1990, the incidence exceeded 30% in some fields. Since adequate data on epidemiology were not available it was essential to identify sources of resistance to TSWV.

Over 300 germplasm lines of groundnuts were acquired from the Plant Introduction Station, Griffin. They represented U.S. commercial cultivars, cultivars from other countries, landraces from South America, wild species closely related to *Arachis hypogaea*, and some rhizomatous wild relatives. Each genotype was field-planted (Decatur, Co., Georgia) at 25 seeds 3 m^{-1} row with 91 cm between rows in a randomized design with four replications. Vegetative rhizomatous groundnut plants were planted at four to six plants row^{-1}. Florunner was used as a susceptible control planted along both sides, where irrigation wheels rolled through plots and as a replicate within the test.

Leaf samples were taken from every plant of an entry. The samples were assayed by enzyme-linked immunosorbent assay for the detection of TSWV. Entries having three or more infected plants were considered susceptible.

The susceptible Florunner plants located in and adjacent to the resistance test plot had 27% natural infection with TSWV by harvest.

Approximately 10% of all entries had at least two plants infected by harvest. Eleven of these entries had no infected plants 100 days after sowing. These were: *Arachis hypogaea* PIs 196621, 339967 and 341267; *A. glabrada* PIs 262794 and 338264; and *Arachis* species PIs 262286, 262828, 276233, 468142, 475883, and S-862.

In addition, the cultivar Southern Runner (3rd year in a row) had one half to one third the number of TSWV-infected plants when compared to Florunner.

None of the other commercial groundnut cultivars were field resistant. The best situation would be to find resistance in *A. hypogaea* because of ease of making crosses with commercial lines; however, newer techniques may permit the moving of resistant genes from closely related wild relatives. We plan to test the best entries from 1990 (plus a few additional lines) under laboratory to field conditions in 1991.

Acknowledgment. This work is supported in part by the Office of Agriculture, Bureau for Science and Technology, U.S. Agency for International Development, under grant no. DAN-4048-G-00-0041-00.

Effect of Harvest Date on Termite Damage, Yield, and Aflatoxin Contamination in Groundnut in Burkina Faso

R.E. Lynch[1], **I.O. Dicko**[1], **S.A. Some**[2], and **A.P. Ouedraogo**[2] (1. USDA-ARS, Coastal Plain Station, Tifton, GA 31794, USA; 2. University of Ouagadougou, Ouagadougou, Burkina Faso)

Termites have been identified as one of the major insect pests of groundnut in SAT Africa (Amin and Mohammad 1980; Wightman 1985; Lynch et al. 1986). Termite damage to groundnut pods not only reduces yield by up to 50% (Feakin 1973; Johnson et al. 1981), but also enhances invasion of pods by *Aspergillus flavus* (Link) and formation of aflatoxin in seed after harvest (McDonald and Harkness 1963; McDonald et al. 1964; McDonald 1969; Lynch et al. 1990).

Research on the relationship between plant age at harvest, termite damage to pods, and aflatoxin contamination of seed is being conducted in Burkina Faso since 1986. Data presented in Table 1 show that at the Gampala Research Station, termite damage to groundnut pods is directly related to the age of plants at harvest. At 70 and 90 days after sowing, termite damage to pods averaged <4% over the 5-year study period. However, by 110 days, damage to pods averaged 15% and by 125 days averaged 46%. This increased damage was characterized by both an increase in external scarification of the pod and pod penetration. Application of insecticides (aldicarb at the time of sowing and chlorpyrifos at 50 and 100 days after sowing) reduced pod damage to an average of 10% and substantially increased yield. Aflatoxin contamination in seed also increased with increase in age at harvest and was significantly correlated with pod damage by termites. Insecticides for the control of termites were effective in reducing contamination of seed with aflatoxin in only one of the 2 years studied.

Acknowledgment. This work is supported in part by the Office of Agriculture, Bureau for Science and Technology, U.S. Agency for International Development, under grant no. DAN-4048-G-00-0041-00

Table 1. Effect of age of groundnut at harvest on termite damage to pods, yield, and aflatoxin in seeds in Burkina Faso.

Groundnut age at harvest (Days)	Termite-damaged pods[1] (%)			Aflatoxin[2] ($mg\ kg^{-1}$)	Yield[1] ($g\ plot^{-1}$)
	Nondamaged	Scarified	Penetrated		
70	98.4	0.4	1.2	0.027	4068.3
90	97.3	1.3	1.4	0.123	5419.3
110	84.9	11.8	3.3	0.680	5140.7
125	54.0	39.5	6.8	1.246	4466.6
100 (with insecticide control)[3]	90.0	7.7	2.4	0.843	5957.5

1. Means based on 5-year data, 1985-90.
2. Means based on 2-year data, 1987 and 1988.
3. Plots treated with 5.6 kg ha^{-1} aldicarb at sowing, 7.5 kg ha^{-1} chlorpyrifos at pegging, and 7.5 kg ha^{-1} chlorpyrifos 50 days later and harvested at 100 days after sowing.

References

Amin, P.W., and **Mohammad, A.B.** 1980. Groundnut pest research at ICRISAT. Pages 158–166 *in* Proceedings of the International Workshop on Groundnuts, 13–17 Oct 1980, ICRISAT Center, India. Patancheru, A.P. 502 324, India: International Crops Research Institute for the Semi-Arid Tropics.

Feakin, S.D. (ed.). 1973. Pest control in groundnuts. 3rd edn. PANS. Manual No. 2, London, UK: Center for Overseas Pest Research.

Johnson, R.A., Lamb, R.W., and **Wood, T.G.** 1981. Termite damage and crop loss studies in Nigeria–a survey of damage to groundnuts. Tropical Pest Management 27:325–342.

Lynch, R.E., Ouedraogo, A.P., and **Dicko, I.** 1986. Insect damage to groundnut in semi-arid tropical Africa. Pages 175–183 *in* Agrometeorology of Groundnut: proceedings of an International Symposium, 21–26 Aug 1985, ICRISAT Sahelian Center, Niamey, Niger. Patancheru, A.P. 502 324, India: International Crops Research Institute for the Semi-Arid Tropics.

Lynch, R.E., Ouedraogo, A.P., and **Some, S.A.** 1990. Effect of harvest date and termite-resistant varieties on termite and millipede damage to groundnut in Burkina Faso. Pages 87–90 in Summary Proceedings of the First ICRISAT Regional Groundnut Meeting for West Africa, 13-16 Sep 1988, ICRISAT Sahelian Center, Niamey, Niger. Patancheru, A.P. 502 324, India: International Crops Research Institute for the Semi-Arid Tropics.

McDonald, D. 1969. *Aspergillus flavus* on groundnut (*Arachis hypogaea* L.) and its control in Nigeria. Journal of Stored Product Research 5:275–280.

McDonald, D., and **Harkness, C.** 1963. Growth of *Aspergillus flavus* and production of aflatoxin in groundnuts. Part II. Tropical Science 5:143–154.

McDonald, D., Harkness, C., and **Stonebridge, W.C.** 1964. Growth of *Aspergillus flavus* and production of aflatoxin in groundnuts. Part VI. Tropical Science 6:131–154.

Wightman, J.A. 1985. Groundnut entomology in the semi-arid tropics: current status and formulae for future research. ICRISAT Center, India. Patancheru, A.P. 502 324, India: International Crops Research Institute for the Semi-Arid Tropics. (Limited distribution.)

Screening of Spanish Bunch Breeding Lines of Groundnut Against *Spodoptera litura* (F.) Damage

R.K. Patil, M.V.C. Gowda, and H.L. Nadaf
(University of Agricultural Sciences, Dharwad, Karnataka 580 005, India)

The defoliating insect, *Spodoptera litura* (F.) is a major insect pest of groundnut in India. The yield losses because of this pest are reported to be 13-71% in the states of Karnataka and Andhra Pradesh (Amin 1983). In India, Dharwad has been identified as a screening center for *S. litura* damage where pod yield loss to the extent of 66.6% was recorded (Kulkarni 1989). At present, the pest is mainly controlled by insecticidal application. However, insecticides often fail to give economic returns because of their high cost and improper use. The problem is more acute with *S. litura* because of its polyphagous nature, rapid multiplication, and resistance developed to some commonly used insecticides (Ramakrishna et al. 1984). Integrated management of this pest with biological agents and resistance breeding appears to be the best alternate strategy.

An outbreak of *S. litura* at Dharwad during the 1989 rainy season provided an excellent opportunity to screen the advanced spanish bunch breeding lines tested in initial varietal trial (IVT) and advanced varietal trial (AVT) of the All India Coordinated Research Project on Oilseeds. The lines were assessed at 75 and 90 days after sowing (DAS) which coincided with peak foliage damage. The criterion used was the percentage of leaflets damaged on the main stem. The data were collected on five randomly selected plants in two replications and subjected to statistical analysis.

In the AVT, 15 entries were screened including the national control, JL 24 and the local control Dh 3-30. Two entries, ICGV 87264 and ICGV 86590, recorded the least damage (<17.5%) at both the stages of screening as against 65% damage on the susceptible control, Dh 3-30 (Table 1). Two other entries, ICGV 86598 and ICGV 86125, also recorded relatively less damage (<27.5%). In the IVT, 27 test entries were screened, of which three entries ICGV 86350, ICGV 86276, and ICGV 87287, showed promise for resistance with the least damage of 17.5% at both the stages of screening (Table 2). RG 97 was another promising line resistant to *S. litura.*

Among these resistant lines, two entries in the AVT, ICGV 87264 (2039 kg ha^{-1}) and ICGV 86598 (2101 kg ha^{-1}), and two entries in the IVT, ICGV 86350 (2320 kg ha^{-1}) and ICGV 86276 (2093 kg ha^{-1}), also had promising productivity and yielded significantly more than the local control Dh 3-30 (1699 kg ha^{-1} in AVT; 1645 kg ha^{-1}

Table 1. Performance of some entries in advanced varietal trial for *Spodoptera litura* damage and productivity, Dharwad, rainy season 1989.

Entry	Leaflets damaged (%) 75 DAS	Leaflets damaged (%) 90 DAS	Pod yield (kg ha^{-1})	Shelling (%)
ICGV 87264	15.0	17.5	2039	59.0
ICGV 86590	17.5	17.5	1815	53.6
ICGV 86598	22.5	17.5	2101	62.3
ICGV 86125	27.5	27.5	1888	67.9
ICGV 86315	30.0	32.5	1400	61.3
ICG(FDRS) 43	30.0	27.5	2107	56.1
ICGV 86600	37.5	32.5	1916	67.9
Controls				
JL 24	52.5	57.5	1879	73.1
Dh 3-30	65.0	65.0	1699	67.6
SE	±2.8	±4.0	± 98	±2.1
Trial mean (15 entries)	36.0	35.5	1716	63.4
CV (%)	10.8	16.0	11.4	4.6

Table 2. Performance of some entries in the initial varietal trial for *Spodoptera litura* damage and productivity, Dharwad, rainy season 1989.

Entry	Leaflets damaged (%) 75 DAS	Leaflets damaged (%) 90 DAS	Pod yield (kg ha-1)	Shelling (%)
ICGV 86350	17.5	15.0	2320	47.5
ICGV 86276	15.0	15.0	2093	56.6
ICGV 87287	15.0	17.5	1818	58.5
RG 97	27.5	15.0	504	63.7
BARCG 3	27.5	32.5	2056	65.5
ICGV 86215	32.5	27.5	1376	53.8
ICGV 87882	35.0	45.0	2014	71.5
NRGS(E) 3	30.0	42.5	2030	60.6
AKG 6-1	35.0	40.0	1921	67.9
NRGS(FDRS) 10	35.0	40.0	2078	69.7
SVGS 4	35.0	37.5	2053	64.0
TVG 6	42.5	35.0	1962	71.1
NRGS(FDRS) 2	37.5	45.0	2447	72.6
NRGS(FDRS) 11	37.5	55.0	1916	70.7
SPS 38	45.0	40.0	1921	62.2
RG 255	55.0	52.5	2226	75.3
Controls				
JL 24	45.0	42.5	1776	71.6
Dh 3-30	55.0	65.0	1645	67.2
SE	±3.7	±2.9	±118	±1.4
Trial mean (29 entries)	36.0	41.8	1745	66.5
CV (%)	14.4	9.7	13.6	4.2

in IVT). But these entries recorded very poor shelling percentage (<60%) which resulted in a lesser seed yield than that in the controls JL 24 and Dh 3-30. Besides, the pods of these entries have such undesirable features as thick shell and more reticulation. These breeding lines may not become popular as varieties because of these drawbacks, but they can be a very good source of resistance in future breeding programs as they are also superior in productivity.

Apart from these resistant lines, some entries in the AVT, such as BARCG 3, ICGV 87882, NRGS(E) 3, NRGS(FDRS) 10, SVGS 4, NRGS(FDRS) 2, and RG 255 yielded more than the controls inspite of the high level of damage. They also possessed better shelling percentage as compared with the resistant lines.

Acknowledgment. The authors thank Dr K. Giriraj, Senior Scientist (Oilseeds) for his encouragement.

References

Amin, P.W. 1983. Major field insect pests of groundnut in India and associated crop losses. Pages 337–344 *in* Proceedings of the National Seminar on Crop Losses Due to Insect Pests, 7–9 Jan 1983, Hyderabad, A.P., India (Krishnamurthy Rao, B.H., and Murty , K.S.R.K., eds.). Special Issue, Indian Journal of Entomology. Vol. 1. Hyderabad, A.P., India: Entomological Society of India.

Kulkarni, K.A. 1989. Bio-ecology and management of *Spodoptera litura* (Fabricius) (Lepidoptera: Noctuidae) on groundnut (*Arachis hypogaea* L.) PhD thesis, University of Agricultural Sciences, Dharwad. India, 270 pp.

Ramakrishna, N., Saxena, V.S., and **Dhingra, S.** 1984. Insecticide resistance in the population of *Spodoptera litura* (F.) in Andhra Pradesh. Pesticides 18:23–24.

Groundnut Genotypes Less Susceptible to Insect Pest Damage in the SADCC Regional Variety Trials in Zambia and Malawi

S. Sithanantham, P.H. Sohati, and **B. Syamasonta** (Food Legumes Research Team, Msekera Regional Research Station, PO Box 510089, Chipata, Zambia)

Insect pests, mainly sucking pests, defoliators, and soil insects, attack groundnut (*Arachis hypogaea* L.) crop at different growth stages, causing substantial losses in seed yield and/or quality in Zambia (Sohati and Sithanantham 1990) and elsewhere in southern Africa (Wightman 1989). Search for sources of resistance to these major insect pests has recently been initiated in Zambia, with a view to incorporate resistance into agronomically acceptable genotypes (Sithanantham et al. 1990).

Another approach towards minimizing losses due to insect pests is to encourage selective cultivation of high-yielding or superior quality genotypes, which can withstand damage by insect pests. As part of this effort, we evaluated, during 1988/89 and 1989/90, the extent of severity of insect pest damage among genotypes included in the SADCC Regional Groundnut Variety Trials that are assembled and distributed by the SADCC/ICRISAT Groundnut Project located at Chitedze, Malawi. Wherever possible, visual ratings were made of the severity of damage symptoms, against sucking pests (based on leaf-tip yellowing, cupping, and crinkling), defoliators (based on the extent of leaflets damaged), termites (pod scarification), and other soil pests (pod borer damage) using a 1–9 scale where 1 = no damage, 9 = very severe damage. The trial sites included were Msekera, Masumba (Zambia), and Chitedze (Malawi).

In the virginia trials, sucking pest damage was distinctly less severe in ICGV-SM 85764 (three trials), ICGV-SM 86703 (two trials), and ICGV-SM 83708 (one

Table L Virginia genotypes found less susceptible to insect damage among SADCC regional trials, in Malawi and Zambia, 1988–90.

		Damage severity score[1]				
Location and year	Genotype	Test entry	Controls (mean)	Trial (mean)	Trial (max.)	SE
Against sucking pests:						
Chitedze (1988/89)	ICGV-SM 85764	2.3	5.2	4.2	5.8	± 0.32
	ICGV-SM 86703	2.5				
	ICGV-SM 83708	3.0				
Msekera (1988/89)	ICGV-SM 85764	2.0	4.1	3.2	5.1	± 0.40
	ICGV-SM 86703	1.9				
Chitedze (1989/90)	ICGV-SM 85764	2.8	5.3	4.8	6.2	± 0.23
Against defoliators:						
Chitedze (1988/89)	ICGM 336	2.5	3.3	3.5	4.8	± 0.32
	ICGV-SM 85764	2.5				
Against soil pests:						
Chitedze (1989/90)	ICGV-SM 88710	3.1	4.5	4.3	5.3	± 0.30
1. Pod scarification by termites:						
Msekera (1989/90)	ICGV-SM 88709	1.2	2.3	2.6	4.9	± 0.70
	ICGV-SM 87733	1.4				
2. Pod borer damage (by other soil pests):						
Msekera (1989/90)	ICGV-SM 87805	1.2	1.8	1.9	2.4	± 0.40
	ICGV-SM 88709	1.2				

1. Scored on 1–9 scale, where 1 = no damage, and 9 = very severe damage.

Table 2. Spanish/valencia genotypes found less susceptible to insect damage among SADCC regional variety trials, 1988–90.

		Damage severity score[1]				
Location and year	Genotype	Test entry	Controls (mean)	Trial (mean)	Trial (max.)	SE
Against sucking pests:						
Chitedze (1988/89)	ICGV-SM 85001	2.3	3.4	4.2	6.3	± 0.48
Chitedze (1988/89)	ICGV-SM 83031	2.5	3.6	3.3	4.2	± 0.36
	ICGM 189	2.6				
Masumba	ICGV-SM 85001	3.3	5.8	5.9	7.3	± 0.40
	ICGV-SM 83005	3.9				
Chitedze (1989/90)	ICGV-SM 85001	3.5	4.2	4.3	5.5	± 0.39
Against defoliators:						
Chitedze (1988/89)	ICGV-SM 85001	2.3	3.5	3.8	5.0	± 0.37
Masumba	ICGV-SM 85001	2.7	3.7	3.6	4.6	± 0.30
	ICGV-SM 83011	2.8				
	ICGV-SM 86014	2.9				
Mochipapa	ICGV-SM 83005	2.0	2.9	2.8	4.0	± 0.30

1. Scored on 1–9 scale, where 1 = no damage, and 9 = very severe damage.

trial) (Table 1). Those found less severely damaged by defoliators (mainly grasshoppers and caterpillars) were ICGV-SM 85764, ICGV-SM 88710, and ICGM 336. Pod scarification (by termites) was distinctly less severe among ICGV-SM 88709 and ICGV-SM 87733, while ICGV-SM 88709 and ICGV-SM 87805 appeared less susceptible to pod damage by other soil pests. It was evident that ICGV-SM 85764 could be useful against sucking pests and defoliators. ICGV-SM 88709 may be preferable where soil pests including termites damage the pods. This genotype is also known to be resistant to rosette disease.

In the spanish/valencia trials, ICGV-SM 85001 was distinctly less damaged by sucking pests (in three trials), besides ICGV-SM 83031, ICGM 189, and ICGV-SM 83005 (in one trial each) (Table 2). The entry ICGV-SM 85001 was also found to be less damaged by defoliators (in two trials). Others found with such low damage (in one trial each) were ICGV-SM 83011, ICGV-SM 83005, and ICGV-SM 86014. Combined low damage by sucking pests and defoliators was observed in ICGV-SM 85001 and ICGV-SM 83005. The former was distinctly high yielding, while the latter provided satisfactory yields in low-rainfall regions (as in Masumba and Mochipapa) in Zambia.

The present study resulted in the identification of genotypes among the potentially high-yielding and/or superior quality entries in the SADCC Regional Variety Trials, which appear to better withstand damage by major insect pest groups in the region. It is expected that such evaluations of entries in the SADCC Regional Trials for insect damage susceptibility will continue as a routine, to identify the potentially suitable genotypes against important pest attacks in Zambia and other countries in the region.

Acknowledgment. We thank Dr G.L. Hildebrand, SADCC/ICRISAT Groundnut Project, Malawi, for his encouragement and permission to make the relevant observations in his trials at Chitedze, Malawi.

References

Sithanantham, S., Sohati, P.H., Syamasonta, B., and **Kannaiyan, J.** 1990. Screening for resistance to sucking insects among groundnut genotypes in Zambia. Pages 117–120 *in* Proceedings of the Fourth Regional Groundnut Workshop for Southern Africa, 19–23 Mar 1990, Arusha, Tanzania. Patancheru, A.P. 502 324, India: ICRISAT.

Sohati, P.H., and **Sithanantham, S.** 1990. Relative damage and extent of yield losses due to insect pests on groundnut in Zambia. Pages 113–116 *in* Proceedings of the Fourth Regional Groundnut Workshop for Southern Africa, 19–23 Mar 1990, Arusha, Tanzania. Patancheru, A.P. 502 324, India: ICRISAT.

Wightman, J.A. 1989. Contribution of insects to low groundnut yields in Southern Africa. Pages 129–140 *in* Proceedings of the Third Regional Groundnut Workshop for Southern Africa, 13–18 Mar 1988, Lilongwe, Malawi. Patancheru, A.P. 502 324, India: International Crops Research Institute for the Semi-Arid Tropics.

Incidence of *Sclerotium rolfsii* on Groundnut Foliage

Suseelendra Desai and **M.P. Ghewande**
(National Research Centre for Groundnut, Junagadh, Gujarat 362 015, India)

Sclerotium rolfsii Sacc. has been reported to cause stem rot in groundnut (*Arachis hypogaea* L.) which results in the loss of 27% or more in crop stand (Chohan 1974). When the stems are infected, the fungus colonizes at the ground level leading to rotting of tissues, thus causing wilting. But so far, this fungus has not been reported to attack groundnut foliage in India. During the 1989 rainy season, spanish bunch lines such as GG 2 and JL 24 showed infection by sclerotial bodies causing blotching of leaflets, when the crop age was 30-40 days. The symptoms were observed on lower as well as middle level leaves. Infected leaves showed oval to irregular dark brown necrotic spots. Some leaflets showed concentric white rings alternating with green tissues. The infected leaf tissues were surface sterilized and transferred on to potato dextrose agar (PDA) slants. After 3 days of incubation, fungal growth and sclerotial formation was observed in the slants. The pure cultures were multiplied on PDA plates. Mycelial discs of 5 mm diameter cut from the periphery of 5-day old inoculated petri dishes were placed on top, middle, and lower quadrifoliates of groundnut cultures GG 2 and JL 24 which were surface sterilized with 5% sodium hypochlorite for 5 minutes before inoculation. The inoculated leaves were placed in test tubes containing sterilized water and incubated at 25°+1°C. Observations were made on the sequence of development of symptoms. After 48 h of inoculation, initial symptoms appeared as water-soaked lesions. After 72 h, these lesions covered more area and caused necrosis of the tissues. Simultaneously the fungus started producing sclerotial bodies as white mycelial knots. The necrotic areas were surrounded by black margins. The fungus also attacked petioles and at the joints of the leaflets causing defoliation. The repeated pathogenecity tests produced similar symptoms.

Acknowledgment. The authors are grateful to Dr P.S. Reddy for providing necessary facilities and encouragement.

Reference

Chohan, J.S. 1974. Recent advances in diseases of groundnut in India. Pages 171-184 *in* Current trends in plant pathology (Raychaudhuri, S.P., and Verma, J.P., eds.). Lucknow, Uttar Pradesh, India: Lucknow University Press.

Book Reviews

Agroclimatology of Asian Grain Legumes (Chickpea, pigeonpea, and Groundnut)

Virmani, S.M., Faris, D.G., and **Johansen, C.** (eds.) 1991. Agroclimatology of Asian grain legumes (Chickpea, pigeonpea, and groundnut). Research Bulletin no. 14. Patancheru, A.P. 502 324, India: International Crops Research Institute for the Semi-Arid Tropics. ISBN 92-9066-175-5.

This ICRISAT research bulletin is based on the proceedings of the workshop, 'Agroclimatology of Asian Grain Legume Growing Areas' held at ICRISAT Center in December 1988. The information given in the bulletin is collated by the participants, including scientists from 11 Asian countries, Bangladesh, China, India, Indonesia, Malaysia, Myanmar, Nepal, Pakistan, the Philippines, Sri Lanka, and Thailand. For each country, a brief introduction, crop distribution in relation to agroclimatic factors, major stress factors, and future prospects of the three major legumes, groundnut, pigeonpea, and chickpea are presented.

Information on each country is given in the form of tables, maps, and a short text commentary. Data on soils, rainfall, temperature, crop importance, distribution and production, major abiotic and biotic stresses affecting each crop are presented. Potential areas for further expansion of these crops are also provided.

This bulletin serves as a model as to how to draw and put together information that serves as a sound foundation on which further location specific research can be planned. This kind of exercise is worth emulating for other crops and regions. The bulletin is a good reference book for research planners and policymakers who are interested in the agricultural prosperity and welfare of the region.

The bulletin can be obtained from: Information Services, ICRISAT, Patancheru, Andhra Pradesh 502 324, India. Prices are: less-developed countries US $7.40 + postage; highly developed countries US $15.80 + postage; India Rs.85.20 + postage.

L.J. Reddy
ICRISAT Center

Fertilizer Recommendations for Oilseed Crops – A guide book

Tandon, H.L.S. (ed.) 1990. Fertilizer Recommendations for Oilseed Crops - A guide book. Fertilizer Development and Consultation Organization, New Delhi 110 048. ISBN: 81-85116-10-5.

It is important to use fertilizers judiciously because of the rising prices, and nonrenewable nature of the raw materials used in fertilizer industry. From this view point, the book 'Fertilizer recommendations for oilseed crops - a guide book' is a welcome addition. The book contains five chapters. In chapter 1, the role of various oilseeds in Indian economy, reasons for low and fluctuating production, and strategies to increase production are presented. A brief reference is also made in this chapter, to the role of technology mission on oilseeds and oilseeds growers' federations, in increasing the oilseed production in India. It is interesting to note that the production trend of total oilseeds in India is similar to that of groundnut, indicating the important role of groundnut in Indian oilseed economy. Chapter 2 deals with the role of both macro and micronutrients and description of symptoms caused by their deficiency. The nutrient content of common fertilizers available in India are also given in this chapter. In chapter 3, fertilizer management in oilseeds including optimum nutrient application, rates, fertilizer types and their application, fertilizers and water use efficiency, and economic aspects are presented. This chapter also provides a summary on the response of groundnut to fertilizer application based on 2358 trials conducted on farmers' fields by the Indian Council of Agricultural Research. Chapter 4 gives statewise and cropwise recommendations on fertilizer doses and improved varieties. Chapter 5 provides information on the potential areas for further expansion of various oilseed crops in different Indian states.

The book is very useful and serves as a source of reference for agricultural officers, extension advisors, and fertilizer industry's field staff in India. The book can be obtained from: Fertilizer Development and Consultation, C 110 Greater Kailash 1, New Delhi - 110 048, India. Prices are: India Rs.65 (registered mail free); outside India US $ 18 (registered airmail free).

L.J. Reddy
ICRISAT Center

ICRISAT Style Guide: References

References

In-text references to entries in the reference list (given at the end) should follow the author-date ("Harvard") system, with no comma:

Brown (1985) reported that ..... or

A study (Brown et al. 1983) found that...

The reference list should be alphabetized and not numbered.

Care must be taken not to cite unpublished documents, i.e., those that have not yet been peer-reviewed and have not been issued for public use, and dated, by an identifiable publishing organization. Such citations, if unavoidable, must be given as a footnote in one sentence, or in the text in parentheses as personal communications, with as much information as available, e.g.: (J.R. Burford, ICRISAT, personal communication 1985).

Citation of semiformal documents (the so-called unrefereed "gray literature" of which ICRISAT program-level reports and newsletters are examples) is permitted, provided that their limited-distribution status is indicated: see, for instance, Walker et al. 1983 on p.4. Such citation is discouraged, however, as inconsistent with the preferred scientific method of publication after peer review, and because the original documents are often difficult to obtain.

Citation of formal publications known to be accepted but not yet issued is permitted, by the use of "in press" in place of the year. See examples.

General rules for citation

1. The surname, or family name, is followed by initials of the other names, each with a period followed by a space. Use initial capitals only because they will normally be printed in bold type, in upper and lower case.
2. The title of the document should be transcribed exactly as it appears in the original publication (though without initial capitals except where required). Punctuation may be added to distinguish a title from a subtitle or extended title.
3. The place of publication is important for ordering purposes. The city or town, the county or state, the postal code if accurately known, and the country, should therefore be given. See examples on pp.4-6.
4. Series information is also important, and must be cited without abbreviation, because of the growing need in ordering to distinguish between series (coded and numbered as ISSNs) and books (ISBNs). The examples on pp.4-6 show how to differentiate between regular serials (journals, periodicals) and occasional serials (e.g., ICRISAT's Research and Information Bulletins).
5. To avoid ambiguity it is necessary to quote journal titles in full, capitalizing the initial letter of principal words.
6. When it is necessary to refer to a specific page or pages, cite it/them in the text, not in the reference list: e.g., (Brown 1985, p. 13); ... shown by Patil (1977, pp. 97–101).
7. Where a cited reference includes more than 10 references, or provides a useful bibliography, it is helpful to state the number of references (e.g., 24 refs.).
8. The abbreviation "et al." is correctly used for citing multiple authors in the text, but it should not be used in the list of references. It is essential to name each author in a multiple-author entry because readers cannot otherwise identify it with precision.

The following examples, as typical entries, provide guidance for citation required in most anticipated situations.

Journal articles

English language article

Sangster, A. G. 1978. Silicon in the roots of higher plants. American Journal of Botany 65(9):929-935. 36 refs.

When only English title is available or possible to reproduce

Robertse, P. J. 1978. [The adaptability of grain sorghums under South African cultivation conditions.] (In Af. Summaries in En, Fr.) Agroplantae 10(2):21-27.

When only original title is available

Saint-Clair, P. M. 1980. Effet de l'âge et des conditions de croissance sur la resistance a la desiccation de cultivars de sorgho grain. (In Fr. Summaries in En, Es.) Agronomie Tropicale 35(2):183-188.

When both English and original titles are available

Rosolem, C. A., Nakagwa, J., and Machado, J. R., Jr. 1980. [Effect of top dressing fertilizing for grain sorghum on two oxisols.] Adubacao em cobertura para sorgo-granifero em dois latossolos. (In Pt. Summary in En.) Revista Brasileira de Ciencia do Solo 4(1):44-49. 12 refs.

Books

Entry with editors and edition

Lyons, J. M., Graham, D., and **Raison, J. K.** (eds.) 1979. Low temperature stress in crop plants: the role of the membrane. 2nd edn. New York, USA: Academic Press. 565 pp.

Entry with series

Binswanger, H. P., Virmani, S. M., and **Kampen, J.** 1980. Farming systems components for selected areas in India: evidence from ICRISAT. Research Bulletin no. 2. Patancheru, A.P. 502324, India: International Crops Research Institute for the Semi-Arid Tropics. 40 pp.

Entry with same author and publisher, and series

Commonwealth Bureau of Soils. 1977. Sorghum composition and quality as affected by fertilizing, 1958-1967. Annotated Bibliography no. S1217R. Harpenden, Herts, UK: Commonwealth Bureau of Soils. 8 pp. 35 refs.

Government publication

Botswana: Ministry of Agriculture, Animal Production Unit. 1979. Livestock and range research in Botswana, 1978. Gaborone, Botswana: Ministry of Agriculture, Animal Production Unit. 172 pp.

Chapter in a book

Bagnall, D. J. 1979. Low temperature responses of three *Sorghum* species. Pages 67-80 *in* Low temperature stress in crop plants: the role of the membrane (Lyons, J.M., Graham, D., and Raison, J.K., eds.). 2nd edn. New York, USA: Academic Press.

Book or serial with limited distribution

Walker, T. S., Singh, R. P., and **Jodha, N. S.** 1983. Dimensions of farm-level diversification in the semi-arid tropics of rural South India. Economics Program Progress Report no. 51. Patancheru, A.P. 502324, India: International Crops Research Institute for the Semi-Arid Tropics. 30 pp. (Limited distribution.)

Proceedings

Complete proceedings

Ahmadu Bello University. 1980. Proceedings of the 4th NAFPP Workshop on Sorghum, Millet and Wheat, 14-16 Apr 1980, Samaru, Nigeria. Samaru, Zaria, Nigeria: Ahmadu Bello University. 318 pp.

Proceedings with independent title

Spiertz, J. H. J., and **Kramer, T.** (eds.) 1979. Crop physiology and cereal breeding: proceedings of a Eucarpia Workshop, 14-16 Nov 1978, Wageningen, Netherlands. Wageningen, Netherlands: PUDOC (Centre for Agricultural Publishing and Documentation). 300 pp.

Paper or abstract in proceedings

Rao, N. G. P. 1982. Transforming traditional sorghum in India. Pages 39-59 *in* Sorghum in the eighties: proceedings of the International Symposium on Sorghum, 2-7 Nov 1981, ICRISAT Center, India. Vol.1. Patancheru, A.P. 502 324, India: International Crops Research Institute for the Semi-Arid Tropics.

Kanwar, J.S., Kampen, J., and **Virmani, S.M.** 1982. Management of Vertisols for maximising crop production—ICRISAT experience. Pages 94-118 *in* Vertisols and rice soils of the tropics. Symposium papers 2. Transactions of the 12th International Congress of Soil Science, 8-16 Feb 1982, New Delhi, India. New Delhi 110 012, India: Indian Agricultural Research Institute.

Singh, R. B., and **Tyagi, B. R.** 1974. Translocation stocks in *Pennisetum typhoides*. Page 367 *in* Advancing frontiers in cytogenetics in evolution and improvement of plants: proceedings of National Seminar, 14-19 Oct 1972, Kashmir, India (Kachroo, P., ed.). New Delhi, India: Hindustan Publishing Corp. (Abstract.)

Renfro, B. L. 1976. The downy mildew disease of pearl millet. Pages 77-83 *in* Proceedings of the Consultants' Group Meetings on Downy Mildew and Ergot of Pearl Millet, 1-3 Oct 1975, ICRISAT, Hyderabad, India. Patancheru, A.P. 502 324, India: International Crops Research Institute for the Semi-Arid Tropics.

Paper presented at a symposium but not formally published

Seshu Reddy, K. V., and **Davies, J. C.** 1978. The rôle of the Entomology Program with reference to the breeding of pest-resistant cultivars of sorghum at ICRISAT. Presented at the Symposium on Strategies for Insect Pest Control through Integrated Methods, 16-17 Aug 1978, Indian Agricultural Research Institute, New Delhi, India. Patancheru, A.P. 502 324, India: International Crops Research Institute for the Semi-Arid Tropics. (Limited distribution.)

Theses

Ph.D.

Huffman, K. W., III. 1978. The effect of environment on seed development in sorghum. Ph.D. thesis, Texas A & M University, College Station, Texas, USA. 89 pp.

M.Sc.

Patil, S. S. 1977. Studies on induced mutations and selection response for yield in sorghum. M.Sc. thesis, University of Agricultural Sciences, Bangalore, Karnataka, India. 217 pp.

Others

Ramadan, G. A. 1980. Heterosis and combining ability in forage sorghum. (Summary in Ar.) Thesis, Tanta University, Kafr El-Sheikh, Egypt. 123 pp.

Annual reports

Complete report

ICRISAT (International Crops Research Institute for the Semi-Arid Tropics). 1983. Annual report 1982. Patancheru, A.P. 502 324, India: ICRISAT. 440 pp.

Section of complete report

ICRISAT (International Crops Research Institute for the Semi-Arid Tropics). 1983. Chickpea. Pages 100-128 *in* Annual report 1982. Patancheru, A.P. 502 324, India: ICRISAT.

Publications "in press"

A journal article accepted by the journal's editor

Soman, P., and **Peacock, J. M.** (In press.) A laboratory technique to screen seedling emergence of sorghum and pearl millet at high temperature. Experimental Agriculture.

A book chapter, similarly accepted for publication but not yet published. (The same rule applies for a book.)

Vasudeva Rao, M. J. (In press.) Techniques for screening sorghums for resistance to *Striga*. *In* Biology and control of parasitic weeds. 1. *Striga* (Musselman, L. J., ed.). Boca Raton, FL 33431, USA: CRC Press.

Note: Please use this form only if you are not in the mailing list already or if there is any change in your address.

Application for Inclusion in the Mailing List of IAN

Please complete this application *in full* and mail to: The Editor, IAN, Legumes Program, ICRISAT, Patancheru, Andhra Pradesh 502 324, India.

I have not received any issue of IAN (   ) *or*

I have received IAN. My mailing label number is .....

1. Title (Dr,Prof,Mr,Mrs,Ms)
2. Surname
3. Given name(s)
4. Designation (e.g. Department Head/Librarian/Breeder SII)
5. Professional Qualifications(Highest Degree/other)
   PhD [   ] MA/MS [   ] BA/BS [   ]
   High School/Diploma [   ] Other .....
6. Institute/Organization
7. Street Address
8. City
9. State/Province
10. Postal/Zip code
11. Country
12. Telex No.
13. Cable Address
14. Telephone Number (Office)
15. Telephone Number (Residence)
16. If you are a member of a Computer-Based Messaging System or Electronic-Mail System please give your CBMS address.
17. Nationality
18. First Language

Relationship with ICRISAT: If you have contacts with ICRISAT, please give name(s) of contact person(s)

19. Contact 1
20. Contact 2
21. Contact 3

and indicate if you are or were

22. ICRISAT Staff (give details and dates)
23. Collaborator with Legumes Program (give details and dates)
24. Collaborator with ICRISAT (give details and dates)
25. Consultant to ICRISAT (give details and dates)
26. Visitor (give details and dates)
27. Trainee (give details and dates)
28. Member of AGLN

Please indicate a maximum of three of the major interests listed overleaf (enter letters selected from A to I) [   ] [   ] [   ] and a maximum of five specific interests (enter numbers selectedfrom 11 to 95). Your specific interests need not be confinedto the major interest groups you have selected. [   ] [   ] [   ] [   ] [   ]

Which ICRISAT Publication do you find most useful?

Which ICRISAT Service do you find most useful?

What activity occupies most of your time?

Administration (   ) Research (   ) Teaching/Training (   ) Extension (   ) Other ....

What percentage of your time do you spend working with Arachis? (   )

List a maximum of three of your publications relevant to Arachis

(You may send a complete list of your publications, if you wish)

A. Breeding

11. Confectionery breeding
12. Disease-resistance breeding
13. Pest-resistance breeding
14. Adaptation breeding
15. Nutrition and food quality
16. Genetic studies
17. Mutation breeding
18. Breeding methodology

B. Cytogenetics

21. Cytology
22. Haploids
23. Aneuploids
24. Wild species
25. Wide crosses
26. Tissue culture
27. Transformation
28. Protoplasts

C. Physiology/Microbiology

31. Water stress
32. Drought screening
33. Nitrogen fixation
34. Mineral nutrition
35. Photoperiod studies
36. Climate and environment
37. Temperature tolerance

D. Pathology

41. Fungal diseases
42. Aflatoxin
43. Bacterial diseases
44. Nematodes
45. Deficiency and toxicity diseases
46. Foliar diseases
47. Pod and soilborne diseases
48. Disease control
49. Surveys

E. Virology

51. Characterization
52. Identification
53. Detection
54. Classification
55. Transmission
56. Cultural control
57. Sources of resistance
58. Integrated management
59. Surveys

F. Entomology

61. Taxonomy
62. Bionomics
63. Ecology
64. Varietal resistance
65. Chemical control
66. Cultural control
67. Cropping systems
68. Integrated pest management
69. Insect vectors

G. Genetic resources

71. Collection and assembly
72. Evaluation
73. Maintenance and conservation
74. Documentation

H. Agronomy

81. Soil and crop management
82. Fertilizer response
83. Interculture
84. Plant population
85. Rotations
86. Harvesting, seed technology, postharvest management
87. Irrigation and water management
88. Tolerance for adverse soils
89. Machinery

I. Other

91. Training
92. Extension
93. Library science/information technology
94. Sociology or anthropology
95. Other

Proforma for Information on Groundnut Cultivars in the World

Information on groundnut cultivars released in various parts of the world

Country: ______________ Cooperator's name and address: ______________________________

S. No.	Cultivar name	Other identity[1]	Pedigree[2]	Breeding method followed[3]	Type[4]	Growth habit[5]	Other plant, pod, and seed characters[6]			Agronomic characters[7]	Area of adaptation[8]	Extent of cultivation[9]	Year of release[10]	Breeders' name/originating center[11]
								Number of branches						
							Branching pattern	Primary	Secondary	Potential yield	Geographical area			
							Leaf shape and color	Seeds/pod	Pod size	Days to maturity	Season			
							Pod constriction	Pod beak	Pod reticulation	Reaction to disease and insects	Soil type			
							Pod ridge	Pod shell thickness	Seed color		Annual rainfall			
							Seed size	Oil (%)	Protein (%)		Altitude			

Key to fill the proforma:

1. Other identity, such as PI number or EC number, e.g., PI 314187; UPL-Pn4; DHT 200.
2. State parentage (if it is a cross derivative) e.g., NC 1 x C 12; Introduction (Cultivar Jacana - Introduction from the USA as PI 262042); Reselection from an Introduction (e.g., cultivar M 13 - selection from NC 13 introduced from the USA); Mutant (e.g., x-ray mutant of NC 13).
3. Pedigree method/bulk pedigree/single pod/seed descent, etc.
4. (a) Oil type, (b) Confectionery type, (c) Dual-purpose type.
5. (a) Spanish bunch, (b) Valencia bunch (c) Virginia bunch (d) Virginia runner.
6. (a) Branching pattern (Sequential/Alternate/Irregular); (b) Number of primary and secondary branches; (c) Leaf shape and color; (d) Seeds/pod (give the majority number first); (e) Pod size (Small/medium/large/very large); (f) Pod constriction (Absent/slight/moderate/deep/very deep); (g) Pod beak (Absent/slight/moderate/prominent/very prominent); (h) Reticulation (Smooth/slight/moderate/prominent); (i) Pod ridges (Absent/moderate/prominent) (j) Pod-shell thickness (Thin/medium/thick/very thick); (k) Seed color (Tan/pale tan/rose tan/purple/red/variegated); (l) Seed size (Small/medium/large); (m) Oil (%), (n) Protein (%).
7. Potential yield ($t\ ha^{-1}$); days to maturity; reaction to diseases and insects (Resistant/moderately resistant/susceptible).
8. Indicate the geographical area (e.g., State/province), season (Rainy/postrainy/spring/autumn), soil type (Alfisol/Vertisol/acid soils/etc.); Annual rainfall (mm); Altitude (Low/medium/high).
9. Area in ha under this variety presently grown by the farmers.
10. The year in which the cultivar is officially released in a country/province.
11. Originating center where the cultivar was developed and name of the breeder.

Note: Please use a separate sheet for each cultivar.