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International Arachis Newsletter

Prepared by
Legumes Program
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● ICRISAT Center, Patancheru
• Other ICRISAT Locations
■ Peanut CRSP, Georgia
▪ Other CRSP Locations

International Arachis Newsletter

Publishing Objectives

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

Style and Form for Contributions

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

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

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

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

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

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

The Editor
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INDIA

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

Contents

News and Views

Editorial

The last issue of the newsletter, IAN 11, was despatched to 202 institutional heads in 48 countries, 643 libraries in 112 countries, and 1019 individual scientists in 79 countries reflecting a marked increase in the number of our readers. However, the number of articles and other items submitted for inclusion in the newsletter do not match with the increase in our readers. So we request you to vigorously contribute to the newsletter. In addition to research articles, please send us news about groundnut scientists, workshops, meetings, and other newsworthy items about institutions working on groundnuts.

The editorial staff of the newsletter has been strengthened with the induction of G.V. Ranga Rao, Groundnut Entomologist, as the Associate Editor. With his help, we hope to catch up with the backlog and ensure timely production of the newsletter in future. K. Ramana Rao, who has been helping in the compilation of the newsletter, is replaced by M.S. Raghavan who has considerable editorial experience. We wish to immensely thank K. Ramana Rao who had been associated with the newsletter since its inception and for his help in bringing out the past issues. We wish to extend our best wishes in his new assignment.

L.J. Reddy
G.V. Ranga Rao

News about ICRISAT Groundnut Scientists and Research Fellows

Ronald William Gibbons retires

Mr R.W. Gibbons, Executive Director, ICRISAT Sahelian Center and West African Programs, retired in June 1992. Mr Gibbons is a British national, and was educated at the Universities of Durham and Cambridge in England and at the Imperial College of Tropical Agriculture, Trinidad, West Indies. He was accepted for Her Majesty's Overseas Civil Service in 1955 and worked as a Groundnut Breeder with the Ministry of Agriculture of northern Nigeria during 1957-63. He then served as a breeder and leader of the Grain Legume Productivity Unit of the Agricultural Research Council of Central Africa from 1963 to 1976. Mr Gibbons joined ICRISAT as Principal Groundnut Breeder and Leader of the Groundnut Improvement Program in April 1976. He drafted and implemented a long-term groundnut research program for

ICRISAT leading to the appointment of 5 principal scientists, 13 national scientists and about 70 technical support staff within six subprograms - Breeding, Pathology, Cytogenetics, Physiology, Entomology, and Microbiology. Under his able leadership, eight groundnut varieties were bred and released for cultivation in India, and sources of resistance to many impotant biotic and abiotic constraints to groundnut production were identified from the World Collection of Groundnut-Germplasm in the ICRISAT Gene Bank and made available to groundnut workers in many parts of the SAT. Considerable advances were made in the understanding of important diseases, pests, and physiological problems affecting groundnut, and international cooperation in dealing with these problems was greatly improved by the organization of international and regional workshops.

In May 1986, Mr Gibbons was appointed Executive Director of ICRISAT's Sahelian Center and West African Programs. In this position, he was responsible for research and development programs in Niger, Mali, and Burkina Faso consisting of multidisciplinary teams working on Groundnut, Millet, Sorghum, Resource Management, and for various support units. He was also responsible for ICRISAT cooperative activities with scientists of several other organizations, including the

International Institute of Tropical Agriculture (IITA), the International Livestock Centre for Africa (ILCA), the International Board for Plant Genetic Resources (IBPGR), L'Institut français de recherche scientifique pour le développement en coopération (ORSTOM), the International Food Policy Research Institute (IFPRI), the University of Hohenheim, and the Agricultural University of Wageningen.

Mr Gibbons is a member of the Association of Applied Biologists (AAB), UK, and of the American Peanut Research and Education Society (APRES), USA. He has served on the Board of Directors of the Peanut Cooperative Research Program (Title XII), USA. He has published over 80 journal articles, conference papers, book chapters, and miscellaneous papers.

His merry countenance, affability, and accessibility made Mr Gibbons a natural leader, well loved by all his staff and colleagues. We wish him all success and happiness in the future.

- **Peter Lonergan,** Visiting Technical Officer, Australia joined the Legumes Entomology Unit in July 1992 to work on the NRI/ICRISAT Insecticide Resistance Management Project.
- **Maria Jose Luz Sison** from the Philippines joined the Entomology Unit on 15 Jul 1992. She will be working on groundnut leaf miner (*Aproaerema modicella*) host natural enemy interaction until March 1993.
- **Z.A. Chiteka,** Groundnut Breeder, Crop Breeding Institute, Harare, Zimbabwe made a study visit to the Groundnut Breeding Unit from 6 Jul to 14 Aug 1992 to discuss his Ph.D. research work with the groundnut breeders.
- **F.H. Kiriro,** Senior Agronomist and Center Deputy Director, Kenya Agricultural Research Institute (KARI) Regional Research Center, Kakamega, Kenya spent 2 months as a Research Fellow in the Groundnut Breeding Unit from 15 Sep to 15 Nov 1992 to familiarize himself with the Units' work.
- **V. Manoharan,** Assistant Professor, Regional Research Station, Vriddhachalam, Tamil Nadu, India worked as a Research Fellow in the Groundnut Breeding Unit from 4 Sep to 3 Nov 1992 to gain practical experience in disease resistance breeding and other breeding activities.

Third ICRISAT Regional Groundnut Meeting for West Africa

The Third Regional Groundnut Meeting for West Africa was held from 14 to 17 Sep 1992 in Ouagadougou, Burkina Faso. This meeting follows the two earlier meetings that were held at Niamey, Niger. About 50 represen-

Field visit to Gampella, during the Third Regional Groundnut Meeting for West Africa, held in Ouagadougou, Burkina Faso, 14-17 Sep 1992. [Source: ICRISAT Happenings no. 499, 30 Oct 1992]

tatives from 14 western and central African countries as well as regional and international organizations concerned with groundnut production and research attended. A field visit to Gampella was arranged on 16 Sep for the participants.

The welcome address was given by Dr Belem Celestin, Director of L'Institut national d'études et de recherches agricoles (INERA), Burkina Faso. Dr Charles Renard, Executive Director, West African Programs, presented the objectives of the meeting, which is held every 2 years, and Dr Ouédraogo Victor gave the opening address on behalf of the Director General, Centre national de la recherche scientifique et technologique (CNRST), Burkina Faso.

About 40 papers concerning research on groundnut agronomy, physiology, breeding, pathology, entomology, and utilization were presented. Four working groups on agronomy, breeding, crop protection, and utilization met separately and finalized recommendations. Some of the important recommendations made by the workshop include strengthening of national programs through training, etc., increased cooperation and coordination among scientists of national programs and ICRISAT, and a proposal to hold four theme-oriented workshop meetings on plant protection, agronomy, aflatoxin, and groundnut utilization. The summary proceedings and recommendations of the meeting will be published by ICRISAT in English and French.

Recent ICRISAT Publications

ICRISAT (International Crops Research Institute for the Semi-Arid Tropics). 1992. ICGL 1, ICGL 2, ICGL 3, ICGL 4, and ICGL 5 Nonnodulating Groundnut Germplasm Lines. Plant Material Description no. 34 (Supplied gratis.)

ICRISAT (International Crops Research Institute for the Semi-Arid Tropics). 1992. Genetic Stock Puckered-Leaf Groundnut Mutant ICGL 6. Plant Material Description no. 36 (Supplied gratis.)

ICRISAT (International Crops Research Institute for the Semi-Arid Tropics). 1992. Proceedings of the Fifth Regional Groundnut Workshop for Southern Africa, 9-12 Mar 1992, Lilongwe, Malawi. (In En. Summaries in Pt.) Patancheru, A.P. 502 324, India: ICRISAT. 138 pp. ISBN 92-9066-234-4. Order code: CPE 079.

IBPGR and **ICRISAT** 1992. Descriptors for groundnut (In En., Fr., and Es.) Rome, Italy: International Board for Plant Genetic Resources; and Patancheru, A.P. 502 324, India: International Crops Research Institute for the Semi-Arid Tropics. 125 pp. ISBN 92-9043-139-3.

Mehan, V.K., Haravu, L.J., McDonald, D., Jayanthi, S., and **Sinha, P.K.** 1992. Database on the groundnut aflatoxin problem and users' manual. (In En. Summaries in Fr, Es.) Patancheru, A.P. 502 324, India: International Crops Research Institute for the Semi-Arid Tropics. 1450 ref. [Database on 10 diskettes; Users' manual of 42 pp.] ISBN 92-9066-215-8.

Subrahmanyam, P., Wongkaew, S., Reddy, D.V.R., Demski, J.W., McDonald, D., Sharma, S.B., and **Smith, D.H.** 1992. Field diagnosis of groundnut diseases. Information Bulletin no. 36 (In En, Fr. Summaries in En, Fr, Es.) Patancheru, A.P. 502 324, India: International Crops Research Institute for the Semi-Arid Tropics. 84 pp.

News from Peanut CRSP (Collaborative Research Support Program)

In Memorium - Dr Bharat Singh, Peanut CRSP Principal Investigator

Dr Bharat Singh died at the age of 53 on October 11, 1992 after a short illness. He was born on February 21, 1939 in Gahmar, Uttar Pradesh, India. He received a B.S. degree in biology from Banaras Hindu University in 1958, and an M.S. degree in chemistry and botany from Ranchi University in 1961. He was a lecturer at St. Columbia's College in Bihar, India from 1961 to 1964. He left India in 1964 to pursue a Ph.D. in plant biochemistry at the University of British Columbia, Canada with the degree awarded in 1968. Dr Singh worked from 1968 to 1972 as postdoctoral scientist and visiting assistant professor for the Medical Research Council of Canada and the Department of Nutrition and Food Sciences at Utah State University, USA.

Since 1972 Dr Singh has been in the Department of Food Science and Animal Industries at Alabama A&M University, Normal, Alabama, USA, reaching the rank of professor in 1975. During the final year of his tenure until his sudden death he served as the interim department chairman. He initiated action to organize the department to obtain and maintain the Institute of Food Technologists' accreditation of the food science program. He organized a cereal quality laboratory and coordinated research on utilization of agricultural wastes for ethanol production, funded by the U.S. Department of Energy.

Bharat Singh was associated with the Peanut CRSP since 1980. He collaborated on the preparation of a State of the Art paper on the utilization of groundnut under the Peanut CRSP Planning Grant with the University of Georgia. Beginning in 1982, he coordinated two Peanut CRSP Projects supported by a USAID Grant to the University of Georgia with a subgrant to Alabama A&M University. One, entitled "Peanut Utilization in Food Systems in Developing Countries" with focus on the Caribbean, was in cooperation with the Caribbean Agricultural Research and Development Institute (CARDI). The second, entitled "An Interdisciplinary Approach to Optimum Food Utility in SAT Africa", was in collaboration with the Food Research Centre, Shambat, Sudan and the University of Ouagadougou, Burkina Faso.

For his research and training efforts, the Association of Research Directors of the 1890 Land-Grant Colleges and Universities awarded Dr Singh, in 1980, the prestigious Morrison-Evans Outstanding Scientist Award. During his career, his name appeared as an author on more than 75 technical presentations at professional meetings.

He was the author or co-author of more than 85 technical publications. At Alabama A&M University, he taught several courses in food science, guided about 40 M.S. students to the completion of their degrees, and a Ph.D. student from the University of the West Indies, Trinidad.

He was a member and served on several professional organizations, including the American Association of Cereal Chemists, the American Association of Oil Chemists, the American Peanut Research and Education Society, the Dixie Section of the Institute of Food Technologists, the Institute of Food Technologists, Sigma Xi, and the Southern Association of Agricultural Scientists, in various capacities.

He organized and served as first President of the Huntsville, Alabama India Association (1980-82), and as Vice President of the Federation of Indian Associations in North America, South Region. Dr Singh is survived by his wife Bibha, daughter Dibya, son Niten, son-in-law Sanjay, and granddaughter Dipty.

Meetings

A Workshop on Social Science Research and The CRSPs was held at the University of Kentucky in Lexington, June 9-11, 1992. The purpose of the workshop was to review social science research conducted by the CRSPs in the past and to recommend future directions.

The Board of Directors met in Griffin, Georgia on April 13, 1992 and by Conference Call on August 6, 1992 to discuss CRSP policy issues and consider budget recommendations made by the Technical Committee with subsequent budget approval.

Dr Phindile Olorunju, virus project collaborator in Nigeria, attended the Fifth Regional Groundnut Workshop in Southern Africa March 9-12, 1992. She had particular interest in the rosette virus research conducted by the ICRISAT-SADC program based in Malawi.

The Technical Committee met in Griffin, Georgia on May 20 and July 10-11, 1992 in Norfolk, Virginia to review and recommend to the Board of Directors program plans and budgets for the 1992-93 fiscal year.

The Annual Peanut CRSP Meeting was held in Norfolk, Virginia in conjunction with the American Peanut Research and Education Society (APRES), July 7-11, 1992. CRSP researchers were well represented in the program sessions of APRES, a CRSP investigators' meeting was held on July 10, and a Technical Committee meeting was held on July 10-11. In addition to a number of U.S. participants, in attendance were Philippe Sankara and Mahama Ouedraogo, Burkina Faso; Sopone Wongkaew, Thailand; and Alain Mayeux, CIRAD-CA (IRHO), France.

The Third ICRISAT Regional Groundnut Meeting for West Africa was held in cooperation with the ICRISAT Sahelian Center September 14-17, 1992 in Ouagadougou, Burkina Faso. Peanut CRSP participants included: Olin Smith, Mike Schubert, Bharat Singh, Robert Lynch, and James Demski from the United States; Ousmane Ndoye and Amadou Ba, Senegal; S. Boye-Goni and O. Aladi, Nigeria; Idrissa Dicko and Philippe Sankara, Burkina Faso; Amadou Mounkaila, Niger; and Kafui Kpodo, Ghana.

New Board Members

Two members of the Board retired June 30, 1992. Dr Gerald Arkin, Associate Director of the Georgia Agricultural Experiment Stations and Resident Director of the Georgia Station replaced Dr Louis Boyd, former University of Georgia Coordinator of International Agriculture. Dr Duncan McDonald, Legumes Program Director, ICRISAT, replaced Mr Ron Gibbons, former Executive Director of the ICRISAT Sahelian Center.

Senegal

Dr Amadou Ba, Peanut CRSP host country Principal Investigator for the Mycotoxin Collaborative Project with Texas A&M University was appointed head of the De-

partment of Vegetable Production in ISRA (Institut sénégalais de recherches agricoles). Dr Ba has been a Peanut CRSP collaborator since 1983 and will continue his research in addition to his administrative duties.

Travel

Dr Manjeet Chinnan traveled to Jamaica in February and September 1992 to discuss progress and plans of the CRSP postharvest project. Project assistant Everett Chapman traveled to Belize and Jamaica in November 1992 to continue collaborative research efforts with CARDI investigators.

Dr C.E. Simpson of Texas A&M University and Coordinator-Principal Investigator on the Texas A&M/West Africa breeding project was joint leader of a germplasm collection expedition to Brazil, May 21-June 15, 1992. Collection sites extended from the eastern coastal region, through Brasilia, to 11°S. The search, primarily for section *Arachis* germplasm, resulted in the acquisition of 122 wild species accessions, 82 cultivated species accessions, and 22 *Rhizobium* collections. Dr David Williams of the USDA Plant Exploration Office; Dr Roy Pittman, USDA/ARS Peanut Curator; and Dr Jose Valls, CENARGEN/EMBRAPA, Brazil Peanut Curator also participated in the expedition.

Drs Marian Beremand, Nancy Keller, Bachir Sarr (Texas A&M), and David Cummins (Management Office) visited Senegal, Ghana and Benin in early June 1992 to review plans and progress of the Mycotoxin Project in Senegal and evaluate potential new linkages in Ghana and Benin. Beremand and Keller are new Principal Investigators and Sarr from Senegal is completing his graduate study program.

Drs David Cummins, Tommy Nakayama, and Allan Norden visited Malawi in August 1992 to further evaluate the expansion of the Peanut CRSP program into southern Africa through a Malawi linkage.

Drs David Cummins and Duncan McDonald traveled to Brazil in August 1992 to participate in the annual PROMANI Meeting (South American southern cone countries) and discuss potential CRSP-ICRISAT linkages with Brazil.

Dr James Demski traveled to Nigeria in July 1992 following the West Africa workshop to discuss research progress and plans with rosette virus project collaborators at the Institute for Agricultural Research, Ahmadu Bello University, Zaria.

Publications

The Peanut CRSP has recently published two Research Reports, Impacts of IPM technology in North Carolina and CARDI/Payne cultivar in Jamaica. Copies can be obtained from the Peanut CRSP Management Office, The University of Georgia, Georgia Station, Griffin, GA 30223-1797, USA.

Research Reports

CSMG 84-1 - A New High-yielding and Rust-resistant Virginia Runner Groundnut Variety

A.B. Singh, O.B. Singh, and **S.K. Srivastava** (Chandra Shekhar Azad University of Agriculture and Technology, Groundnut Research Station, Mainpuri 205 001, Uttar Pradesh, India)

CSMG 84-1 is a newly identified, high-yielding, and rust-resistant virginia runner groundnut variety developed at the Groundnut Research Station, Mainpuri, Uttar Pradesh. It was field-tested under the All India Coordinated Research Project on Oilseeds (AICORPO) and was recommended for prerelease multiplication and consideration by the Central Subcommittee on Crop Standards, Notification and Release of Varieties, Department of Agriculture and Cooperation, Ministry of Agriculture, Government of India, for release and notification.

The variety performed distinctly better than the three control varieties, M 13, MA 10, and M 335, in terms of both pod and seed yields. In Zone I, comprising Rajasthan, Uttar Pradesh, Punjab, and Haryana states of India, it was among the highest yielding group in 10 out of 13 test locations. On an average, the pod yield increase was 29.26% over the national control M 13, 9.17% over zonal/local control MA 10, and 21.91% over the minikit control M 335. CSMG 84-1 gave a seed yield 31.33% higher than the national control, 9.38% higher than the zonal/local control, and 21.78% higher than the minikit controls (Table 1).

CSMG 84-1 was also superior to the controls in foliar disease resistance. It remained rust-free under natural infection over the years it was tested in the coordinated trials, scoring 1 (completely rust free) for rust disease on a 1-9 rating scale. It also showed higher late leaf spot resistance levels than the controls. Hence CSMG 84-1 can be used not only as a donor for resistance to rust and late leaf spot, but also to stabilize groundnut production in the country where runner varieties are grown, as most of the present day high-yielding cultivars are susceptible to rust and leaf spots.

Table 1. Performance of CSMG 84-1 in coordinated groundnut varietal trials conducted in zone I, India, rainy seasons 1988-1990.

			Mean pod and seed yields (t ha^{-1})				
				Controls			
Year	No. of trials		CSMG 84-1	M 13 (NC)[1]	MA 10 (Z/LC)[2]	M 335 (MC)[3]	CD[4]
1988	5	P[5]	3.13	2.51 (19.73)[7]	2.87 (8.27)	2.66 (15.13)	0.34
		S[6]	2.06	1.55 (25.06)	1.85 (10.32)	1.77 (14.15)	-
1989	4	P	2.67	1.76 (34.12)	2404 (10.06)	2.04 (23.57)	0.35
		S	1.69	1.10 (34.60)	1543 (8.43)	1.21 (28.01)	-
1990	4	P	2.31	1.53 (33.92)	-	1.69 (26.94)	0.30
		S	1.45	0.95 (34.32)	-	1.11 (23.18)	-
	Mean	P	2.70	1.93 (29.26)	2638 (9.17)	2.13 (21.88)	0.32
		S	1.73	1.20 (31.33)	1696 (9.38)	1.37 (21.78)	
Frequency in the highest yielding group (pooled over 3 years)			10/13	0/13	5/13	2/13	

1. NC = National control.
2. Z/LC = Zonal/local control.
3. MC = Minikit control.
4. CD = Critical difference.
5. P = Pod yield.
6. S = Seed yield.
7. Figures in parentheses indicate percent increase of CSMG 84-1 over the controls.

CSMG 84-1 also appears to be more tolerant of thrips, termites, white grub, and pod borer than the controls. It has a very good shelf life. In comparison to the three controls it had less insect pest damage in storage. In the agronomic trials undertaken for sowing, irrigation, and fertilizer schedules, the variety clearly showed a wide range of adaptability. The foliage remains dark green until maturity and gives a high quantity hay. It has a spreading habit with profuse branching. The pods are reticulated and two-seeded, with rose and prominent white variegated seeds. The distinctive red seed color facilitates maintaining the purity of this variety.

RG 141 – A New High-yielding Groundnut Variety for the Heavy Soils of Rajasthan, India

D.K. Saxena[1], A.K. Singh[2], and P. Joshi[3]
(1. Rajasthan Agricultural University, Agricultural Research Station, Fatehpur, Sikar district, Rajasthan 323 301, India;
2. Agricultural Research Station, Durgapura, Jaipur, Rajasthan 302 018, India;
3. Agricultural Research Station, Mandor, Jodhpur, Rajasthan 342 304, India)

Groundnut is an important rainy-season crop of Rajasthan State where it is cultivated on about 0.25 million ha. In Rajasthan groundnut is cultivated in three distinct situations: (1) rainfed Alfisols where runner types are grown; (2) rainfed Vertisols where spanish types are grown; and (3) irrigated conditions.

At present two groundnut varieties, JL 24 and AK 12-24, are recommended and are grown in Vertisols during the rainy season in Kota, Chittorgarh, Bhilwara, Udaipur, and Jhalawar districts. These varieties are low-yielding and are susceptible to diseases and insect pests. There is a need to replace them with high-yielding disease- and insect-resistant varieties.

The variety RG 141 was developed at the Agricultural Research Station, Durgapura, Jaipur from the F_4 generation bulk of a cross, Robut 33-1 × NC Ac 2821, received from ICRISAT. It was released by the State Variety Release Committee and notified by the Government of India in 1991. In yield trials conducted over different years and locations in the rainy seasons between 1982 and 1988, this variety gave pod yields 23.6% higher than JL 24 and 28.8% higher than AK 12-24 (Table 1). It was also tested

Table 1. Pod yields of RG 141 and other groundnut varieties in trials conducted in Rajasthan, India, rainy seasons 1982-88.

		Pod yield (t ha^{-1})				
Year	Location	RG 141	JL 24	AK 12-24	SE	CV (%)
1982	Durgapura	3.09	2.21	2.39	±180.3	13.6
1983	Durgapura	3.41	2.83	2.64	±200.4	15.9
1984	Durgapura	2.40	1.69	1.78	±122.3	19.6
1985	Durgapura	3.47	2.27	2.92	±187.0	12.5
1985	Kota	1.98	1.66	1.43	± 74.0	17.1
1986	Durgapura	4.07	3.92	2.96	±194.0	10.0
1987	Durgapura	2.76	2.29	2.00	±176.5	15.6
1987	Kota	1.10	1.13	0.56	±174.4	22.8
1988	Durgapura	3.56	2.33	3.18	±150.0	9.4
1988	Diggi	3.71	3.20	3.13	±191.0	19.9
1988	Bhilwara	2.13	2.09	1.57	±174.5	18.9
	Mean	2.88	2.33 (23.6)[1]	2.24 (28.8)		

1. Figures in parentheses refer to mean percentage of yield increase of RG 141 over JL 24 and AK 12-24.

Table 2. Mean pod yield of RG 141 and other groundnut varieties in multilocational trials in AICORPO groundnut Zones I and III, India, rainy seasons 1986 and 1987.

	Mean pod yield (t ha^{-1})		Increase over control variety (%)			
			JL 24		AK 12-24	
			Zones		Zones	
Variety	Zone I (Mean of 6 locations)	Zone III (Mean of 7 locations)	I	III	I	III
RG 141	2.02	1.44	14.2	14.3	16.8	28.8
JL 24	1.77	1.26	-	-	-	-
AK 12-24	1.73	1.12	-	-	-	-

during 1986 and 1987 at various locations in groundnut Zones I and III of the All India Coordinated Research Project on Oilseeds (AICORPO). In Zone I it recorded pod yields 14.2% higher than JL 24 and 16.8% higher than AK 12-24. In Zone III, under rainfed conditions, it recorded pod yields 14.3% higher than JL 24 and 28.8% higher than AK 12-24 (Table 2). In adaptive trials conducted in Ajmer division, Rajasthan, in the 1988 rainy season, RG 141 yielded 1.65 t pods ha^{-1} in comparison with the 1.38 t ha^{-1} of JL 24 and 0.98 t ha^{-1} of AK 12-24. In on-farm demonstrations during the 1988 rainy season it gave 1.80 t ha^{-1} pod yield, which compared favorably with the 1.30 t ha^{-1} pod yield of a local cultivar.

Analysis of 4 years of data from agronomic trials with RG 141 revealed that it gave, on an average, 500 kg ha^{-1} more pod yield in advanced (mid-June) sowing (3465 kg ha^{-1}) than from mid-July sowing (2965 kg ha^{-1}). In the advanced sowing it gave pod yield 28.2% higher than JL 24 and 25.4% higher than AK 12-24, thus showing its superiority in both advanced- and normal-sowing situations.

The variety RG 141 has shown better resistance to late leaf spot, collar rot, rust, and bud necrosis diseases over seasons/locations than either JL 24 or AK 12-24. The variety matures in 110-115 days. Pods are medium sized with a shelling percentage of 74.0. Seeds are medium sized with pale pink testas and 50.8% oil content.

Performance of Introduced Confectionery Lines for Yield and Quality Characteristics at ICRISAT Center, India

S.L. Dwivedi, G.V.S. Nagabhushanam, S.N. Nigam, and **R. Jambunathan**
(ICRISAT Center)

About a third of the world's groundnut production is consumed in the form of edible nuts. Large-seeded groundnuts are preferred for direct consumption. Development of large-seeded varieties with improved seed quality characteristics is an important breeding activity at ICRISAT Center, India and at North Carolina State University (NCSU), Raleigh, USA. We obtained 65 large-seeded advanced breeding/germplasm lines from NCSU to broaden the genetic base of our confectionery breeding program at ICRISAT Center. These lines were evaluated along with Chandra, a large-seeded confectionery cultivar released in India, and ICRISAT-bred lines for yield and seed quality characteristics in the rainy and postrainy seasons of 1988-91 at ICRISAT Center.

The NCSU lines were assigned ICGV (ICRISAT Groundnut Variety) numbers. Except for ICGV 89236 and ICGV 90213 which belong to subsp *fastigiata*, all belong to subsp *hypogaea*. The introduced lines, in general, possess uniform, elongated, medium-sized, constricted pods, and tan-colored seeds. However, most of them were low yielders and had lower 100-seed masses than Chandra and ICRISAT-bred lines. After evaluation in four successive rainy and postrainy seasons, we identified five lines, ICGV 88424 (NC Ac 18420), ICGV 88429 (NC Ac 18437), ICGV 88438 (GP NC 343 × NC 17367), ICGV 88448 (NC Ac 18437), and ICGV 89235 (NC 18016), that are either superior to, or comparable with Chandra in pod yield, shelling percentage, 100-seed mass, and oil and protein contents (Table 1). The seed quality of these lines, as measured by their oleic (O)/Linoleic (L) acid ratio, is better than that of Chandra and locally bred lines at ICRISAT Center. These lines have now been included in the International Confectionery Groundnut Varietal Trial (ICGVT) for wider testing. The Fourth ICGVT, which includes ICGVs 88424, 88429, and 88438, has been sent to 19 countries. Results of the trial are awaited. ICGV 88448 and ICGV 89235 are included in the Fifth ICGVT, and this set with 24 entries is now available to our cooperators.

Table 1. Mean performance of five introduced confectionery groundnut lines at ICRISAT Center, rainy and postrainy seasons, 1988-1991.

Genotype	Pod yield (t ha^{-1})	Shelling (%)	100-seed mass (g)	Oil (%)	Protein (%)	O/L ratio
ICGV 88424	3.02	66	75	49	22	2.4
ICGV 88429	2.79	66	75	48	21	1.9
ICGV 88438	2.82	66	86	49	22	2.3
ICGV 88448	3.32	65	80	48	23	2.2
ICGV 89235	2.24	68	84	48	23	2.3
Control Chandra	2.57	66	74	47	23	1.5

Lines with high average performance, stable seed mass, and high O/L ratio have been crossed with locally bred confectionery lines. These are ICGV 88424, ICGV 88438, ICGV 88448, ICGV 88430 (NC Ac 18440), ICGV 88442 (NC 6 × Early bunch), ICGV 89235, and

ICGV 90213 (NC Ac 17921 × NC 8C). Of these, ICGV 90213 was a better parent than the others in producing a wide range of segregants in early generations. Some of the progenies derived from such crosses are now in yield trials at ICRISAT Center.

Induced Mutants of Taxonomical Importance in Groundnut

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The cultivated groundnut, *Arachis hypogaea* L., has been divided into two subspecies based on several morphological differences. The subspecies *hypogaea* is further subdivided into variety *hypogaea*, virginia type, and variety *hirsuta*, Peruvian runner type. The virginia type is characterized by either erect (virginia bunch) or prostrate (virginia runner) growth habit. The subspecies *fastigiata* Waldron is further subdivided into variety *fastigiata*, valencia type, and variety *vulgaris*, spanish type (Krapovickas 1968). Two inconclusive theories have been put forward to explain the possible origin of the two subspecies (Singh 1988). First, it is possible that *A. hypogaea* subsp *fastigiata* evolved from an amphidiploid hybrid between A and B genome species, and *A. hypogaea* subsp *hypogaea* subsequently evolved through a mutation in subspecies *fastigiata* that produced occasional vegetative branches in an otherwise sequential branching pattern. Alternatively, subspecies *hypogaea* and *fastigiata* may have evolved from different A and B genome species combinations.

The mutants isolated in our laboratory lend indirect support to the theory of monophyletic origin of the sub-

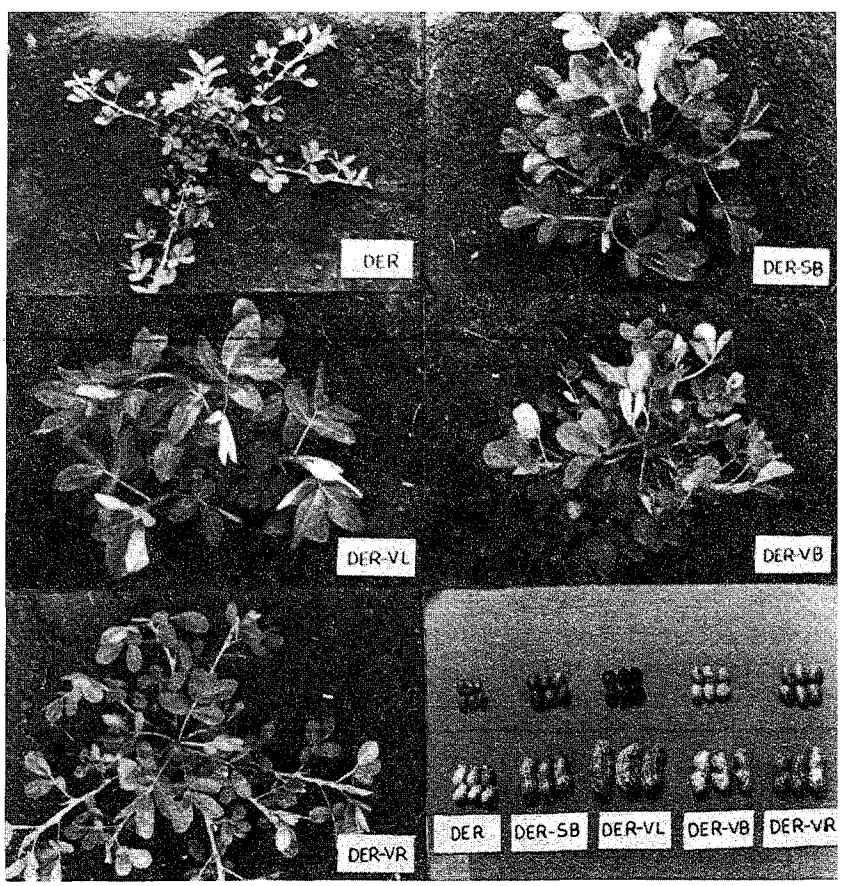

Figure 1. Growth habit and pod and seed features of mutants derived from ethyl methane sulfonate-treated Dharwad Early Runner (DER) groundnut genotype.

Table 1. Description of groundnut mutants derived from ethyl methane sulfonate-treated Dharwad Early Runner genotype.

Descriptor	Parent (DER)	Mutants[1]			
		DER-VL	DER-SB	DER-VB	DER-VR
Main stem flowering	present	present	absent	absent	absent
Branching pattern	sequential	sequential	sequential	alternate	alternate
Growth habit	procumbent	erect	erect	decumbent	decumbent
Inflorescence	simple	simple	compound	simple	simple
Number of n+1 branches	4.0±0.99	4.3±0.67	5.4±0.97	8.0±1.41	7.60±1.67
Number of n+2 branches (n+1 branch)$^{-1}$	0.00	0.00	1.67±0.32	2.60±0.42	5.80±1.17
Length of main stem (cm)	17.9±2.47	44.6±3.92	29.8±3.79	27.7±4.45	29.2±2.39
Length of n+1 branches (cm)	52.2±4.97	44.7±3.65	28.6±2.27	31.2±2.77	27.2±2.20
Leaf color	pale green	dark green	pale green	dark green	dark green
Leaflet length (cm)	5.32±0.34	7.36±0.75	5.48±0.30	5.31±0.49	5.31±0.27
Leaflet width (cm)	2.90±0.17	3.43±0.18	3.27±0.42	3.00±0.22	2.90±0.17
Number of seeds pod^{-1}	2-1	3-2-1	2-1	2-1	2-1
Pod length (cm)	2.31±0.15	3.82±0.25	2.90±0.10	2.77±0.18	3.22±1.15
Pod width (cm)	0.95±0.05	1.43±0.07	1.27±0.04	1.27±0.08	1.27±0.08
Pod reticulation	medium	high	medium	slight	slight
Seed color	light tan	purple	tan	tan	tan
100-seed mass (g)	20-25	35-40	30-35	30-35	35-40
Mean shelling percent	80.0	53.8	63.7	60.0	69.4
Dormancy	present	absent	absent	present	present
Leaf spot incidence (1-9 scale)	7	2	8	4	7
Rust incidence (1-9 scale)	4	3	7	2	8
Days to maturity	95-100	100-110	100-110	115-120	125-130

1. DER = Dharwad Early Runner; -VL = Valencia type mutant; -SB = Spanish bunch type mutant; -VB = Virginia bunch type mutant; -VR = Virginia runner type mutant.

species. The mutants were isolated from ethyl methane sulphonate-treated (0.02%) Dharwad Early Runner (DER). This true breeding DER genotype is a derivative of a cross between Dh 3-20 and CGC 1 and has many features of subspecies *fastigiata* but is prostrate in habit with short main axis, small seeds, and fresh seed dormancy (Gowda et al. 1989), thus resembling some primitive forms of *A. hypogaea* (Simpson et al. 1986) and some forms of the wild tetraploid progenator of groundnut, *A. monticola* (Smartt 1990), in growth habit. The true breeding mutants (Fig. 1 and Table 1) resemble typical spanish bunch and valencia belonging to subspecies *fastigiata* and virginia runner and virginia bunch belonging to subsp *hypogaea*. The valencia type mutant (DER-VL) has typical features of primitive valencia landraces of Peru with resistance to rust and late leaf spot, ribbed pods, and colored kernels, thus providing critical evidence to support the theory of origin of foliar-disease resistant valencia type as spontaneous mutants (Subrahmanyam et al. 1989).

Besides emphasizing the importance of mutation in generating significant morphological diversity, these mutants, because of single source of origin, constitute good material for investigations on the genetic basis of infraspecific differentiation. Such information has important implications for evolutionary studies as well as for genetic improvement of groundnut.

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Field Screening for Drought Resistance in Groundnut

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Developing drought-resistant varieties will result in higher productivity in groundnut, which is predominantly cultivated under rainfed conditions. Hence studies were

Table 1. Observations on some plant characteristics related to drought resistance in 25 groundnut genotypes tested under rainfed conditions, Vriddhachalam, Tamil Nadu, India, rainy season 1990.

Genotype	DWL[1] (g plant^{-1})	LP[2]	PW[3]	RWC[4] (%)	DMA[5] (g plant^{-1})	FL[6]	HI[7]	DP[8] (g plant^{-1})
ICG 3143	2.73	28.7	95.0	92.5	7.15	18.6	0.35	3.43
ICG 3400	2.28	30.3	86.7	69.4	5.27	14.1	0.40	3.16
ICG 3556	3.18	32.7	83.3	70.9	6.83	19.5	0.43	5.02
ICG 4747	2.34	33.0	85.0	85.9	5.83	18.3	0.18	0.99
ICG 4790	2.63	38.0	90.0	81.5	10.29	10.7	0.44	3.91
ICG 5305	3.24	41.0	90.0	74.6	7.12	15.8	0.37	3.33
ICG 8048	2.73	38.7	98.3	73.8	6.43	9.3	0.32	2.48
ICGV 86169	2.94	45.0	98.3	66.3	7.75	8.3	0.33	2.82
ICGV 86607	3.83	31.7	55.0	80.2	8.40	17.5	0.28	5.46
ICGV 86635	3.88	39.0	46.7	87.2	7.64	19.2	0.38	5.42
ICGV 86644	4.95	47.0	53.3	88.4	10.59	17.3	0.26	4.91
ICGV 86654	3.48	55.3	91.7	73.0	8.10	14.4	0.22	2.45
ICGV 86707	3.36	40.0	60.0	84.6	8.80	10.5	0.25	3.67
ICGV 86742	3.89	37.3	65.0	76.8	8.20	17.7	0.31	3.48
ICGV 86754	3.68	54.0	63.3	77.4	7.34	16.3	0.29	4.06
ICGV 87050	4.68	55.3	60.0	80.1	11.77	16.2	0.33	4.34
ICGV 87086	4.39	43.0	75.0	80.9	7.81	9.1	0.36	3.71
ICGV 87118	4.38	43.3	96.7	71.1	9.97	11.4	0.23	3.53
ICGV 87259	3.68	39.7	70.0	79.2	7.87	11.3	0.27	3.19
ICGV 87264	3.43	39.7	58.3	73.3	7.79	16.8	0.27	3.38
ICGV 87354	4.88	57.0	60.0	75.7	10.00	12.8	0.28	3.69
ICGV 87358	4.21	42.7	55.0	78.6	8.34	14.7	0.25	3.96
PCG 9018	4.88	42.3	83.3	87.2	9.12	8.1	0.30	4.46
PCG 9019	3.82	40.7	85.0	76.9	8.79	14.4	0.44	4.33
PCG 9020	3.27	44.0	96.7	43.7	8.61	14.8	0.47	3.15
Mean	3.63	41.57	76.07	77.01	8.23	14.28	0.32	3.69
SE	±0.154	±1.538	±3.388	±1.848	±0.290	±0.700	±0.015	±0.192
Correlation with pod yield	0.5368**	0.0098	-0.5545**	0.2392	0.4270*	0.2447	0.3197	

1. DWL = Dry weight of leaves, 2. LP = No. of leaves per plant, 3. PW = Percentage of wilting, 4. RWC = Relative water content, 5. DMA = Dry matter accumulation, 6. FL = No. of functional leaves per plant, 7. HI = Harvest index, 8. DP = Dry weight of pods.

undertaken with the objective of identifying the physiological attributes associated with drought tolerance that can be used as selection indices in breeding programs.

Twenty-five groundnut cultures [22 received from ICRISAT, and 3 from the Project Coordinating Unit (Groundnut), Junagadh] were evaluated during the 1990 rainy season in a randomized-block design with three replications. The trial was sown on 1 August in a sandy loam soil under totally rainfed conditions. Each genotype was sown in a 4.0 × 1.2 m^2 plot at a plant spacing of 30 × 10 cm. The following observations were recorded during the stress period (i.e., at 70 days after sowing): number of leaves per plant (LP), dry weight of leaves (DWL), total dry matter accumulation (DMA), relative water content of leaf (RWC), and percentage wilting of plants. The number of functional leaves, pod yield, and harvest index (HI) were recorded at the time of harvest. Simple correlation coefficients were worked out and are presented in Table 1.

A rainfall of 460 mm was received in 19 days during the crop growth period. The crop experienced severe drought during the pod development stage since there was no rain between 55 and 75 days after sowing. The soil moisture status during this drought period was 4.58%.

Highest pod yield was recorded in ICGV 86607 (5.46 g $plant^{-1}$) closely followed by ICGV 86635 (5.42 g $plant^{-1}$) and ICG 3556 (5.2 g $plant^{-1}$). These genotypes possessed many desirable attributes such as higher DWL, RWC, DMA, HI, and more functional leaves than other entries, and the first two also had lower wilting percentage.

Pod yield was positively and significantly correlated with DMA (r = 0.4270) and DWL (r = 0.5368) recorded on the 70th day. Upretty et al. (1979) also observed that DMA and pod yield were positively associated in cowpea. RWC on the 70th day was weakly correlated with yield (r = 0.2392) and functional leaves at harvest were positively but weakly correlated with yield (r = 0.2447). Percentage wilting of plants on the 70th day was negatively and significantly correlated with yield (r = -0.5545). Under drought stress conditions, the entire plant growth is ultimately affected in terms of DMA and partitioning efficiency. Therefore genotypes possessing higher DMA and LW will show drought tolerance and have greater productivity. Arjunan et al. (1988) also reported positive association of pod yield with DMA and LW under drought stress conditions.

The higher number of functional leaves at harvest observed in the tolerant genotypes ensured the plants a supply of photosynthates to the sink until maturity. For example, the genotypes ICG 3556 and ICGV 86635 had more functional leaves at the time of harvest (19.5 and 19.2) and recorded higher pod yield of 5.02 g and 5.42 g $plant^{-1}$ than other entries.

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Production of Monoclonal Antibodies to Bud Necrosis Virus

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The bud necrosis disease of groundnut (*Arachis hypogaea* L.) was first reported from India by Reddy et al. (1968). It was subsequently reported that bud necrosis disease was caused by tomato spotted wilt virus (TSWV) (Ghanekar et al. 1979). Recent studies using advanced serological techniques have shown that the causal agent of bud necrosis disease is distinct from TSWV and it has therefore been named bud necrosis virus (BNV) (Sreenivasulu et al. 1991, Reddy et al. in press). Hence BNV is considered to be a distinct member of the tospovirus group.

Following established facilities at ICRISAT Center, monoclonal antibodies (McAbs) against BNV were produced using the strategy initially described by Kohler and Milstein (1975). Purified BNV was used for immunization of Balb/c mice. Lymphocytes collected from mice spleen were fused with SP2/O Ag.14 myeloma cells using polyethylene glycol as fusing agent (PEG m.w. 1300–1600, 40%). Seven hundred hybridoma cultures, deriving from three fusion experiments, were tested by direct antigen coating ELISA (DAC-ELISA) and protein-A coating ELISA (PAC-ELISA) for the production of

Table 1. Stable hybridoma cell lines secreting BNV-specific monoclonal antibodies.

McAb code	Type of McAb secreted: Heavy chain	Light chain	Ascitic fluid titer[1]
F15-4G8	IgG3	Kappa	ND[2]
F16-3A7	IgG1	Kappa	1/5 000 000
F16-3A9	IgG1	ND	1/50 000
F16-3A11	IgG1	Kappa	1/500 000
F16-3C12	IgG1	ND	1/500 000
F16-4F12	IgG1	Kappa	1/500
F16-3C6	IgG1	Kappa	1/500 000
F16-3E11	IgG1	Kappa	1/500 000
F16-3G8	IgG1	Kappa	ND
F16-4G7	IgG1	Kappa	1/50 000

1. Ascitic fluid titer was determined by testing the fluids in DAC-ELISA (Hobbs et al. 1987) using purified virus as antigen.
2. Not determined.

virus-specific antibodies. Ten such cultures were selected, cloned by limit dilution, and used to induce ascite tumors in mice (Table 1).

All the 10 BNV-specific McAbs failed to react, either in ELISA or in dot immunobinding assay (DIBA) with the TSWV isolate that infects groundnut in the USA. In addition, 12 McAbs produced against a lettuce isolate of TSWV (Hsu et al. 1990) were tested for their ability to react in ELISA with the groundnut isolate of TSWV and BNV. Five of them did react with the groundnut isolate of TSWV but none with BNV. These results further support the proposal that BNV should be considered a distinct member of the tospovirus group as suggested by Reddy et al. (in press).

In another experiment, 10 BNV-specific McAbs were tested for their ability to distinguish eight isolates of BNV collected from various parts of India. All of them reacted to the eight BNV isolates, indicating that these McAbs are specific to common epitopes.

The BNV-specific McAbs were tested for virus detection. F16-3A7 McAb (Table 1) showed strong reaction in DAC-ELISA (Hobbs et al. 1987). A test was conducted to compare the potential of F16-3A7 McAb with rabbit polyclonal antibodies currently being used to detect the virus. The DAC-ELISA was performed by diluting the antigens (crude groundnut leaf extracts) in carbonate buffer and incubating for 1 h at 37°C. F16-3A7 McAb was used as ascitic fluid diluted 1/10 000 in PBS-Tween buffer and incubated for 1 h at 37°C. Polyclonal antibodies (antiserum diluted 1/3 000) were first cross-adsorbed for 1 h at 37°C with healthy plant extract and incubated for 1 h at 37°C with the antigens. Horseradish peroxidase (HRP) labelled anti-mouse immunoglobulins (1/4 000) and HRP labelled anti-rabbit immunoglobulins (1/1 000) were then incubated for 1 h at 37°C. The substrate, 3,3',5,5'-tetramethylbenzidine, was finally added and incubated at room temperature. As shown in Table 2, the F16-3A7 McAb was 10 times more sensitive than polyclonal antibodies in detecting the virus from infected plant tissue, thus improving the sensitivity of detection. Since the McAb can be produced in unlimited amounts, diagnostic tests utilizing the F16-3A7 McAb have the advantage of reproducibility, increased sensitivity, and specificity over the polyclonal antiserum. Further tests to detect the virus in thrips vectors are in progress.

Table 2. Detection of BNV in DAC-ELISA using F16-3A7 McAb and rabbit polyclonal antiserum.

Dilution of plant extract	Type of extract	Optical density at 450 nm: F16-3A7 McAb	Polyclonal antibodies
1/10	I[1]	>2	1.975
	H[2]	0.113	0.096
1/100	I	>2	1.958
	H	0.064	0.051
1/1 000	I	>2	1.355
	H	0.050	0.037
1/10 000	I	0.826	0.287
	H	0.047	0.030
1/100 000	I	0.222	0.057
	H	0.048	0.027
Antigen buffer		0.044	0.033

1. Infected plant extract.
2. Healthy plant extract.

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Seed Transmission of Peanut Stripe Virus in Groundnut

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A groundnut potyvirus distinct from peanut mottle virus has been reported from China (Xu et al. 1983). Demski et al. (1984) reported a similar virus naturally infecting groundnut in the USA and named it peanut stripe virus (PStV). These were later considered to be the same and there are at present 24 isolates of PStV that induce different symptoms in groundnut (Wongkaew and Dollet 1990).

The spread of PStV to different countries is considered to be mainly due to its seed-transmitted nature in groundnut. Thus the supply of virus-free seed has assumed great importance for curtailing the spread of this virus. Studies conducted so far have shown that the rate of PStV seed transmission in groundnut is highly variable, depending on the PStV isolate and varieties of groundnut (Demski et al. 1984, Xu et al. 1983, Xu et al. 1991, and Ohki et al. 1989). To determine the influence of PStV isolate on groundnut varieties, we tested 22 groundnut varieties with a single isolate of PStV and one groundnut variety with different PStV isolates.

Five isolates of PStV that induce stripe, necrotic, chlorotic ring mottle, blotch, or mild mottle symptoms were used to inoculate Tainan 9 groundnut in field trials at the Khon Kaen University. A replicate test with 56 plants per plot were established during the rainy season (May-August). Plants in one set were inoculated 2 weeks after emergence with each isolate separately and plants in the other set served as healthy controls.

In another test, seed from 22 groundnut varieties were sown in 5-m long rows with a spacing of 30 cm between rows. Seedlings were inoculated 2 weeks after emergence with a Thai isolate, T 2, that induces stripe symptoms. The percent PStV incidence in each variety was recorded 80 days after sowing.

Percentage seed transmission was determined by the seed test described previously by Demski and Warwick (1986). Seeds were also used in growing-out tests where the seedlings were observed for PStV symptoms.

The rate of seed transmission in Tainan 9 groundnut infected with five PStV symptom variants was between 6 and 16% (Table 1).

Percentage of seed transmission in 22 groundnut varieties infected with Thai isolate T 2 varied from 0 to less than 7% (Table 2).

These preliminary data suggest that the percentage of PStV seed transmission is highly variable. Further studies should be conducted under more controlled

Table 1. Effect of peanut stripe virus symptom variants on seed transmission frequencies for Tainan 9 groundnut grown under field conditions at Khon Kaen, Thailand.

Virus isolate	Seed transmission (%)[1]
Stripe (T 2)	13.30
Necrotic (T 6)	8.38
Chlorotic ring mottle CP-N (T 3)	10.91
Blotch (T 8)	6.32
Mild Mottle (T 1)	16.10

1. Based on 200-400 seeds using growing-out test combined with indexing by direct antigen coating ELISA.

Table 2. Seed transmission frequencies of peanut stripe virus in groundnut varieties grown under field conditions at Khon Kaen, Thailand.

Variety	Seed transmission (%)
ICGS 36	1.60
ICGS 1	1.05
NC Ac 2240	0.00
ICG 19	1.02
148-7-4-3-12B × NC Ac 17090	4.07
ICG 149 (Philippines Pink)	0.00
RCM 387	0.29
(Comet × NC Ac 17090)-F2-B2-4B1	1.63
ICG 43	0.76
FSB7-2 × EC 76446 (292)	6.72
No. 324	NA[1]
NC 7 (Khon Kaen 60-3)	0.00
Tainan 9	0.82
Moket (Khon Kaen 60-1)	0.00
(Comet × NC Ac 17090)-F2-3B1-B2-B1	1.98
KAC 290	0.00
TMV 3 (Khon Kaen 60-2)	0.34
ICG 18	1.11
EC 76446 (292)	3.41
(MGS 9 × Robut 33-1)-18-3-F6-1	0.49
ICG 12	0.35
EC 76446 (292) × Robut 33-1	3.18

1. NA = Not available.

environmental conditions to determine the critical factors that influence seed transmission.

Some of the varieties, i.e., NC Ac 2240, NC 7, Moket, and KAC 290, that have shown no seed transmission in our tests need to be tested with other PStV isolates for this character. Developing cultivars that do not transmit the virus through their seeds will avoid virus spread and help in ensuring sustainability of groundnut cultivation.

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Occurrence of Entomopathogenic Nematodes at ICRISAT Center

M. Singh, S.B. Sharma, and **G.V. Ranga Rao** (ICRISAT Center)

Two entomopathogenic nematodes, *Steinernema* sp and *Hetero rhabditis,* are important biocontrol agents for the management of insect pests because of their wide host range and high virulence (Poinar 1979). Surveys were conducted at ICRISAT Center between June and December 1991 for steinernematid and heterorhabditid nematodes. Soil samples were collected from 110 sites in five Vertisol and six Alfisol fields. Ten soil cores (0-15 cm soil depth) were collected from each field, and insect parasitic nematodes were collected using a soil-baiting technique (Bedding and Akhurst 1976) that employs larvae of the rice moth as bait, *Corcyra cephalonica* Stainton. Ten full-grown larvae of *Corcyra* were placed at the bottom of 250 cm^3 plastic containers, and thoroughly bulked and mixed soil from within each field was placed on the *Corcyra* larvae. Containers were covered with muslin cloth and incubated at 25±1°C. After 1 week, dead *Corcyra* larvae were collected and examined for the presence of nematodes. Infective stages of the nematodes

were killed in hot saline water and fixed in 5% formalin. The nematodes were treated by the glycerin evaporative process (Poinar 1975). The processed specimens were mounted in dehydrated glycerin and morphometric data were recorded.

Populations of *Steinernema* sp were found only in soils collected from two Vertisol fields. More than 10 000 nematodes per rice moth larva were present. Nematodes killed the rice moth larvae within 48 h. Dead rice moth larvae were yellowish brown in color. *Steinernema* sp also infected larvae of *Spodoptera litura* (F.). Morphometrics of 15 infective nematode juveniles indicated that this nematode species is closely related to *Steinernema feltiae* Filipjev (=*Neoaplectana carpocapsae* Weiser) (Table 1).

Table 1. Morphometric data of infective nematode juveniles collected from soils at ICRISAT Center, India.

Character	Dimensions (n=15)	
Average body length	613.1 µm (554.4-659.2 µm)[1]	
Maximum body width	26.9 µm (25.2-28.2 µm)	
Distance from anterior end to excretory pore	47.9 µm (43.7-52.3 µm)	
Distance from anterior end to base of pharynx	101.6 µm (94.2-109.2 µm)	
Tail length	56.1 µm (51.5-61.2 µm)	
Body width at anus	15.7 µm (14.6-17.7 µm)	
A ratio[2]	22.83	(21.3-24.7)
B ratio[3]	6.0	(5.6-6.4)
C ratio[4]	10.9	(10.0-12.0)
D ratio[5]	0.47	(0.46-0.50)
E ratio[6]	0.85	(0.79-0.91)

1. Figures in parentheses represent range.
2. Ratio A: Total body length/Greatest body width.
3. Ratio B: Total body length/Distance from head to base of pharynx.
4. Ratio C: Total body length/Length of tail.
5. Ratio D: Distance from head to excretory pore/Distance from head to base of pharynx.
6. Ratio E: Distance from head to excretory pore/Length of tail.

This nematode species may be useful for the management of such soil-inhabiting pests as white grubs (*Holotrichia* spp), termites (*Odontotermes* spp and *Microtermes* sp), and foliar pests, e.g., *Spodoptera litura* (F.) and *Helicoverpa armigera* Hub., that pupate in soil.

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Persistence of Chlorpyriphos Residues in Soil and Groundnut Seed

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In India, groundnut crops are infested by several insect pests at different stages. Among these, white grubs, *Holotrichia consanguinea* (Blanch), are known to be highly damaging, particularly in light soils. The pest can be effectively controlled by use of chlorpyriphos. The available literature shows that this compound remains active for several weeks after application (Sree Ramulu 1979). Therefore it was postulated that the residue of this insecticide may persist in groundnut seed and hay at harmful levels, and the present study was undertaken to examine the persistence of chlorpyriphos in a groundnut crop (variety M 13) in the 1991 rainy season at the Agricultural Research Station, Durgapura, Jaipur, India. The experiment was laid out in a randomized-block design with three treatments. The treatments comprised soil application of chlorpyriphos at 800 and 1200 g a.i. ha^{-1} and a nontreated control, each replicated three times. The plot size was 5 × 8 m. While irrigating the crop, chlorpyriphos was applied to the plots drop by drop at their water inlet source, 4 weeks after the onset of the monsoon. Soil samples were collected at 0, 10, 20, 30, and 40 days after treatment for residue analysis. Groundnut seed samples were also collected for this purpose at harvest time.

For the determination of chlorpyriphos residue in soil, 50 g soil was extracted with 150 mL of acetone. The

Table 1. Chlorpyriphos residues in soil and in groundnut seeds at harvest.

Dosage (g a.i ha^{-1})	Material	Sampling interval (d)	Residual level (ppm) R1[1]	R2	R3	Average residues (ppm)	SD	Dissipation (%)	RL_{50}[2] (d)
800	Soil	0	0.71	1.08	0.71	0.83	±0.214	-	
		10	0.53	0.80	0.53	0.62	±0.156	25.30	
		20	0.25	0.25	0.25	0.25	±0.000	69.87	11.55
		30	BDL[3]	BDL	BDL	BDL	-	100.00	
	Groundnut seed	at harvest	BDL	BDL	BDL	BDL	-	100.00	
1200	Soil	0	1.45	1.36	1.64	1.48	±0.143	-	
		10	1.08	0.80	1.36	1.08	±0.280	27.00	
		20	0.71	0.71	0.80	0.74	±0.052	50.00	
		30	0.57	0.25	0.53	0.45	±0.162	70.94	16.96
		40	BDL	BDL	BDL	BDL	-	100.00	
	Groundnut seed	at harvest	BDL	BDL	BDL	BDL	-	100.00	

1. Replication.
2. RL_{50} = Half-life of the pesticide.
3. BDL = Below detectable limit.

extract was purified by passing through a column containing activated charcoal, celite, and magnesium oxide in the ratio of 5:2:2. Chlorpyriphos residue was determined in the purified extract by the colorimetric method of Getz and Watts (1964).

Chlorpyriphos residue from groundnut seed was extracted with n-hexane in a Soxhlet apparatus. The extract was partitioned with acetonitrile, and after further purification the residue was determined by the same colorimetric method.

The data on chlorpyriphos residues in soil and groundnut seeds are presented in Table 1. The average initial deposit of 0.83 ppm in soil at the lower dose of 800 g a.i. ha^{-1} had dissipated to the below detectable limit in 30 days, while at the higher dose the initial deposit of 1.48 ppm took 40 days to fall below the detectable limit. The half-life values of chlorpyriphos in soil were found to be 11.55 and 16.96 days for 800 and 1200 g a.i. ha^{-1} treatments. The groundnut seed did not contain any chlorpyriphos residue at harvest.

The short persistence of chlorpyriphos in soil and its below-detectable limit in groundnut seeds may be attributed to high temperature (maximum temperature 28.4-37.5°C), 109.5 mm rain during the crop period, sandy nature of soil at the experiment site, and the insecticide loss through leaching.

We conclude from this study that groundnut seeds from a crop treated with chlorpyriphos at 800 and 1200 g a.i. ha^{-1} could be safely consumed.

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Studies on the Cultural Method for Increasing Yields of Intercropped Wheat and Groundnut in Shandong, China

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We have earlier reported on the factors responsible for high yields of groundnut in Shandong, China (Yanhao and Caibin, 1989). In this paper, a new cultural method for obtaining high yields of both wheat (winter) and

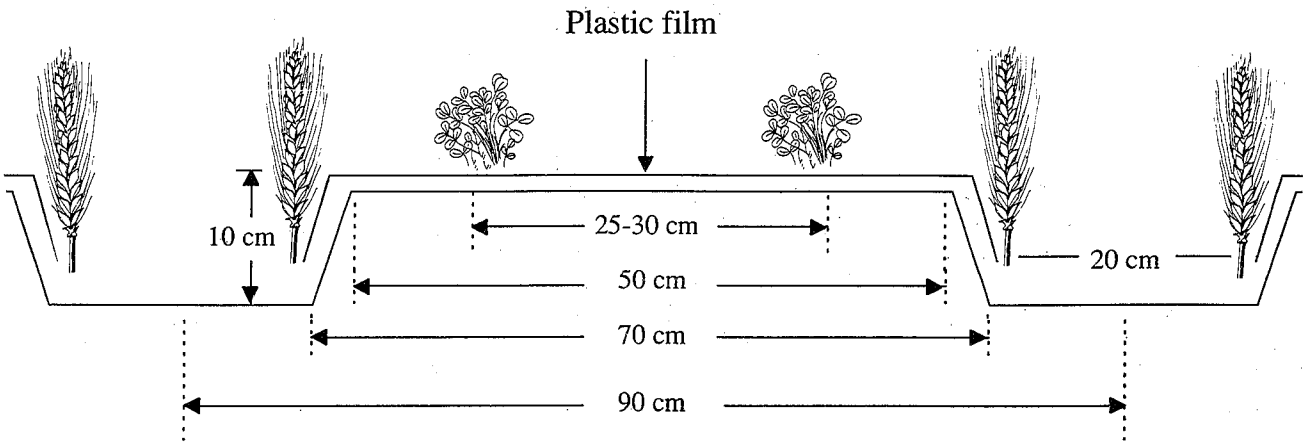

Figure 1. Planting method of wheat/groundnut intercrop in Shandong Province, China.

groundnut when intercropped are discussed. The study was carried out during 1987-1991, and high yields of above 6.00 t ha^{-1} were achieved, both in wheat and in groundnut, on over 7000 ha.

Sowing Method

Ridges 90-cm wide were made with a plow. The width of ridge was 50 cm at the top (10-13 cm height), and the width of the furrow was 20 cm (Fig. 1). Seeds of wheat were sown in the furrows in autumn. In the following spring (in March), the ridge surface was covered with plastic film (70-75 cm in width and 0.007 mm in thickness). During the internode elongation stage, two lines of holes were made with a perforator on the ridge surface at a distance of 25-30 cm between lines and 16.5-18.5 cm between holes. Two groundnut seeds per hole were dibbled to give a population of 244.8-269.4 thousand plants ha^{-1}. Wheat was harvested during mid- to late-June.

Principle of Cultivation

This cultural method was developed for areas where irradiation and heat factors are not enough to support two crops in a year, but are more than sufficient for one crop, especially for areas such as east Shandong where the fog-free stage is short. The climatic characters in Shandong have been described earlier (Yanhao and Caibin 1989).

Table 1. Yield and yield parameters of wheat and groundnut in Shandong, China.

Wheat					Groundnut				
Variety	Earhead no. ('000 ha^{-1})	Seed no. ear^{-1}	1000-seed mass (g)	Yield (kg ha^{-1})	Variety	ANHP[1] ('000 ha^{-1})	Pods $plant^{-1}$	TPN[2] ('000 ha^{-1})	Pod yield (kg ha^{-1})
Yannu 15	6513	32.0	36.1	6393	Hua 37	255	14.04	358.0	6299
Zong 144	6418	33.1	36.0	6415	Luhua 10	250	16.6	415.0	6192

1. ANHP = Actual number of harvested plants.
2. TPN = Total pod number.

Wheat varieties with early maturity, compact habit with short stem, and with big earheads and seed were used to shorten the intergrowth duration, and increase the intensity of ventilation and light transmission. Groundnut varieties of long duration (150-160 days) with big pods, and tolerant of shading were selected to prolong the growth duration, increase the photosynthate accumulation, and enhance pod yield.

The soil temperature was increased by plastic mulching. Data from the field experiment showed that the accumulation of thermal time due to the rise in soil temperature during the crop growth period at 5 cm depth was greater by 851°C days [27.8% higher compared to no-mulching condition (3908°C days)]. So it is possible with this system for long-duration varieties of groundnut to mature fully.

Yield Parameters

The number of wheat earheads was 6418-6513 thousand ha^{-1} with 32-33.1 seeds ear^{-1} and 36-36.1 g 1000 $seeds^{-1}$. The actual numbers of harvested groundnut plants were 250 000-255 000 ha^{-1} with 14.04-16.6 pods $plant^{-1}$ (Table 1).

Key Cultivation Practices

1. Crop rotation: wheat-corn (or cotton), wheat-groundnut rotation.
2. Deep plowing (30 cm deep) was practiced once every 3-4 years, usually for the first crop (wheat), and shallow plowing (15-20 cm deep) for succeeding crops.
3. Fertilizers were applied to wheat before plowing at the rate of 4500-6500 kg ha^{-1} farmyard manure, 1035-1125 kg ha^{-1} ammonium bicarbonate (or 375-420 kg ha^{-1} urea), 795-840 kg ha^{-1} calcium superphosphate, and 375-405 kg ha^{-1} muriate of potash. No fertilizers were applied to groundnut normally.
4. Strengthen field management. During seedling stage of groundnut, the emphasis should be on timely control of the damage caused by aphids and thrips. During the growth stage, measures should be taken to control diseases such as leaf spots and web blotch, and attack by subterranean insects, such as scarib beetle and wireworms. In addition, a growth-inhibiting substance (such as 'Ba') should be applied when plant height exceeds 40 cm. During the late-growing stage, aqueous solutions of 1% urea and 2% calcium superphosphate should be applied once or twice to extend the functional life of leaves and increase the percentage of well-filled pods. In addition, soil should be irrigated during flowering and pod-filling stages if the water content was less than half of the maximum water-holding capacity of the soil.

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A Study on Nitrogen Fixation by Groundnut in an Acid Lateritic Soil at Bhubaneswar, India

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A field experiment was conducted in the acid lateritic soil (Oxic Maplustult) of the University Central Research Farm at Bhubaneswar, India, during the 1989/1990 post-rainy season to quantify nitrogen fixation in groundnut. The soil was a sandy loam with pH 5.5, organic carbon 0.312%, total N 991.8 kg ha^{-1}, available P (Olsen's) 31.5 kg ha^{-1}, and available K 120 kg ha^{-1}. Groundnut cultivar AK 12-24 was sown, noninoculated, in a randomized-block design with three replications. A basal dose of 20 kg N and 40 kg K_2O ha^{-1} was applied in rows with variable doses of P as single super phosphate to supply 0, 20, 40, and 60 kg P_2O_5 ha^{-1}. A 60-mm irrigation was given to the crop when the irrigation water/cumulative pan evaporation ratio was 0.75. An unusual rainfall of 164 mm was received by the crop during the growing season. The number of nodules per plant (average of 5) were counted at 30, 50, 70, and 90 days after sowing and at harvest. The yields of dried pods were recorded. Composite samples of plant and soil were analyzed for total N by the Kjeldahl method. The amount of N_2 fixed by the crop was calculated by the following empirical formula without taking into consideration the loss of N.

N_2 fixed by crop: (N uptake by the crop + postharvest total soil N) − (Initial total soil N + added fertilizer N).

Table 1 shows that the average nodule number per plant increased with the increase in applied P levels. The low number of nodules per plant may be due to low native populations of rhizobia in the acid lateritic soil. The pod yield at 20 kg P_2O_5 ha^{-1} level was maximum and significantly superior to all other treatments. The poor response of the crop to increased doses of P applied at 40 and 60 kg P_2O_5 ha^{-1} may be due to high initial available P status in the soil. Similar findings were reported by Tomar et al. (1980). Madhawadio et al. (1981) and Ali and Rawat (1982) also reported that a low dose of P ranging from 20-25 kg P_2O_5 ha^{-1} was suitable for groundnut.

Table 1. Effect of phosphorus levels on the nodule number and amount of N_2 fixed by groundnut crop.

Levels of P_2O_5 (kg ha^{-1})	Mean nodule number $plant^{-1}$	Pod yield (t ha^{-1})	N uptake (kg ha^{-1})	Post-harvest total soil N (kg ha^{-1})	N_2 fixed in soil (kg ha^{-1})
0	19.7	1.81	166.29	863.0	17.49
20	21.2	2.46	248.05	825.7	61.95
40	23.8	1.86	251.24	811.4	50.84
60	26.2	1.50	191.49	850.1	29.79
SEm		±0.160			
CD ($P = 0.05$)		0.553			

The residual total N after crop harvest was found to be less than that initially present in the soil. It seems that the N assimilation by the crop in the presence of a high P level is greater than the amount of N contributed to the soil through N_2-fixation. The present observation that groundnut depleted soil N to a considerable extent agrees with the findings of Lenka and Misra (1973).

The amount of N_2 fixed by the crop was lowest (17.5 kg ha^{-1}) in the control and highest (62 kg ha^{-1}) at the 20 kg level of P_2O_5 ha^{-1}. The highest amount of N_2 fixation corresponds to highest pod yield of the crop. This may be due to more bioenergy being supplied by the host plant during N_2 fixation in the nodules.

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- 21. Cytology
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C. Physiology/Microbiology
- 31. Water stress
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- 37. Temperature tolerance

D. Pathology
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- 47. Pod and soilborne diseases
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- 49. Surveys

E. Virology
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- 56. Cultural control
- 57. Sources of resistance
- 58. Integrated management
- 59. Surveys

F. Entomology
- 61. Taxonomy
- 62. Bionomics
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- 66. Cultural control
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G. Genetic resources
- 71. Collection and assembly
- 72. Evaluation
- 73. Maintenance and conservation
- 74. Documentation

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Mehan, V.K., Haravu, L.J., McDonald, D., Jayanthi, S., and Sinha, P.K. 1992. **Database on the groundnut aflatoxin problem and users' manual.** (In En. Summaries in Fr, Es.) Patancheru, A.P. 502 324, India: International Crops Research Institute for the Semi-Arid Tropics. 1450 ref. [Database on 10 diskettes; Users' manual of 42 pp.] ISBN 92-9066-215-8.

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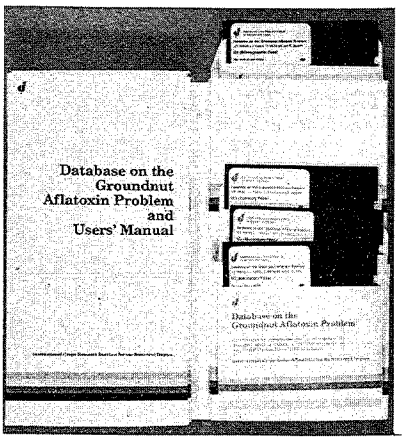

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The semi-arid tropics (SAT) encompasses parts of 48 developing countries including most of India, parts of southeast Asia, a swathe across sub-Saharan Africa, much of southern and eastern Africa, and parts of Latin America. Many of these countries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

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

ICRISAT was established in 1972. It is one of 18 nonprofit, research and training centers funded through the Consultative Group on International Agricultural Research (CGIAR). The CGIAR is an informal association of approximately 50 public and private sector donors; it is co-sponsored by the Food and Agriculture Organization of the United Nations (FAO), the World Bank, and the United Nations Development Programme (UNDP).