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

International Arachis Newsletter

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

o. 5. May 1989

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

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

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

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

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

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News and Views

Editorial

While we write this editorial to IAN 5, in mid-February, the composing unit of ICRISAT Information Services is phototypesetting IAN 4. To those of us involved with the production of the Newsletter, this is proof that we have caught up with the backlog of legumes Newsletters, which occurred due to staff shortages and changes in production procedures. The International Arachis Newsletter, International Chickpea Newsletter, and International Pigeonpea Newsletter, each with two issues a year, are all produced by the Legumes Program. Issues are staggered so as to spread the workload of K. Ramana Rao, office assistant, who enters the edited papers into the computer, the two scientific editors of each Newsletter, and the technical editors and production staff of Information Services.

There are many pleasures associated with editing the Newsletter. Apart from accepting and publishing papers, the editors also receive a number of queries from readers. These are referred to the relevant experts for reply, and we publish those that are of general interest. We are also pleased when articles are reprinted in other newsletters or journals. Unfortunately, we have to return a number of papers to the authors. Some of these are rejected; occasionally, they are returned for a complete rewrite; but sometimes only because authors have exceeded the 600-word limit (see inside front cover). As publishing costs are high, we cannot accept papers where the results are very location- or genotype-specific. Examples of these are genotype x environment interaction and heritability studies on a narrow range of genotypes, which often add little to the extensive volume of knowledge on these subjects.

However, most of the papers and reports we receive are suitable, and we hope readers will continue to send material to help us achieve our objective of maintaining communication between scientists involved with *Arachis*.

J.P. Moss
L.J. Reddy

Letters to the Editor

Dear Editor:

I found your--and from now on our, because I am already included in your regular mailing list--International Arachis Newsletter very helpful in my job.

Our groundnut fields this season were almost completely destroyed by very minute termites. The species of these termites is not well identified, and we have sent them to be identified.

What do your scientists recommend, provided such problems occur there, for the control of this insect pest, by chemical and any other possible means?

Sincerely,
Melaku Wale
Assistant Research Officer
Kobo Research Centre
Kobo, Wollo
Ethiopia

ICRISAT Entomologists reply:

The insecticides that are effective and cheap for termite control are DDT and cyclodienes, but these are no longer recommended due to their hazardous nature. The possible alternatives are carbofuran and chlorpyrifos, but these are either too expensive or not available in most of the SAT areas.

The Overseas Development Natural Resources Institute (ODNRI) is quite active in termite research. T.G. Wood, J.W.M. Logan, and their group are the right people to contact for more information. Write to:

Dr T.G. Wood
Dr J.W.M. Logan
Overseas Develoment Natural
Resources Institute
Central Avenue
Chatham, Kent ME4 4TD; UK
Telephone (0634) 880088

Dear Editor:

I am in receipt of IAN 3, May 1988. Groundnut is and will remain the greatest cash crop in the world; therefore, we have to increase it in all aspects. It is not enough to produce high technology and high-yielding varieties; more important is that knowledge and recommendations reach the farmers and other users.

As you know, groundnut hay is the major livestock nutrition in West African countries.

Do aflatoxin problems affect groundnut hay? If so, do breeders and other scientists pay attention to them? Is there any analysis of groundnut hay?

Does groundnut hay contain something bad for the livestock?

Sincerely yours,

Babacar Dieng
Amélioration variétale arachide
BP 17 ISRA Nioro du Rip
Senegal

ICRISAT Pathologists reply:

Groundnut hay is a valuable fodder for livestock in many regions of the world and in particular in the semi-arid tropics. In some places in West Africa in and close to urban areas, groundnut hay may be more expensive than pods on a dry-weight basis. The nutrient value of the hay is, of course, much influenced by the severity of attack by foliar fungal diseases, by time of harvesting, and by care taken in removal of pods and in postharvest drying.

Under very wet and humid conditions, the hay may become moldy and lose some of its nutritive value and be less attractive to livestock. I would not regard colonization by Aspergillus flavus *and contamination with aflatoxins as a very likely occurrence, but I have seen one report of this many years ago. In any case, molded hay may not be attractive to livestock, and there are other reasons than possible aflatoxin contamination to make feeding of such fodder inadvisable. Good quality groundnut hay contains no substances likely to have any deleterious effect upon animals consuming it.*

Breeders are aware of the need to produce varieties that give good hay yield as well as pod yield. Varieties can vary considerably in ratio of hay to pods, and it is useful to have information on the required levels when requests are made to breeders. However, the proportion of pod yield to hay may change in some varieties when they are grown in different agroclimatic environments.

News from ICRISAT Center

Asian Grain Legumes Network (AGLN)

A "Workshop on Agroclimatology of Asian Grain Legume Areas," from 5 to 17 Dec 1988, was organized by the Resource Management Program of ICRISAT and AGLN. Participants were from India, Indonesia, Malaysia, Nepal, Pakistan, the Philippines, and Thailand; and from the Food and Agriculture Organization of the United Nations (FAO), the International Rice Research Institute (IRRI), and the International Benchmark Soils Network for Agrotechnology Transfer (IBSNAT).

Participants discussed the agroclimatic classification of countries and mapped the area, production, potential areas for production, and various biotic and abiotic stresses on groundnut in their countries. Dr Afzal Mohammed, Professor, Centre for Economic and Social Studies, Hyderabad, India, was a consultant geographer. He helped the participants to prepare maps and oversaw the drawing of maps by cartographers. Later, Dr and Mrs R.E. Huke of Dartmouth College, New Hampshire, USA, explained the various mapping designs and techniques and assisted with refining the maps. FAO's involvement through its Agroecological Zoning, and the Data Base Management System and crop modeling studies of IBSNAT by Dr J. Jones, with a demonstration of the operation of the PNUTGRO model, added much useful input to the workshop. A booklet containing the maps for all the countries of the AGLN, showing the factors listed above for groundnut will be published soon by ICRISAT.

The Regional Legumes Network Coordinators' Meeting was held 15-17 Dec 1988. AGLN country coordinators from eight countries and representatives from the Australian Centre for International Agricultural Research (ACIAR), Coarse Grains, Pulses, Roots, and Tubers Centre (CGRT), FAO, the International Develoment Research Centre (IDRC), South Asian Association for Regional Cooperation (SAARC), International Center for Agricultural Research in Dry Areas (ICARDA), Asia Pacific Association of Agricultural Research Institutions (APAARI), and IRRI participated in the meeting. The meeting reviewed the activities of AGLN since its establishment in 1986, and made recommendations for the future:

- ICRISAT should continue supporting AGLN activities,
- ~~AGLN objectives should be reevaluated,~~
- AGLN should form a steering committee,
- training should be emphasized,
- use of the Semi-Arid Tropical Crops Information Services (SATCRIS) should be implemented,
- AGLN should attempt to incorporate network activities with more legume crops, and

- AGLN should seek further funds to support network activities.

Groundnut forms an important component of the AGLN activities.

News About ICRISAT Center Groundnut Scientists

P. Subrahmanyam completed his assignment as Principal Groundnut Pathologist at ICRISAT Sahelian Center, and returned with his family to ICRISAT Center after working in West Africa for 2 years.

News from ICRISAT Sahelian Center

The ICRISAT Sahelian Center (ISC) programs have until recently been housed in temporary facilities located at Sadoré, about 40 km from Niamey, Niger. A new complex has been completed, with offices, seed-storage facilities, laboratories, and physical plant services. This complex was officially inaugurated on 7 Mar 1989. The ICRISAT Governing Board meeting, Program Committee meeting, and two seminars were planned to coincide with the inauguration of the ISC.

News from Peanut CRSP

Peanut CRSP Collaborative Linkages in Southeast Asia

The Peanut Collaborative Research Support Program (CRSP) has been active in Southeast Asia since 1982. The primary goal is to enhance ongoing national agricultural research systems (NARS) peanut research programs to address the relief of constraints to peanut production and utilization. Support is provided in terms of supplies, equipment, short-term and degree training, and technical assistance in program planning and in analysis and application of results. United States domestic research programs should also benefit from the collaborative program.

Research in the Peanut CRSP involves breeding, entomology, integrated pest management (IPM), virus with emphasis on peanut stripe, and food and postharvest technology.

Collaborative linkages with the Asian Grain Legumes Network (AGLN) come through the CRSP research in the Philippines and Thailand. The CRSP supports extensive breeding programs in these countries, which also have AGLN linkages. The NARS, CRSP, and AGLN programs are mutually enhanced by the collaborative linkages. CRSP and NARS efforts in IPM and virus research are also supportive of goals of mutual interest to AGLN. The CRSP program in Thailand has a long and mutually beneficial relationship with the International Development Research Centre (IDRC) program of Canada. Thailand research programs have been jointly supported. CRSP virus research is closely coordinated with the Australian Centre for International Agricultural Research (ACIAR, with a collaborative linkage in Indonesia) and ICRISAT, which strengthens the regional impact of the virus program. The food technology and postharvest programs provide quality and sensory evaluations on promising lines and cultivars and stimulate increased utilization.

Four cultivars have been released in the program. In 1987, Thailand released Khon Kaen 60-1 (high-yielding type) and Khon Kaen 60-2 (boiling type) and in 1988, Khon Kaen 60-3 (large-seeded). The Philippines released an improved, higher yielding cultivar, IPB Pn-6, in 1986. Lines with multiple resistance to insects have been identified. Breeding efforts are seeking to incorporate disease, insect, drought, and aflatoxin resistance into improved lines. Shade and acid soil tolerant lines are being developed in the Philippines.

Peanut CRSP research in the future will focus on the countries of the Philippines and Thailand. Priorities will be in areas of breeding, IPM, virus, and food and postharvest technology. Linkages will be sought with other countries in the region for dissemination of research information. Funds for these additional linkages may be obtained through "buyins" by United States Agency for International Development (USAID) missions in interested countries.

Discussions at the Groundnut Scientists' Meeting, 14-17 Nov 1988, in Malang, Indonesia, resulted in some suggestions for improving networks. Close communications with AGLN participants should be maintained to provide germplasm for testing that meets minimum requirements, i.e., resistance to a prevalent disease or tolerance to acid soils. This should increase the probability for success in the program. Additionally, special-interest groups should be developed as the need arises. An example is the Stripe Virus Workgroup now active in the region. Other possibilities are an entomology group and a followup on the Aflatoxin Workshop. Finally, all researchers should take every opportunity to communicate results where appropriate in journals or other media. The International Arachis Newsletter published by ICRISAT in cooperation with the Peanut CRSP encourages publication of new, preliminary type research findings.

International *Arachis* Species Germplasm Survey

A working group of groundnut geneticists and germplasm specialists met at the Centro Internacional de Agricultura Tropical (CIAT), Colombia, to determine critical needs of the wild *Arachis* species germplasm resources. A priority set forth was to make a survey of existing wild species collections of *Arachis* to

1. enhance seed distribution,
2. estimate deficiencies,
3. plan better future collection expeditions, and
4. inform the scientific community of potential resources for evaluation and utilization.

If *Arachis* species are maintained at your institute, could you please prepare a table following this format:

Col. 1: Original collection data (if known): Collector(s) name(s) or initials and collector no.
Col. 2: P.I. no. (if known).
Col. 3: Other I.D. number (if available).
Col. 4: No. of seeds in the collection: enter 1, 2, 3, or 4, where 1 = fewer than 25, 2 = 25-100, 3 = 100-1000, and 4 = 1000+.
Col. 5: Perennial plants of collection maintained (Yes/No).

To be included in the survey, send information by September 1989 to:

Dr H.T. Stalker
Department of Crop Science
Box 7629
North Carolina State University
Raleigh, NC 27695, USA

The accession list and passport data will then be compiled and distributed.

Reports

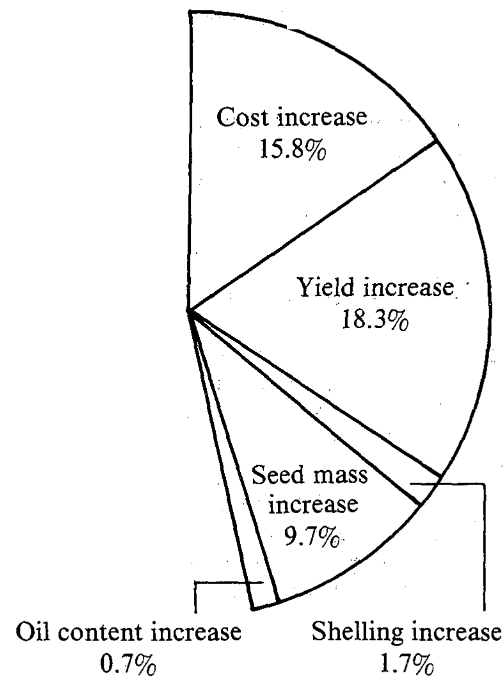
Groundnut yield maximization trials in India, postrainy season 1987/88

P.W. Amin, K.C.Jain, J.V.D.K. Kumar Rao, and C.S. Pawar (ICRISAT Center)

As part of the activities of ICRISAT's Legumes On-Farm Testing and Nursery (LEGOFTEN) unit, groundnut yield maximization trials were laid out on government farms in six states of India: Andhra Pradesh, Gujarat, Karnataka, Maharashtra, Orissa, and Tamil Nadu. The trials consisted of four treatments:

1. ICRISAT-recommended package of practices and improved variety.

A



B

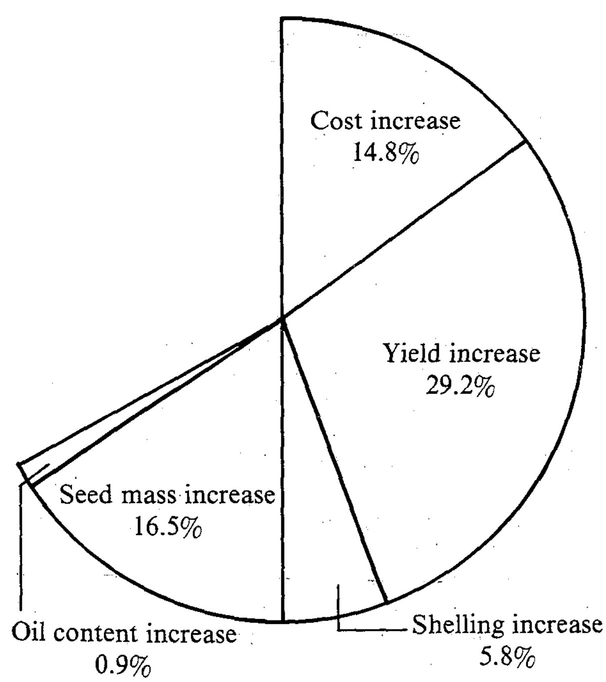


Figure 1. Relative production cost and returns of ICRISAT-recommended improved groundnut cultivation practices with A. local variety and B. improved variety.

2. ICRISAT-recommended package of practices and state variety.
3. State-recommended package of practices and improved variety.
4. State-recommended package of practices and state variety.

Out of 20 trials, 6 failed for reasons such as salinity, bud necrosis disease, poor stand establishment, and lack of irrigation. At all the 14 locations, the combination of the ICRISAT-recommended package of practices and improved variety gave higher yields and a harvest index than the other three treatments (Table 1) and also improved shelling percentage, kernel mass, and oil content. The degree of improvement in yield and other parameters was much higher for improved varieties than for traditional varieties (Fig. 1).

The data on site characteristics and on cultivation practices used by farmers revealed several constraints on groundnut yields, such as: high soil pH; excessive use of nitrogen and water; phosphorus, zinc, and iron deficiencies; excessive seeding rate (probably resulting from poor seed quality); improper seedbed; and poor weed control. In addition, as judged from the significant response to gypsum application, calcium deficiency appears to be more widespread than previously assumed.

Our trials generated the desired impact on the farmers and the improved practices are being adopted on a wide scale, while simultaneously, large-scale multiplication of improved varieties has been undertaken by government agencies and oilseeds federations.

Table 1. Relative performance and cultivation cost of irrigated groundnut crops grown by ICRISAT- and state-recommended practices in six states of India, postrainy season 1987/88.[1]

	ICRISAT-recommended practices		State-recommended practices	
Parameter	ICRISAT variety	Local variety	ICRISAT variety	Local variety
Dry pod mass (t ha^{-1})	3.82	2.66	2.95	2.25
Range	2.28-5.55	0.69-3.73	1.60-4.31	0.56-3.65
Harvest index	0.48	0.42	0.43	0.36
Shelling percentage	74.61	72.78	70.70	71.50
Range	68.5-82.0	63.0-80.0	65.0-78.0	64.0-76.0
1000-kernel mass (g)	517.13	399.15	444.07	363.76
Range	461-603	349-520	313-558	300-443
Oil content (%)	47.05	46.72	46.62	46.38
Range	44.4-50.6	44.0-48.8	42.8-52.2	42.4-49.0
Haulm mass (t ha^{-1})	4.13	3.66	3.87	3.93
Range	2.62-6.00	1.73-4.98	2.64-5.36	1.70-6.10
Cost of cultivation (Rs ha^{-1})	9316	9073	8251	8019
Range	7047-13 365	7047-12 370	5923-11 665	5104-10 665

1. Plot size for each treatment = 0.2 ha.

Eighth International Legumes Pathology Training Course

M.V. Reddy (ICRISAT Center)

The Eighth International Legumes Pathology Training Course was held at ICRISAT Center, 9-27 Feb 1989.

The objective of the course was to acquaint the scientists of the national programs with the work going on at ICRISAT on the diseases of groundnut, pigeonpea, and chickpea; to exchange ideas; and to explore the possibilities for future cooperation between ICRISAT and national programs. Ten scientists from seven countries participated. Nearly 40 ICRISAT scientists served as resource personnel for the course.

The first part of the course was conducted for 2 weeks at ICRISAT Center, Patancheru, and included visits to farmers' fields, Andhra Pradesh Agricultural University, and the Central Plant Protection Training Institute at Rajendranagar, Hyderabad. The second part involved a week of visits to the Indian Agricultural Research Institute, New Delhi; Haryana Agricultural University; and the ICRISAT collaborative program at Hisar, Haryana, in northern India.

The course covered theoretical aspects of plant pathology in general and ICRISAT legume crops in particular. Some of the major aspects covered in the course were: genetic resources of groundnut, pigeonpea, and chickpea available at ICRISAT; fungal, bacterial, viral, and nematode diseases of the crops; breeding for disease resistance, including inoculation techniques; disease surveys and crop loss assessment; nutritional disorders; aerobiology, disease epidemiology, and forecasting; and integrated control of plant disease. The emphasis throughout the course was on discussion, demonstration of techniques, and practice of the techniques by the participants. Lecture notes and relevant literature were provided on all aspects of legumes pathology covered in the course.

Groundnut in Vietnam[a]

L.J. Reddy[1] and **Nguyen Xuan Hein**[2]
1. ICRISAT Center; 2. Institute of Agricultural Technology, Ho Chi Minh City, Vietnam

History and importance of groundnut: The antiquity of groundnut cultivation in Vietnam is not well documented. The first known description of groundnut in Vietnam was in 1818, in a book entitled, *Chronological notes of the Nguyen dynasty.* Hence it appears that groundnut has been grown for at least 170 years in Vietnam.

Groundnut is believed to have been first introduced into Vietnam by the Chinese or through Chinese territory, judging from the local name of the crop, *lac,* which is a Chinese word. Many of the presently grown groundnut cultivars in Vietnam appear to be secondary introductions from neighboring countries--the Philippines, Malaysia, and Indonesia--where spanish and valencia types predominate. Of the two earliest groundnut-growing areas in Vietnam--Central Nghe An Province (now Nghe Tinh Province) and the central highlands--the latter bears close anthropological, ethnographic, and ethnobotanical similarities to Luzon island in the Philippines.

In recent years, groundnut has emerged as the second major agricultural export commodity after tea. Its production has sharply increased, mainly due to increase in area. The Ministry of Agriculture and Food Industry has ambitious plans to extend groundnut cultivation to 1 million hectares by the year 2000.

Groundnut areas and production trends. Groundnut is grown both in northern and southern Vietnam, and the area under the crop has increased phenomenally in recent years--from 33 700 ha in 1955 to 86 000 ha in 1965 to 211 000 ha in 1985.

The northern part of the central coast in northern Vietnam and the northeastern part of the Mekong Delta in southern Vietnam are by far the most important groundnut-growing regions in the country, with Nghe Tinh province in the north and Song Be province in the south being the foremost individual provinces (Fig. 1).

The other important groundnut-growing provinces are Dong Nai, Dac Lac, Tay Ninh, Quang Nam, and Da Nang in the south and Thanh Hoa, Ha Bac and Vin Phu in the north.

Soil types. Groundnut is mainly grown on degraded soils (tropical podzols) and to some extent on gley soils, red basalts, and acid sulfate soils.

Utilization. A major part of the produce is exported to countries such as Singapore, Hong Kong, the USSR, and Japan, mainly as seed and, to some extent, as raw oil and confections. In recent years, Vietnam has emerged as one of the major groundnut-exporting countries in the region. Domestically, groundnut seed is used both as food and for oil. The seed is used for various confections such as groundnut candy, *lac chao dan,* and groundnut *magi.* Groundnut haulms are used as animal feed and manure. In the hilly areas, intercrops of groundnut/*Tephrosia* spp are used to reduce soil erosion and to improve soil fertility.

a. Based on a FAO/UNDP consultancy report by the senior author under Project VIE/ 82/001 - Development of Agricultural Research, Vietnam.

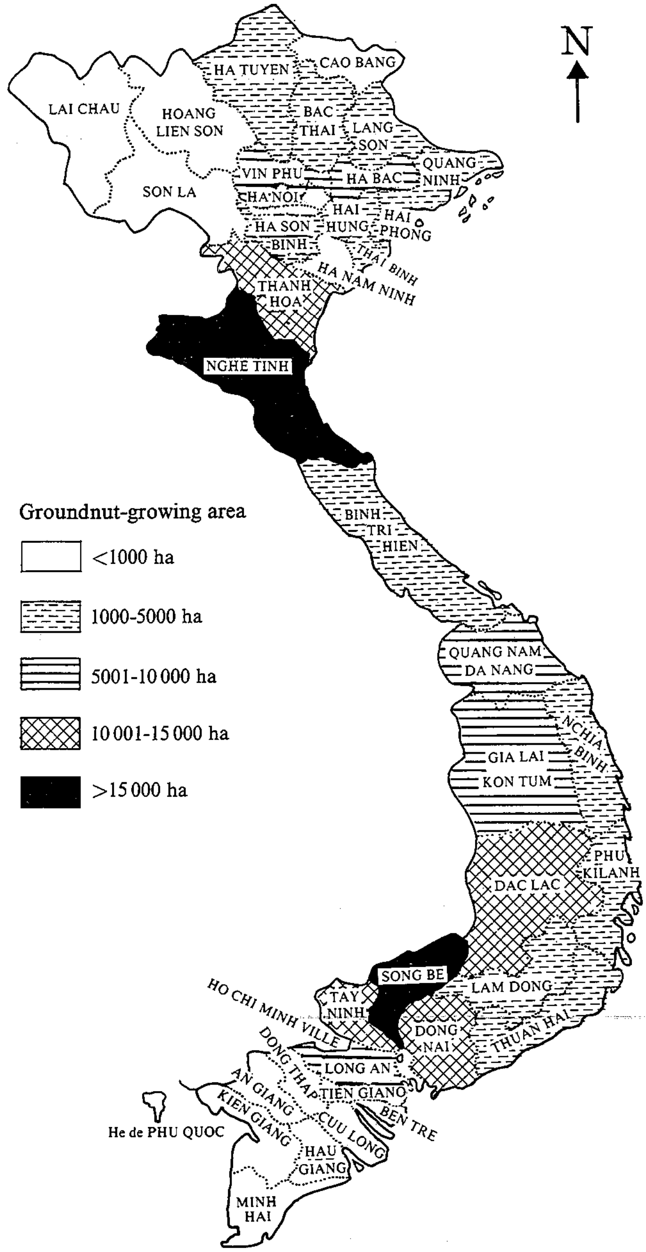


Figure 1. Groundnut production areas in Vietnam.

Cropping seasons and systems. Although groundnut is grown all year, spring and autumn can be considered as the two main seasons. Spring is the most important season for the commercial production of the crop. The autumn crop is used mainly to obtain high-quality seed for the spring crop.

Groundnut is predominantly grown as a sole crop. To some extent, it is intercropped with sugarcane, maize, cassava, and upland rice, with two rows of groundnut sown between two rows of sugarcane and three rows of groundnut sown between three to five rows of maize, cassava, or upland rice. Groundnut is also grown to some extent in orchards and rubber or coffee plantations.

The predominant cropping systems involving groundnut in Vietnam are shown in Figure 2. Spring groundnut followed by autumn rice and winter groundnut in southern Vietnam and spring groundnut followed by autumn rice and winter maize or potato or vegetables in northern Vietnam are the popular crop rotations followed. In mountain and highland regions of northern Vietnam, autumn groundnut succeeds the spring sweet potato crop.

Research and future research needs. There has been only a limited amount of groundnut research conducted in the country. Some studies have been made by various agricultural universities and other national organizations. In 1981, a national program on legume, production was established to coordinate the research activities on legumes, including groundnut. The present research activities and future needs are summarized below.

Germplasm collection: Germplasm collections were initiated in 1960, by Nghi Kim Experimental Station (Institute of Crops Research). The responsibility of germplasm collection was transferred to Dinh Tuong Experimental Station (Institute of Industrial Crops) in 1968. About 200 germplasm collections have been made, including local collections and exotic varieties from Africa and France. The Center for Vietnamese-Soviet Union Cooperation at Van Dien Station added 500 germplasm accessions in 1983. Of these, 250 varieties have been imported from The Vavilov National Institute of Plant Crops (VIR), Leningrad, USSR. The rest of them were local collections and introductions from India, China, the Philippines, Senegal, and France; however, most of these appear to have been lost.

Besides the need for proper evaluation, documentation, and maintenance of the germplasm available within the country, there is a need to import and evaluate additional exotic germplasm from ICRISAT and other neighboring countries, keeping in view Vietnam's particular needs.

Varietal improvement: There are about 15 groundnut cultivars that are grown by farmers in various provinces. Moket, Giay Nam Dinh, Sen, Cuc, and Tram Xuyen are the most popular cultivars. All these cultivars belong to subspecies *fastigiata*, variety *vulgaris* (spanish type). A majority of them are direct introductions and the rest of them are reselections. Tram Xuyen, the last cultivar that was released in the country, is more than 20 years old.

Top priority should be given to breeding new varieties suitable for diverse agronomic regions, with high yield potential and resistance to major diseases and pests. The breeding objectives should be in this order of priority:

- breeding varieties with high yield under specific environments;

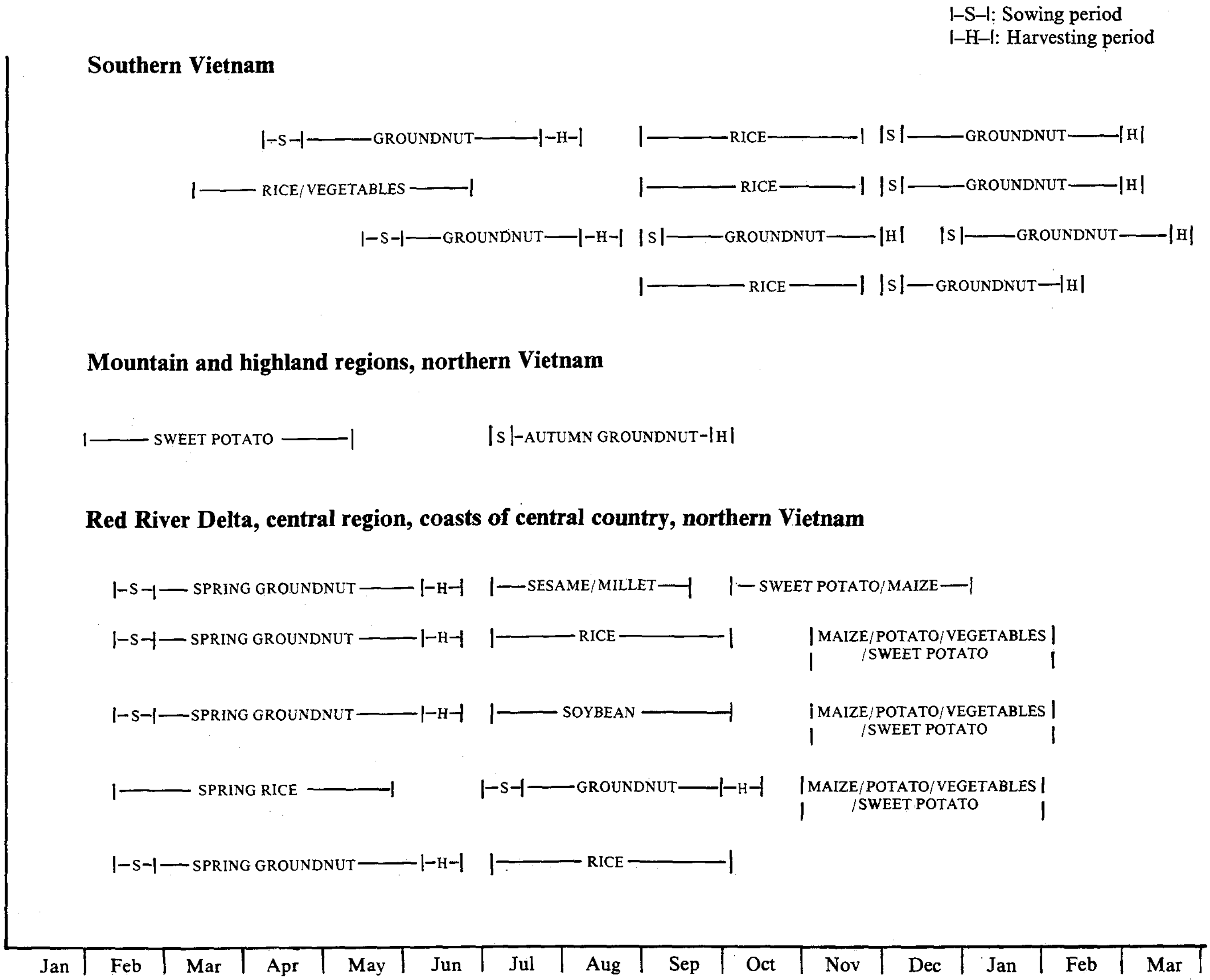


Figure 2. Predominant cropping systems involving groundnut in different regions of Vietnam; bars indicate a choice of crops.

- breeding for earliness for rice-based cropping systems;
- breeding for medium- to large-seeded confectionery types for the export market; and
- breeding for resistance to late leaf spot and rust, to stabilize yields in various groundnut-growing areas.

Agronomy: Agronomic studies have been undertaken to determine optimum sowing dates and plant densities, and some fertilizer trials have been conducted. For northern provinces, the best sowing period is from late February to 10 March. Spacing trials have indicated that a 30 x 10 cm spacing with one seed per hill or 30 x 20 cm spacing with two seeds per hill is optimum. In areas where groundnut is grown on acid soils, research has shown that calcium and phosphorus applications are very important. For the winter crop in the acid soils of southern Vietnam, the following fertilizer schedule is recommended: 800-1200 kg ha^{-1} lime, 50 kg ha^{-1} urea, 200 kg ha^{-1} calcium superphosphate, and 100 kg ha^{-1} potassium chloride at the time of land preparation and 500 kg ha^{-1} land plaster at flowering time. Superphosphate has been found to be the best phosphorus fertilizer and boron + superphosphate application is recommended for Nghe Tinh province.

Most of the groundnut-growing soils in Vietnam are low in organic matter content and in available phosphorus, calcium, sulfur, and molybdenum. These elements should therefore receive top priority in future fertilizer trials. Also, it has been widely observed that addition of coconut ash to the soils in southern Vietnam results in higher groundnut yields. A series of large-scale factorial fertilizer trials based on the information already available from the research stations should be conducted in the farmers' fields in various agroclimatic zones. Two of the objectives of such trials should be to (1) arrive at proper fertilizer schedules for the major groundnut-growing areas and (2) find good substitutes for the coconut ash, which is in short supply.

Measures to ameliorate the acidic nature of the majority of the groundnut soils through lime application should form part of the fertilizer schedules. Groundnut pods get their calcium requirements directly from the topsoil, not through the root system. The usefulness of gypsum application at the initial pegging stage in increasing the pod yields by decreasing the pops (empty pods) has been demonstrated in several countries such as the USA, India, Zimbabwe, Nigeria, Sudan, and Malawi in a wide range of soil types. Since gypsum is not available in Vietnam, studies should be conducted to find a good substitute for gypsum, such as soluble calcium salts applied at the base of the plant at the time of peg initiation.

Microbiology and physiology: Microbiological studies have shown that groundnut yields could be increased up to 20% by *Rhizobium* inoculation, but such increases were inconsistent.

Application of a growth stimulator at a rate of 160 g ha^{-1} (50 g alpha naphthalene acetic acid--NAA, 50 g $NaHCO_3$, 10 g micronutrients, and 50 g soluble substances) at the seedling stage, followed by a growth inhibitor at a rate of 160 g ha^{-1} (150 g succinic acid + 10 g adhesive) at the flowering stage has been found to increase groundnut yields by 18%.

Physiological studies should aim at quantifying the deficiencies of micronutrients in various groundnut soils and the best ways to alleviate the ill effects of these deficiencies.

All the groundnut cultivars grown in Vietnam belong to the spanish group, which quickly loses seed viability under hot, humid conditions; thus the seed produced in spring cannot be used to sow the subsequent spring crop. So physiological research should aim at screening exotic germplasm to identify genotypes that do not lose their seed viability quickly. Also these cultivars lack seed dormancy, which results in sprouting of the seeds if there is rain at the time of maturity or if there is adequate moisture in the soil. Attempts should be made to identify early-maturing genotypes with fresh seed dormancy lasting up to 20-25 days.

Under humid conditions, spanish bunch cultivars produce excessive vegetative growth and show poor partitioning of dry matter to pods. Genotypes belonging to various botanical groups should be screened to identify those that can efficiently partition their photosynthates to their pods. In the USA it has been reported that pruning at the time of flowering, and spraying a growth retardant, Kylar (succinic acid dimethyl hydrazide), would increase the partitioning coefficient from 46 to 86%, with a pod yield increase from 3760 kg ha^{-1} to 5310 kg ha^{-1}. Similar studies should be taken up to identify chemicals that can consistently result in higher yields, so that such simple but effective methods could be applied on a large scale in the farmers' fields.

Pathological and entomological research: Information on the importance of various diseases and insect pests in the major groundnut-growing areas in the country is scanty or lacking; therefore, systematic surveys should be undertaken to assess the economic nature of the damage caused by various diseases and pests. Assessments of crop loss from major diseases (bacterial wilt, stem rot, late leaf spot, and rust) and insect pests (leaf hoppers, leaf miner, and thrips) should be initiated to determine the economic thresholds for their control. Sources of resistance to the major diseases and insects identified in other countries should be imported and screened against these pests under Vietnam conditions. Attempts should be made to incorporate such resistance into the locally adapted groundnut cultivars.

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Groundnut Cropping on Residual Moisture in Coastal Tracts of Karnataka, India

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In South and North Canara, the coastal districts of Karnataka, groundnut has become a very popular crop in lateritic (Oxisols) and coastal alluvial (Inceptisols) soils after the rainy-season (June-November) rice crop, under progressively receding--or residual--soil moisture conditions. Groundnut was virtually unknown to the farmers of this tract until the early 1950s. The area under groundnut has steadily increased, from 800 ha in 1961/62 to about 8000 ha in 1986/87, with a potential for further increase. The soils in this tract facilitate better pod development and high yields that often exceed the yields of summer groundnut crop in traditional groundnut-growing areas, in spite of a very short cropping period. Dry pod yields of 2.5-3.0 t ha^{-1} in 90 days are common in this tract. Harvesting is easy, because of the nature of the soil, and the produce is clean and often fetches a premium price in the market.

At the time of rice harvest in October, the soil moisture content is generally high. The fields are plowed four or five times with a wooden plows to bring down the soil moisture to an optimum level for groundnut germination. The nutrient requirement of the crop is usually met by applying heavy doses of farmyard manure. The usual practice is to sow groundnut behind a country plow. The fields are sown as and when they come to condition for sowing. Hence there is a range of sowing dates within a block of fields. The contiguous block of fields is fenced on a community basis with shrub twigs and mud immediately after sowing, to protect the crop from animals.

The hot and humid climate of this region results in loss of seed viability within a short period; hence farmers have to buy fresh seed every season from far-away places, such as Hubli. The major source of seed is from the rainy-season crop of bunch varieties. Thus the local farmers are deprived of a chance to produce quality seed locally and have to incur additional expenditure on its transport.

The crop often suffers from inadequate moisture during the late pod development phase, due to the fast-receding residual moisture. Also, with the receding moisture, salinity in the water table rises rapidly and sudden crop wilting occurs in patches. The community fence is removed when the first fields are harvested, and other fields are then unprotected. Removal of the fence, receding soil moisture, and the salinity invariably force an early harvest of the crop, sometimes as early as 70-75 days after sowing.

The anaerobic and acidic (some fields with pH as low as 4.5-5.0) conditions, perhaps, reduce the populations of rhizobia. Nodulation is generally less than normal in most fields. The crop often shows deficiency symptoms, especially of Ca, P, and K.

Though groundnut in this region is relatively free from pest and disease problems, insects such as *Spodoptera litura* and leaf miner, and diseases such as rust, alternaria leaf spot, and late leaf spot are present in varying intensities.

TMV 2 is the variety popularly planted on a large scale in this tract. The All India Coordinated Research Project on Oilseeds (AICORPO), at its main center in Dharwad, has also screened germplasm of spanish bunch types and identified Dh 3-30, which matures in 95 days in this region, as a variety suited for growing in the coastal tracts of Karnataka. Three early-maturing lines--generated at the AICORPO, Dharwad; ICRISAT Center, Patancheru; and the Bhabha Atomic Research Center (BARC), Trombay--are now being evaluated to identify high-yielding varieties that mature in 85-90 days.

Preliminary agronomic investigations on groundnut grown on residual moisture have indicated that the crop in this tract responds well to high populations (up to 500 000 plants ha^{-1}) and to Ca, P, and K fertilization. Storing dried pods in polyethylene bags, along with silica gel to absorb moisture, helps preserve seed viability through the hot and humid rainy season.

We suggest the following areas for future research on groundnut cropping on residual moisture:

1. Identification and development of extra-short-duration (75-80 day) varieties that can escape end-of-season salinity and that also give high yields, are adapted to acid soils (pH as low as 5.0), and show resistance to leaf spots and rust.
2. Development of appropriate plant protection practices, research on soil corrections (to acidity), studies on lime application (to improve pod filling), confirming high population density requirements, and soil fertilization to correct elemental deficiencies.
3. Improvement of the storability of groundnut seed through the hot and humid climate in the rainy-season production of groundnut for seed in the local uplands.
4. Identification of more efficient and locally adapted *Rhizobium* strains.

Research Reports

New Viral and Fungal Diseases on Groundnut in the Southern Telangana Zone of Andhra Pradesh, India

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In the course of routine disease surveys carried out in the southern Telangana zone of Andhra Pradesh, 1984-87, viral and fungal diseases not previously reported from the area were observed. The viral diseases are: yellow leaf spot, witches' broom, peanut stripe, and veinal chlorosis; the fungal diseases are: leaf scorch (*Leptosphaerulina trifolii*), phyllosticta leaf spot (*Phyllosticta arachidis-hypogaea*), and colletotrichum leaf spot (*Colletotrichum dematium*).

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Research on Wild Relatives of *Arachis* in the People's Republic of China

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Agricultural scientists in China have introduced more than 100 accessions of wild species of *Arachis* from the USA, ICRISAT, and Argentina since 1980. Wild species of *Arachis* grown in southern China, where the climate is similar to that of South America, where they were originally collected, show normal growth and development. Species can also be grown in northern China, in cooler areas.

Scientists consider that introgression of germplasm from wild species of *Arachis* to *A. hypogaea* L. has great potential for improving disease and pest resistance in cultivated groundnut. Some agricultural institutes have given priority to research on germplasm, production of interspecific hybrids, and studies of their cytology. At the Institute of Oil Crops, Hubei, interspecific hybrids between *A. hypogaea* and wild species that were resistant to disease have been obtained. Triploid, tetraploid, and hexaploid hybrids, and autotetraploids from chromosome doubling by colchicine treatment have been obtained using *A. stenosperma*. Scientists at Hubei are utilizing wild *Arachis* species in the genetic improvement of *A. hypogaea*, using the cross compatibility between *A. hypogaea*, both subspecies *fastigiata* (valencia and spanish) and subspecies *hypogaea* (virginia and peruvian), and wild species in section *Arachis*.

Relationship Between Plant Hormones and Pod Development in in-vitro Cultured Gynophores of Groundnut

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The groundnut ovary develops into a pod only after the gynophore penetrates into the soil. The purpose of this paper is to study the relationship between plant hormones and pod development in groundnut (cv Yue-you No. 551-116).

The content of endogenous phytohormones at different stages of pod development was determined by the gas chromatography method. One to 2 days before the groundnut ovary penetrated into the soil, the auxin level was less than 100 ng indole acetic acid (IAA) g^{-1} fresh mass and ethylene evolution was less than 15 nL g^{-1} fresh mass, but gibberellin content was greater than 600 ng gibberellic acid (GA) g^{-1} fresh mass (Fig. 1). However, 1 to 3 days after the gynophore penetrated the soil, although the ovary was not yet enlarged, auxin content increased tenfold and ethylene evolution threefold, but gibberellin content had decreased to one-sixth of that before penetration into the soil. During ovary enlargement, the content of all these hormones first increased, then decreased (Fig. 1).

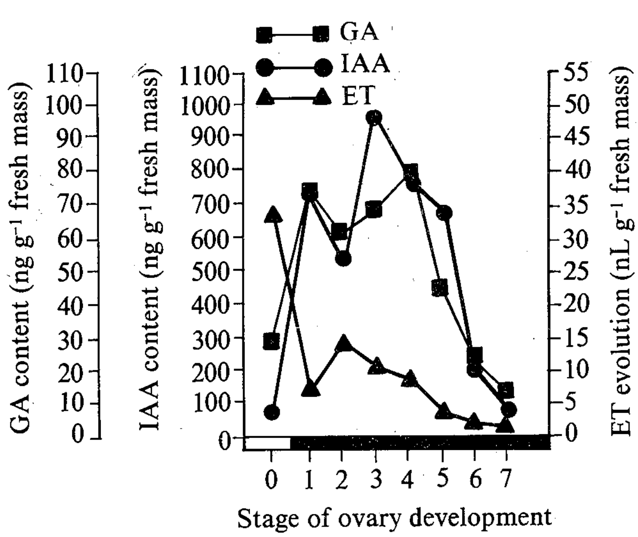

Figure 1. Changes in gibberellic acid (GA), endogenous auxin (indole acetic acid, IAA), and ethylene (ET) levels in the groundnut ovary at different development stages; pod matures at stage 7. ▭ above the soil and in light; ▬ beneath the soil and in the dark.

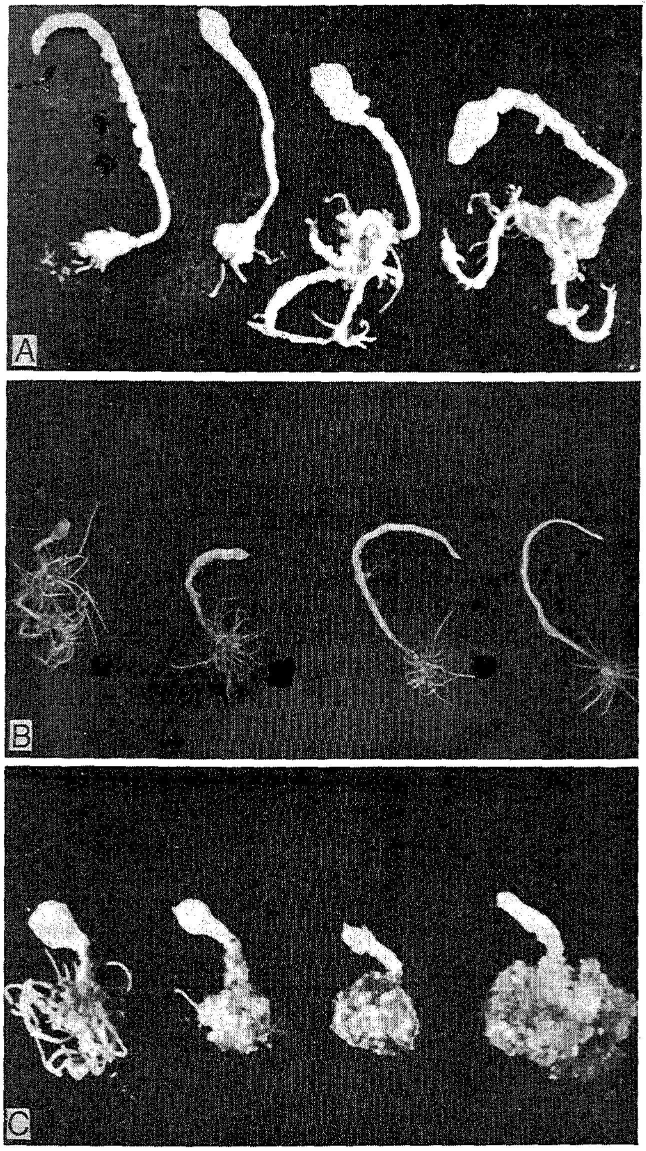

Figure 2. The effects of phytohormones on gynophore elongation, pod development, root growth, and callus formation in groundnut gynophore explants cultured in vitro in media containing different levels of GA (gibberellic acid), naphthalene acetic acid (NAA), and benzyl amino purine (BA).

A. 0.2 mg L^{-1} GA_3, plus NAA levels of, from left to right, 0.0, 0.2, 1.0, and 2.0 mg L^{-1}.

B. 2.0 mg L^{-1} NAA, plus GA_3 levels of, from left to right, 0.0, 0.2, 1.0, and 2.0 mg L^{-1}.

C. 2.0 mg L^{-1} NAA, plus 6-BA levels of, from left to right, 0.0, 0.2, 1.0, and 2.0 mg L^{-1}.

Groundnut gynophore explants (1 cm apical part) were cultured in vitro to study the role of hormones in ovary enlargement and gynophore elongation. The media consisted of the organic components of B_5 and inorganic components of MS in L_{16} (4^3) test of three factors (naphthalene acetic acid, NAA; GA_3; and 6-benzyl amino purine, 6-BA) at four levels (0.0, 0.2, 1.0, and 2.0 mg L^{-1}). The results indicated that, with the increase of NAA concentration, ovary enlargement and root formation of gynophore explants were stimulated, but gynophore elongation was inhibited (Fig. 2A). With an increase in the GA_3 concentration, gynophore elongation was stimulated but ovary enlargement and root growth were inhibited (Fig. 2B). Higher concentrations of 6-BA depressed both ovary enlargement and gynophore elongation, but enhanced callus formation on the cut surface (Fig. 2C). The gynophore elongation was negatively correlated with the overy enlargement, but root formation was correlated with ovary enlargement. The correlation coefficient between pod development and gynophore elongation was - 0.969 (P = 0.01), and that between pod development and the fresh mass of root was 0.886 (P = 0.05). NAA alone, at 2 mg L^{-1} was found to be able to induce groundnut ovary enlargement and pod development in vitro, giving more than 80% pod formation.

These results suggest that gynophore elongation and ovary enlargement in the groundnut plant are controlled by plant hormones. Gibberellin is a major factor controlling gynophore elongation, and after the gynophore penetrates the soil, the decrease of gibberellin content and the increases of auxin and ethylene levels are important causes for the cessation of gynophore elongation and the induction of ovary enlargement in groundnut plants.

Effect of Partial Defoliation and Leaf Shading on Nitrate Reductase Activity in Groundnut

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Nitrate reductase (NR) is a key enzyme in nitrogen assimilation, and it has been shown that plants with high growth rates often have high nitrate reductase activity (NRA) (Elrich and Hageman 1973; Sinha and Nicholas 1981). NRA has been reported in almost all parts of the plant (Abrol et al. 1984). The role of different plant parts in nitrogen assimilation (Abrol and Nair 1978) and photosynthesis (Archbold 1942; Ghosh and Sengupta 1986) has been investigated by several workers. Defoliation or leaf-shading techniques have generally been employed in such studies. Defoliation causes a shock effect on the plant, and a recovery mechanism operates, followed by the development of compensatory vegetative growth (Wang and Hanada 1982; Ghosh and Sengupta 1986). The present study reports the effect of reduction in photosynthetic surface area by partial defoliation or shading of leaves on NRA in the remaining leaves of groundnut plants.

A bunch type of groundnut (cv J 11) was raised in pots. Partial defoliation or leaf-shading treatments were started when the plants were 30 days old. Defoliation was done by manually removing all the leaves on selected branches. Newly formed leaves were removed as and when they appeared. Leaf shading was achieved by enclosing selected branches in black polythene bags with small holes on the lower side for aeration. The primary branches on the axil of the cotyledons were designated as branches 1 and 2, and subsequently, the branches on the nodes above were numbered: branches 3 and 4. Leaves on the main shoot or on a combination of branches were removed or shaded as above (Table 1), exposing the rest of the plant to the sun. The NRA of the topmost fully expanded leaf of the untreated branch (main shoot or branch 1) was assayed in vivo by the method described by Klepper et al. (1971) 50 and 80 days after sowing (DAS).

Table 1. Effect of defoliation or shading of leaves on nitrate reductase activity (NRA) (nm NO_2 produced g^{-1} leaf fresh mass h^{-1}) in groundnut.

Branches defoliated or shaded	Defoliation 50 DAS	Defoliation 80 DAS	Shading 50 DAS	Shading 80 DAS
	NRA of main shoot			
Nos. 3 and 4	500 (174)[1]	825 (105)	312 (109)	875 (111)
Nos. 1 and 2	525 (183)	975 (124)	425 (148)	895 (113)
Control	287 (100)	787 (100)	287 (100)	787 (100)
	NRA of branch 1			
Main shoot	500 (125)	875 (115)	425 (106)	800 (105)
Nos. 3 and 4	550 (137)	987 (129)	436 (109)	825 (108)
Control	400 (100)	762 (100)	400 (100)	762 (100)

1. Figures in parentheses indicate NRA increase (%) over control.

Reduction in leaf area, either by partial defoliation or by leaf shading, caused increased NRA in the leaves on other branches, at both 50 and 80 DAS (Table 1). Although NRA was comparatively higher at 80 DAS, the enhancement due to defoliation or shading was greater at 50 DAS. This could be due to a larger overcompensation in NRA at 50 DAS than at 80 DAS. The enhancement of NRA due to defoliation was greater in the main shoot than in branch 1. Thus defoliation of branches 3 and 4 caused 75% increase in NRA of the main shoot as compared with 37% in branch 1 at 50 DAS. Although a similar trend in enhancement of NRA was observed due to leaf shading, the effect was much less than the effect of defoliation. Overcompensation in vegetative growth or photosynthesis in partially defoliated or shaded plants has been reported earlier (Carmi and Koller 1979; Hanson and West 1982). A similar effect on NRA observed in this study indicates a generally increased metabolic activity of the remaining leaves of partially defoliated plants.

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

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Of the four economically important groundnut pests in India, leaf miner, white grub, hairy caterpillars, and termites (Rai 1976), the groundnut leaf miner is the key pest in Tamil Nadu, both in rainfed and in

Table 1. Leaf-miner resistance, yield, and shelling percentage of selected groundnut entries, Vriddhachalam, Tamil Nadu, India, rainy season 1987.

Entry	Origin	Identity	Leaf-miner damage score[1]	Mean pod yield (g $plant^{-1}$)	Shelling percentage
ICG 10361	Nigeria	Nan 181	3	12.6	73.1
ICG 9212	Senegal	58-32 IA	3	12.1	65.6
ICG 1458	Senegal	V 37	3	8.9	66.6
ICG 1989	Uganda	G 4-24-5	3	9.2	73.3
ICG 10383	Nigeria	Nan 251	4	10.6	68.1
ICG 8555	S. Africa	Natal Common	4	9.6	71.5
ICG 10558	Taiwan	0310	4	10.2	63.7
ICG 8717	Indonesia	Indonesia	4	10.2	65.7
Controls					
JL 24	India	JL 24	6	9.8	71.6
VRI 1	India	VRI 1	7	10.0	73.0
Trial mean (155 entries)			6.95	8.51	66.38
SE			±0.12	±0.24	±0.57
CV			21.6	29.09	8.68

1. Based on a 1-9 scale, where 1 = no damage and 9 = 90-100% damage.

irrigated crops. In the present study, 155 genotypes were evaluated for leaf-miner resistance under unprotected field conditions at the Regional Research Station, Vriddhachalam, Tamil Nadu, during the 1987 rainy season.

Each entry was sown in a 3-m row, with a spacing of 15 cm between plants. For every five entries, one row of the control variety, VRI 1, was grown. Soybean was sown around each plot 15 days prior to groundnut sowing, to ensure leaf-miner incidence. The percentage of leaf area dried by leaf-miner activity 65 days after sowing was estimated visually (Amin 1984) and scored on a scale of 1-9, where 1=no damage and 9=90-100% of leaves damaged by leaf miner. The yield of each of the five plants taken randomly from each genotype was recorded.

Eight spanish bunch entries showed some resistance to groundnut leaf miner (Table 1) compared with the control varieties. Four entries--ICG nos. 10361, 9212, 1458, and 1989--scored 3; and four entries--ICG nos. 10383, 8555, 10558, and 8717--scored 4. A score of 8 was given to 79 genotypes. The control variety VRI 1 scored 6 and JL 24, 7.

Most of the entries tested were superior in yield to the national control JL 24; ICG 10361 and ICG 9212--which also showed the most resistance to leaf miner--had the highest pod yields, of 12.6 and 12.1 g plant^{-1}. The moderately resistant entries will be evaluated further.

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Screening of Interspecific Derivatives for Leaf-Miner (*Aproaerema modicella* Deventer) Resistance in Groundnut

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Groundnut leaf miner (*Aproaerema modicella* Deventer) is a serious pest of groundnut in Tamil Nadu. Though the pest can be controlled effectively with pesticides, poor farmers raising groundnut under rainfed conditions need varieties that possess resistance to this pest. The All India Coordinated Research Project on Oilseeds (AICORPO) reported that ICG nos. 41, 57, 156, 1440, 1697, 2248, 7016, 7404, and 9110 are moderately resistant to leaf miner. This

Table 1. Reaction of 18 interspecific derivatives[1] to groundnut leaf miner in field screening at Vriddhachalam, Tamil Nadu, India, postrainy season, 1986/87.

Entry	Leaf-miner damage (%)[2]	Dry pod yield (t ha^{-1})
VG 78	9.6	2.43
VG 85	6.0	1.94
VG 86	8.6	1.39
VG 91	8.3	1.84
VG 101	4.0	2.29
VG 108	8.2	2.29
VG 113	9.2	2.29
VG 174	5.2	2.12
VG 183	5.7	2.01
VG 219	4.8	1.53
VG 220	11.4	2.36
CS 9	26.1	2.36
CS 11	9.5	1.88
CS 26	4.3	1.49
CS 31	18.3	2.01
CS 820	15.3	2.08
CS 850	17.8	2.01
CS 886	20.3	1.74
Controls		
CO 1	15.7	1.74
VRI 1	20.3	2.08
JL 24	22.4	1.60
TMV 10	14.8	2.08
GM	12.08	1.98
SE	±2.6	±0.13
CV	30.6	9.3
b	0.0036	
r	0.0796	

1. *Arachis hypogaea* x *A. cardenasii.*
2. Visually estimated percentage of leaf area dried by leaf-miner attack.

article describes the screening of some interspecific derivatives for resistance to leaf miner.

The cultivated species *Arachis hypogaea* Linn. (2n=40) has been classified as a member of the section *Arachis*, along with a number of cross-compatible wild diploid species (2n=20). These are potential sources for the genetic improvement of *A. hypogaea*. Of these, *A. cardenasii* Krap. et Greg nom. nud., a wild diploid species, has been crossed with *A. hypogaea*, and the 18 derivatives supplied by ICRISAT were screened for leaf miner incidence under unprotected field conditions in a randomized-block design with two replications during the postrainy season 1986/87. The plot size was 4.5 m^2, with a 30-cm spacing between rows and 10 cm between plants within the row. Observations on leaf-miner incidence were made 70 days after sowing (DAS) and the percentage of leaf area dried by leaf-miner activity was estimated visually as per Amin (1984) (Table 1).

The lowest incidence (4.0%) was recorded in the entry VG 101, though there was no statistically significant difference between VG 101 and 11 other entries, VG 78, 85, 91, 108, 113, 174, 183, 219, 220, CS 11, and 26, in which the percentage of leaf damage ranged from 4.3% (CS 26) to 11.4% (VG 220). Few of the entries tested combine resistance with high yield.

Earlier, ICGS 50, a derivative of the cross *A. hypogaea* x *A. cardenasii* had been reported to be resistant to leaf miner (Mahadevan et al. 1988). These studies reveal that other *A. cardenasii* derivatives can also probably be a source for incorporation of resistance to leaf miner.

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Depth of Sowing and Productivity of Rainfed Groundnut at Anantapur, Andhra Pradesh, India

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Germination fails when the soil in the vicinity of the germinating seed has dried before the radicle reaches into deeper wet horizons of the soil. Perhaps to counter this, the farmer sows deep to ensure moisture availability during emergence. But under irrigated conditions, sowing at a depth of 8-10 cm reduces groundnut yields by 25-30% compared with sowing at 5 cm (Nambiar et al. 1987, Swanevelder, 1983). We conducted three experiments during 1987 and 1988 under rainfed conditions at Anantapur, in south India, to study the effects of sowing depth on germination. All three experiments were laid out in a randomized-block design with six replications.

The land was cultivated after the first showers in June, incorporating 100 kg ha^{-1} diammonium phosphate. Sowing was done after sufficient rain had fallen, on the dates shown in Figure 1. Experiments I and II were sown on different dates in 1987, so that the crops were subjected to different patterns of droughts. The mean maximum and minimum temperatures were 35 and 24° C in 1987 and 32 and 22° C in 1988.

The cultivar J 11 was used in all experiments. Seed was treated with Captan and thiram at 3 g kg^{-1} seed, and placed 7-8 cm apart, by hand, in furrows opened at 30-cm intervals to a depth of 4-6 cm. For deep sowing, the furrows were further deepened with hand-hoes, to 8-10 cm. The crop was protected from pests and diseases and hand-weeded as necessary. Yield measurements were sampled from a ground area of 7.2 m^2.

In Experiment I, the high evaporation rate (about 12 mm d^{-1}) immediately after sowing resulted in moisture inadequate to support emergence from the shallow sowing, but 90-95% emerged in the deep sowing. After emergence there was little growth until 35 days after sowing, when 70 mm of rain fell. Following this rain, 50-60% of the shallow-sown seeds emerged. About 40% of the seeds in this treatment either had desiccated plumules or suffered damage by soil insects. The deep-sown crop gave higher pod yield and vegetative dry matter than the shallow-sown one (Table 1).

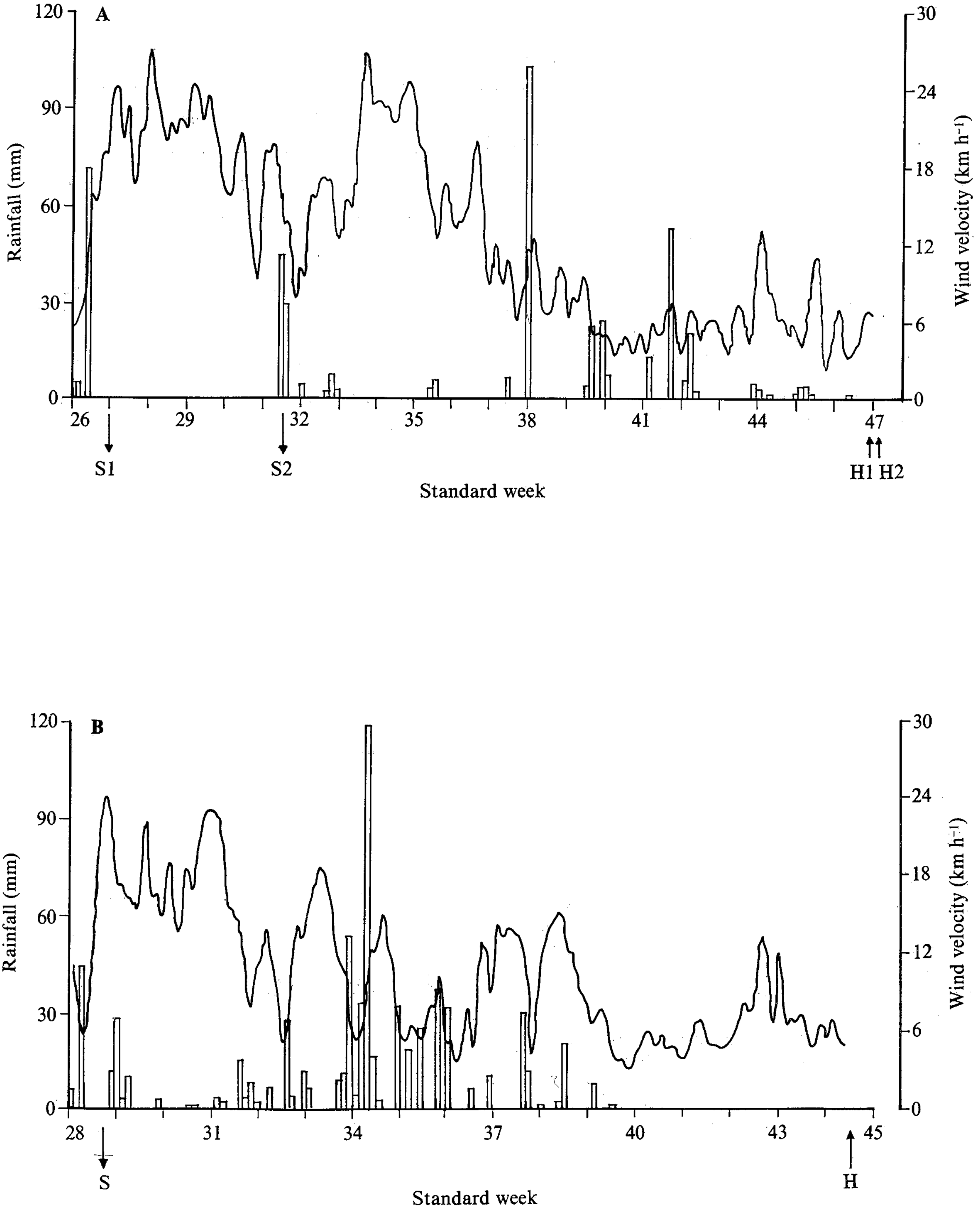

Figure 1. Rainfall (histograms) and wind velocity during experiments on the effect of sowing depth on groundnut emergence and productivity at the Dry Farming Research Station, Anantapur, Andhra Pradesh, India. A. 1987 rainy season: S1 = first sowing (1 Jul), H1 = first harvest (20 Nov); S2 = second sowing (6 Aug), H2 = second harvest (21 Nov). B. 1988 rainy season: S = sowing (13 Jul), H = harvest (13 Nov).

Table 1. Effect of depth of sowing on the productivity of groundnut cultivar J 11, under rainfed conditions at the Dry Farming Research Station, Anantapur, Andhra Pradesh, India, rainy seasons 1987, 1988.

Year	Experiment	Sowing depth	No. of plants m^{-2}	Dry mass (kg ha^{-1}) Vegetative	Pod	Total
1987	I	Shallow	13	1005	1030	2035
		Deep	25	1320	2031	3351
		SE	± 2.2	± 50.5	± 101	± 52.2
1987	II	Shallow	40	1821	1951	3772
		Deep	37	1824	1906	3730
		SE	± 1.6	± 99	± 78.1	± 154
1988	III	Shallow	40	3840	3032	6872
		Deep	41	4130	3148	7278
		SE	± 1.5	± 51	± 90.6	± 74.7

In Experiments II and III, rainfall after sowing favored emergence in both shallow- and deep-sown treatments. Rains during the seed-filling phase resulted in good crops in both treatments but there was no difference in yields due to depth of sowing (Table 1).

Experiment I provides a classic demonstration of the need to sow deep to ensure emergence under erratic rainfall situations. However, when the sowings were successful in achieving establishment at either depth, we did not observe the lower yield expected from deeper sowings, indicating that effects of depth of sowing are site-specific and cannot be generalized for all situations.

It is possible that at Anantapur, where soil is sandy and initial wind velocities are high, growth of plants is affected by wind agitation; this effect could be more pronounced in shallow-sown crops where there is less mechanical support for the plants.

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Nambiar, P.T.C., and **Srinivasa Rao, B.** 1987. Effect of sowing depth on nodulation, nitrogen fixation, root and hypocotyl growth and yield in groundnut (*Arachis hypogaea*) Experimental Agriculture 23:283-291.

Swanevelder, C.J. 1983. The influence of planting depth and seed size on the seed yield of groundnuts. Crop Production 12:48-50.

Recent ICRISAT Publications

The publishing address for each item is: ICRISAT, Patancheru, Andhra Pradesh 502 324, India.

ICRISAT. 1988. Coordinated research on groundnut rosette virus disease: summary proceedings of the consultative group meeting, 8-10 March 1987, Lilongwe, Malawi. Price: Less-developed countries U.S.$1.80; highly developed countries U.S.$5.40; India Rs.23.00.

ICRISAT. 1988. Coordination of research on peanut stripe virus: summary proceedings of the First Meeting to Coordinate Research on Peanut Stripe Virus Disease of Groundnut, 9-12 Jun 1987, Malang, Indonesia. Price: less-developed countries U.S.$1.60; highly developed countries U.S.$4.80; India Rs.22.00.

Book Reviews

Chauhan, Y.S., Nene, Y.L., Johansen, C., Haware, M.P., Saxena, N.P., Sardar Singh, Sharma, S.B., Sahrawat, K.L., Burford, J.R., Rupela, O.P., Kumar Rao, J.V.D.K., and Sithanantham, S. 1988. **Effects of soil solarization on pigeonpea and chickpea.** Research Bulletin no.11. Patancheru, A.P. 502 324, India: International Crops Research Institute for the Semi-Arid Tropics. ISBN 92-9066-167-4 ICR 88-0040.

This ICRISAT research bulletin records the experience gained with field tests on the effects of soil solarization on pigeonpea (*Cajanus cajan* (L.) Millsp.) and chickpea (*Cicer arietinum* L.) crops at ICRISAT Center during 1984-87. The studies--a multidisciplinary team effort--were conducted in fields infested with fusarium wilt. Solarization was done by covering the soil with transparent polythene sheeting (100μm thick) for 6-8 weeks during summer (April/May). This increased soil temperatures by 6-10° C in the 0-20-cm soil profile. Other changes recorded were: increased mineralization of soil nitrogen to nitrate, a decline in populations of fusarium propagules and plant-parasitic nematodes, and decreased weed infestation. When the crops were grown, effective control of fusarium wilt disease in the susceptible genotypes of pigeonpea and chickpea was observed, along with improved plant growth and yield. Nodulation and nitrogen fixation were adversely affected because of the decline in *Rhizobium* population with solarization. However, plant growth and yield were not adversely affected, probably because of the compensatory effect of increased soil nitrate. Even in wilt-resistant genotypes of both crops, particularly of pigeonpea, there was a significant increase in yield, indicating beneficial effects of solarization other than disease control. There was a considerable residual effect of solarization in the second and third seasons on yield of chickpea, but not of pigeonpea. Different techniques and methods employed in applying solarization and in assessing its impact are described.

Although the study was undertaken for chickpea and pigeonpea, the decrease in weed infestation and in disease level, plus the other benefits, resulting from solarization would most probably increase yields of groundnut also.

The bulletin can be obtained from: Information Services, ICRISAT, Patancheru, Andhra Pradesh 502 324, India. Prices are: less-developed countries U.S.$ 1.00 + postage; highly developed countries U.S.$ 3.00 + postage (airmail U.S.$ 3.60; surface mail U.S.$ 1.80), India Rs.15.00 + postage.

J.P. Moss
ICRISAT Center

Evered, D., and Harnett, S. (eds.). 1987. **Plant resistance to viruses.** Proceedings of Ciba Foundation Symposium 133, 31 Mar-2 Apr 1987, London, UK. Chichester, UK: John Wiley and Sons Ltd. 215 pp. (ISBN 0 471 91263 8)

This book consists of papers presented at a symposium held at the Ciba Foundation, London, UK, 31 Mar-2 Apr 1987.

The brief introduction takes a historical look at resistance breeding, and indicates the object of the symposium, which was to describe and discuss the many recent findings relevant to this resistance.

The first paper deals with general principles of the genetics of plant resistance to viruses. Other papers cover different aspects of virus resistance: resistance of cowpeas to cowpea mosaic virus and to tobacco ring spot virus; resistance mechanisms of tobacco mosaic virus strains in tomato and tobacco; The role of pathogenesis-related proteins; characterization of pathogenesis-related proteins and genes; mechanism of the hypersensitivity reaction of plants; resistance systems related to the N gene and their comparison with interferon; analysis of the N gene of *Nicotiana*; and mechanisms of cross-protection between plant virus strains. Two papers--"Genetic engineering of plants for protection against virus diseases" and "Resistance to viral disease through expression of viral genetic material from the plant genome"--are concerned with the use of transformed plants that are resistant to viruses; a third--"Plant DNA viruses as gene vectors"--with the use of caulimo- and gemini-viruses as vectors for transforming plants.

Final discussions cover durability of resistance, pathogenesis, and genetic engineering approaches to plant resistance

The book contains much detail that will be of most value to virologists, though some papers will be of general interest to breeders and pathologists. Price: U.S.$ 49.95.

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Indian Council of Agricultural Research (ICAR). 1988. **Groundnut.** New Delhi, India: ICAR.

This book is a revised edition of the monograph on groundnut published in 1962; this new edition contains many new research findings, and some critical distillation of relevant literature, research results, achievements, and reports on the current status of the groundnut crop.

The book starts with the origin and history of groundnut and continues with chapters on distribution, area, production, and trade; botany; anatomy; and physiology, cytogenetics, and genetics; breeding and varieties are covered in the next two chapters, followed by two chapters on cultivation, storage, and marketing; and cost of production. Some pest and disease problems are discussed in the next two chapters, insect and mite pests and their control; and fungal and nematode diseases. The last four chapters--on virus diseases; the mycotoxin problem; nodulation and nitrogen fixation; and chemistry and utilization--did not appear in the earlier edition.

This is a useful source book on a wide range of subjects. The literature citations are extensive, and it has many useful tables and figures, and deserves a place on the shelves of libraries and groundnut scientists.

This book can be obtained from: Publications and Information Division, Indian Council of Agricultural Research, Krishi Anusandhan Bhavan, Pusa, New Delhi. Price: Rs.100 + postage.

J.P. Moss
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