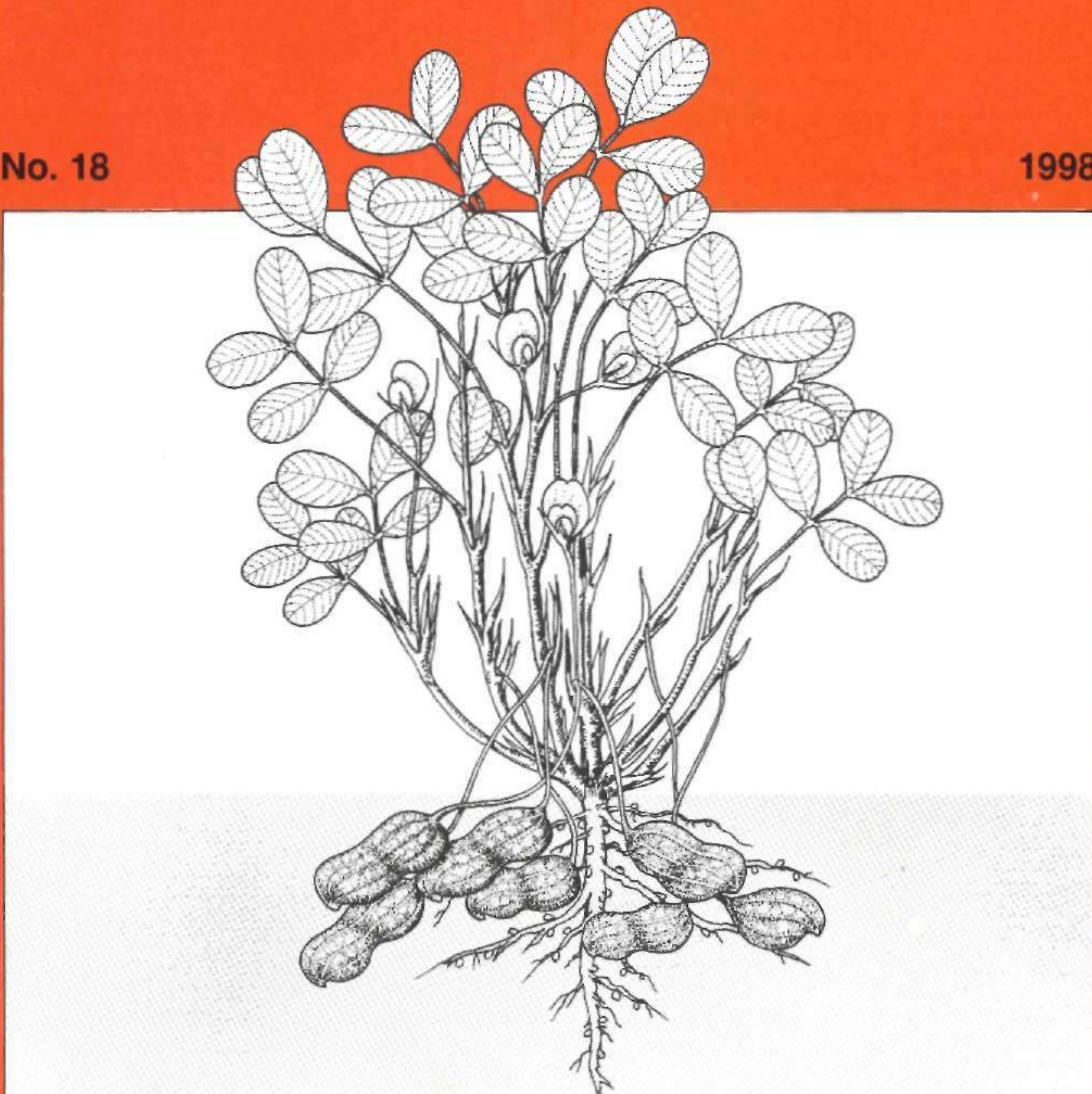
International *Arachis* Newsletter

No. 18 1998



International *Arachis* Newsletter

Co-publishers

Peanut CRSP
Peanut Collaborative Research Support Program
(http://www.griffin.pcachnet.edu/pnutcrsp.html)

ICRISAT
International Crops Research Institute for the Semi-Arid Tropics
(http://www.cgiar.org/icrisat)

About Peanut CRSP

The Peanut Collaborative Research Support Program is an international program supported by USAID Grant LAG-G-00-96-00013-00 to The University of Georgia. The research supported seeks environmentally sound, sustainable agriculture production and food delivery systems for peanut. The program has five thrusts addressing priority constraints to the global peanut industry (aflatoxin, production efficiency, socio-economic forces, post-harvest processing, and utilization). Peanut CRSP also works to foster human resource development and the communication of research results.

The Peanut CRSP provides support for collaborative research, training, and exchange of information through grants to 10 universities in the USA linked to 14 host countries in the developing world. Both host countries and the USA are expected to benefit from the activities of Peanut CRSP. Peanut CRSP actively collaborates with other organizations with interest in advancing development through the application of science and technology.

About ICRISAT

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

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

ICRISAT was established in 1972. It is one of 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).

IAN Scientific Editor

S N Nigam

Contents

News and Views

Research Reports

Genetics and Plant Breeding

Pathology

News and Views

From the Editor

I am happy to report to our readers the news that Peanut CRSP, the co-publisher of the Newsletter, has decided to play a more proactive role in promoting it. In future, we will have more coverage from Peanut CRSP-supported projects in the USA and elsewhere. However, I would urge our readers in Africa to continue to share their experiences, and the results of their experiments, with other groundnut scientists through the medium of this Newsletter.

The News and Views section has tended to be dominated by events occurring at ICRISAT. 1 invite our readers to send contributions to make this section more representative of the world groundnut community. There are many success stories in technology transfer, development, and promotion of groundnut which, if shared with others, may help them draw useful lessons and encourage them to succeed in similar efforts.

I would like to acknowledge the contribution of S L Dwivedi, P K Joshi, N Mallikarjuna, R C Nageswara Rao, S Pande, G V Ranga Rao, T J Rego, H C Sharma, K K Sharma, S B Sharma, and H D Upadhyaya, as reviewers of contributions to this issue of IAN, and the Library and Documentation Services at ICRISAT for compiling the SATCRIS listing and verifying the references cited in this issue.

To expedite acceptance of your contribution to IAN, I would request you, while preparing your manuscript, to consult the information for IAN Contributors' appearing on the back cover page of each issue.

I look forward to your contributions to the 1999 issue of IAN.

S N Nigam

ICRISAT Presents the Second Mashler Award

The second Doreen Margaret Mashler Distinguished Scientific Achievement Award was presented at ICRISAT-Patancheru, India, at a special function on 19 June 1998, to a multidisciplinary team who contributed to the "Development of integrated pest management in groundnut with special attention to defoliating insects." Each recipient was awarded a certificate and a specially designed, engraved silver plate depicting various aspects of ICRISAT's research.

The team comprised scientists from ICRISAT and the national agricultural research programs of India and Vietnam, NGOs (Krishi Vigyan Kendras), farmers, and media people from Andhra Pradesh. From several nominations made in 1997, the ICRISAT Governing Board selected this team for its outstanding contribution over an extended period in developing and implementing

L Sadasiva Reddy, one of the recipients from the farmers' group, receiving his Mashler Award from ICRISAT Director General, S M Barghouti.

Second Mashler Award Winners with the Director General of ICRISAT.
Standing: L-R: D D R Reddy, G V Ranga Rao, P Suryanarayana Raju, A Satyanarayana, G Appaji, G V R Chella Rao, K Rama Devi, S M Barghouti, P Arjuna Rao, S Pande, D V Ranga Rao, L J Reddy, C L L Gowda, M Vijaya Saradhi, V Mahesh Baba.
Sitting: Y Mohan Rao, V Rameshwara Rao, L Sadasiva Reddy, L Shesha Reddy.

integrated pest management (IPM) strategies to reduce insecticide pollution and improve farmers' quality of life. As a result of this remarkable concerted effort, difficult biological constraints of groundnut have been eliminated in several areas of India and Vietnam.

The Mashler Award is an endowment presented to ICRISAT in 1992 by Dr W T Mashler in memory of his wife. Dr Mashler was Chairman of the ICRISAT Governing Board for three years and was instrumental in ICRISAT's founding in 1972. He had a special affection for the Institute until his death in 1995.

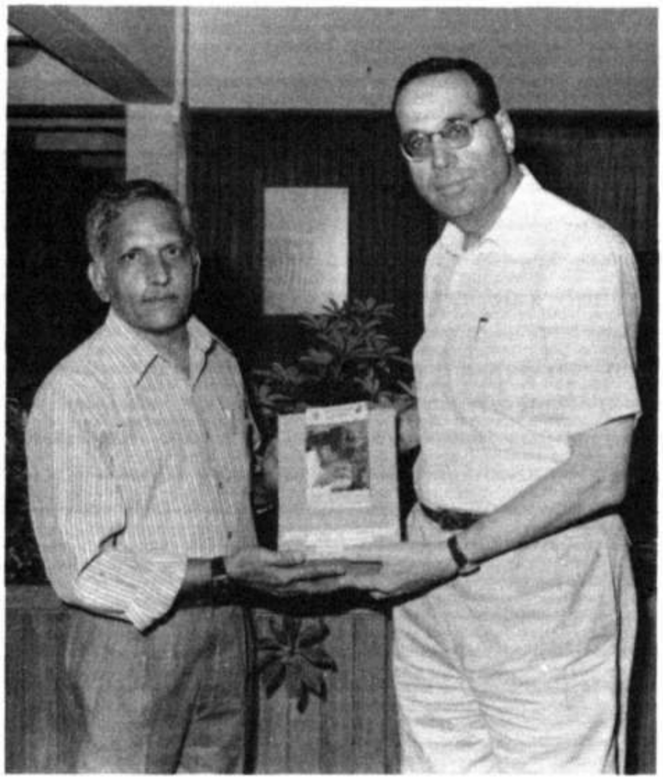
The 1997 Mashler Award has special significance because it recognizes the contribution of progressive farmers, such as G Appaji, "The IPM Farmer", who pioneered the implementation of IPM in the Guntur District of Andhra Pradesh.

Farmers in his region - who were earlier spending about 20% of the value of their harvested crop on pesticides against tobacco catterpillar and cotton boll-worm, the two most most devastating groundnut pests - were convinced by Appaji's successful control methods and stopped using pesticides. Despite this they obtained bumper harvests as a result of the simple technology developed by ICRISAT scientists who monitored insect populations with the help of pheromone traps, and helped them identify and protect beneficial insects and birds. This technology has now been transferred to Vietnam where the tobacco caterpillar is also a major pest of groundnut.

This IPM success story has been widely publicized through publications, videos, and television programs. The IPM program was funded by the UK Overseas Development Administration (ODA), now know as the Department for International Development (DFID).

Book release

A handbook on Field Diagnosis of Groundnut Diseases, in Telugu, was released in June by the Andhra Pradesh Commissionerate of Agriculture and ICRISAT



Assistant Director of Agriculture (Publicity) A V L N Murthy presents a copy of the new publication to the Director General of ICRISAT, S M Barghouti.

'Verusenaga pairulo vyadhi nirdharana' joins the versions of this popular reference book in English and French, published by ICRISAT, and those copublished with national organizations in China, Myanmar, and Vietnam. About 10 000 copies have been published for sale and distribution to farmers and agricultural extension officers in the state.

About Scientists

J Russell, Technology Transfer Specialist and Project Manager, SADC/1CRISAT Groundnut Project based at ICRISAT-Lilongwe, left ICRISAT in January 1998 after serving the institute for about a year.

B R Ntare, Principal Scientist (Breeding), who was based at ICRISAT-Kano, Nigeria, has relocated to ICRISAT-Mali. This is in line with the external review recommendation that the groundnut research program in West and Central Africa should be consolidated at one location.

News from Africa

Workshop

The sixth regional groundnut workshop for West and Central Africa will be held from 5-8 October 1998. The objectives of this workshop are to review regional groundnut production, assess research and development aspects and to formulate a strategy for sustainable groundnut production in the region.

Groundnut Research Wins Prize

ICRISAT-Malawi collaborative research on management of groundnut rosette disease won the second prize at the Field Day at Chitedze Agricultural Research Station on 2 April 1998. The presentation was made by Dr A J Chiyembekeza, Commodity Team Leader and Breeder (Groundnut) and Dr Pala Subrahmanyam, ICRISAT Country Representative, Malawi. Over 500 participants from all over Malawi were present at the Field Day.

ICRISAT Completes an Inventory of Seed Available for Drought Relief in Southern Africa

In late 1997, southern Africa received predictions of severe drought as a result of the El Nino weather patterns. With the United States Agency for International Development (USAID) support, ICRISAT conducted a quick inventory of seed in the region in order to facilitate the planning for emergency seed relief programs prior to the 1998/99 season. The study revealed that the Southern African Development Community (SADC) faces an overall seed surplus of 45 752 t for maize, 7 278 t for sorghum, 2 329 t for pearl millet, 3 018 t for groundnut, and 5 144 t for cowpea. However, Angola, Botswana, and Lesotho face seed supply deficits. These can be resolved through intraregional seed trade. Part of this trade may be on commercial terms. However, the poverty of many of the smallholder farmers most affected by drought (or continuing war in the case of Angola) may justify some concessional assistance.

The report cautions donors and nongovernmental organizations (NGOs) interested in purchasing and distributing seed relief that seed varieties in surplus in one country are not necessarily suited for distribution in another. While there is substantial scope for the trade of seed across borders, experts knowledgeable about variety characteristics and zones of adaptation should be consulted in cases where variety adaptation is uncertain. Seed importers also need to be aware of phytosanitary regulations, variety registration restrictions, and import/export licensing in each country. Such regulatory policies do not represent major barriers to the movement of seed in southern Africa, but awareness of local regulations remains important to avoid trading difficulties. Paradoxically, though southern Africa holds a regional seed surplus, most farmers still lack access to varieties of sorghum, pearl millet, groundnut, pigeonpea, and cowpea released within the past 10 years. The regional seed surpluses essentially reflect the expected levels of commercial seed sale. For crops other than maize, this largely constitutes sales to governments, donors, and NGOs for drought relief and resettlement programs. Since efforts to build retail networks for the sale of sorghum, pearl millet, groundnut, pigeonpea, and cowpea seed have been limited in most countries, the magnitude of true seed demand is probably underestimated.

Improving Linkages between Seed Producers and Consumers

Well functioning seed multiplication and distribution channels are essential to ensure the impact of international and national crop breeding programs. Unfortunately, seed supply channels throughout much of southern and eastern Africa are deficient. Varieties are released but never multiplied. Varieties are multiplied but never distributed. Seed companies complain about the lack of demand for seed which remains in centralized stocks. Farmers complain about their lack of access to new seed.

These problems are particularly severe for new open pollinated varieties (OPVs). Since farmers can save seed from their previous year's grain harvest, seed companies expect little demand after a year or two of seed supply. This limits incentives to initiate multiplication. Seed company interest in secondary grain crops is further reduced by the limited area planted to these crops. Finally, companies justify limited multiplication by citing their lack of information on the level and extent of seed demand.

ICRISAT and the Overseas Development Institute (ODI) have initiated a Department for International Development (DFID)-funded project to diagnose information, institutional and regulatory constraints limiting the development of national seed markets and preventing the rapid multiplication and distribution of a range of seed varieties to small-scale farmers. The analysis targets the identification of strategies for improving information flows about seed demand to public and private seed multiplication agents, and improving information about seed availability and performance to small-scale farmers. The analysis additionally considers how information constraints on seed flows affect the financial viability of multiplication and distribution.

In March 1998, stakeholder meetings were held with seed industry representatives in Zimbabwe, Zambia, and Kenya to review national seed delivery constraints, and set an agenda for analyses targeting the improvement of public and private seed supply channels. A related meeting will be held in Malawi later this year. Small research grants are being provided in each of these study countries to evaluate alternative seed supply strategies. These include analyses of factors influencing seed demand, evaluations of the economics of decentralized seed production, and assessments of opportunities for promoting expanded seed production in the informal sector. The results of these studies will be reported back to seed sector stakeholders in meetings planned for mid-1999.

News from Cereals and Legumes Asia Network (CLAN)

Workshops and Meetings

Fourth Groundnut Bacterial Wilt Working Group Meeting, 11-13 May 1998, Hanoi, Vietnam.

The fourth working group meeting on groundnut bacterial wilt was organized from 11-13 May 1998 at the Vietnam Agricultural Science Institute (VASI), Hanoi, Vietnam. The meeting was co-sponsored by the Ministry of Agriculture and Rural Development (MARD), Hanoi, the Asian Development Bank (ADB), and ICRISAT. The participants from China (4), Vietnam (6), and ICRISAT (1) reviewed past research on groundnut bacterial wilt since the 1994 meeting held in Wuhan, China, and prepared plans for future research aimed at developing integrated management strategies to reduce losses by the disease.

Participating working group members presented results of the research on the bacterial wilt pathogen (*Ralstonia solanacearum*), and its detection and diagnosis using both conventional and molecular approaches. The following areas were identified for future research efforts:

Disease monitoring. Annual surveys by the national program scientists will continue and information on the changing scenario of bacterial wilt disease will be gathered. Targeted surveys will be conducted in endemic areas using Geographic Positioning Systems (GPS) and Geographic Information Systems (GIS).

Genetic enhancement for host-plant resistance. Further screening of groundnut germplasm for resistance to bacterial wilt will be conducted in China, Indonesia, and Vietnam. Combining bacterial wilt resistance with resistance to other foliar diseases, drought tolerance, and improved quality will be of high priority. Further investigations on genetics and mechanisms of resistance to bacterial wilt will be undertaken. Suitable priority will be accorded to improving methods for artificial inoculation, and for detecting latent infection.

Integrated disease management. Substantial information on host-plant resistance and cultural practices is available. However, the role of crop rotation in influencing the pathogen population dynamics and pathogenicity needs further study. Increased research efforts on biological control by using avirulent strains of R. solanacearum will be made. Farmer-participatory research to devise appropriate location-specific integrated management strategies will also be initiated.

Strategic research on Ralstonia solanacearum. Research on monoclonal antibodies to detect biovars and pathotypes should be carried out in collaboration with advanced research laboratories in Asia and Europe. Systematic studies on the role of the interaction between R. solanacearum and other soil-borne pathogens are needed to assist in formulating management options.

Workshops and training. In-country training workshops on serological and molecular methods for detecting the pathogen and screening methods and disease management were recommended for information exchange and technology transfer among the member countries. These activities will be sponsored and organized by the member countries with limited support from CLAN/ICRISAT.

Funding. It was recommended that concerned national programs should continue support for research on groundnut bacterial wilt. External funding is imperative for some of the research and technology exchange activities, hence it was recommended that efforts should be made to seek funds bilaterally with international institutions. Proposals for external funding will be prepared jointly and submitted to prospective donors.

Newsletter. It was strongly felt that a newsletter or news sheet should be brought out at least twice a year to share new research information and working group activities.

CLAN Country Coordinators' Steering Committee Meeting, 24-28 Nov 1997, Malang, Indonesia.

The meeting was co-sponsored by the Research Institute for Legumes and Tuber Crops (RILET), Indonesia, the Asian Development Bank (ADB), and ICRISAT. The Country Coordinators (or Deputy Country Coordinators) from Bangladesh, China, India, Iran, Indonesia, Myanmar, Nepal, Pakistan, The Philippines, Sri Lanka, Thailand, and Vietnam and a representative from Yemen participated in the meeting. The country representatives presented the current status and future plans for collaborative research in CLAN, and provided suggestions for improving networks' usefulness to members. All Country Coordinators expressed satisfaction over the previous year's network activities and agreed to extension of the CLAN-ADB project up to Mar 1999. The work plan for 1998 was discussed and participants of the steering committee meeting considered the following topics for future collaboration:

Technology transfer/on-farm research. The participants agreed that there were many promising technologies in the region which might be helpful for improving productivity at farmers' fields in their own country, and other countries, if adaptive research trials could be conducted. Some participants felt that a better terminology might be "Technology Exchange/Technology Refinement" or "Fine Tuning of Production Technologies".

On-farm research is on-going in some countries and can be strengthened. The group felt that there was a need to chalk out a targeted activity in each country for technology exchange. It was also emphasized that in addition to variety and agronomic practices, natural resource management (NRM) technologies needed to be included. Technology exchange activities needed to be focused on a systems perspective rather than on individual crops. Farmer-participatory research approaches should be emphasized to ensure that technologies met their needs.

All participants felt that additional funding would be required to make this initiative successful.

Spillover of technology. The potential of technology spillovers among the CLAN member countries is very high. For example, polythene film mulch - a technology available in China - has proved successful for groundnut cultivation in India and Vietnam. It may also perform well in other countries where soil temperatures are low at the time of groundnut sowing.

Improved cultivars released by one country may be useful for technology spillover in other countries. For example, sorghum cultivars from India are in evaluation trials in Thailand and Indonesia; and some Indonesian groundnut varieties were reported to be promising in Vietnam.

Maruca pod borer tolerance (pigeonpea), available in Sri Lanka, should be shared among the pigeonpea growing regions where Maruca is a major production constraint.

Nomination of technical coordinators for working groups. The participants felt that Technical Coordinators (TC) are essential for each of the six technical Working Groups. The TC should be nominated on the basis of technical capability and willingness of the person, and quantum of research in the country of the potential coordinator. The following individuals were proposed as the TCs for different Working Groups (the TCs for the latter three Working Groups are already in place):

a) Botrytis gray mold of chickpea	Dr M A Bakr (Bangladesh)
b) Bacterial wilt of groundnut	Mr Liao Boshou (China)
c) Aflatoxin in groundnut	Dr Phan Lieu (Vietnam)
d) Groundnut viruses	Dr D V R Reddy (ICRISAT)
e) Biological nitrogen fixation in legumes	Dr O P Rupela (ICRISAT)
0 Drought tolerance in legumes	Dr N P Saxena (ICRISAT)

It was agreed that the term for TC should be three years, with yearly reviews and possibility of re-nomination.

Regional and in-country training programs. It was felt that these have a great impact on technology generation and development. Therefore, regional as well as in-country training programs need to be continued and strengthened. Country Coordinators provided suggestions on proposed training programs (both regional and in-country).

It was also agreed that Country Coordinators will provide additional lists of required training programs (after consultation in each country) to the CLAN Coordinator. These will be consolidated, prioritized, and plans will be made to organize these, subject to availability of funds.

Bilateral funding. The participants felt the need for accessing bilateral funds to address country-specific priority problems. It was suggested that respective NARS and ICRISAT should look for bilateral donors for funding, and develop proposals jointly.

Exchange of scientists/study tours. All the member countries acknowledged the benefit of study tours and the exchange of scientists. Scarcity of funds was identified as the main constraint for such activities. To augment the funds, it was proposed that the host country may bear the in-country costs (e.g., food, lodging, and in-country transport) while the international travel costs (air ticket) can be provided by CLAN-ADB funds. The Country Coordinators agreed in principle to this proposal. Since this type of policy commitment can be made only after consultation with the respective country authorities, it was decided that the CLAN Coordinator would write as soon as possible to the Country Coordinators to facilitate discussions in each country. Country Coordinators agreed to confirm their commitment and assurance by March 1998.

Exchange of germplasm and information among countries. All the .member countries agreed that they have greatly benefited from germplasm exchange activities. They also acknowledged the benefit of exchange of publications and information. Some countries mentioned the problems faced in receiving germplasm from others. It was agreed that in future more attention will be paid to such requests and to helping each other get the desired germplasm. Member countries also agreed to disseminate their publications (Annual Reports, Research Papers etc.) among the member countries for enhancing each other's technical capabilities and knowledge. CLAN will help member countries (on a needs basis) to translate publications published in languages other than English.

To have an effective exchange of released varieties among the member countries, in the absence of

ICRISAT's international varietal trials program, it was decided to have bilateral and multilateral exchange. A one-row nursery of available elite varieties in the member countries can be initiated with the help of ICRISAT. This will be a needs-based activity for each country.

Some member countries (Myanmar, Nepal, Yemen) also expressed the need for collecting the landraces for conserving biodiversity; and exploring the possibility of getting the best germplasm available with various organizations and countries around the world. The information on such material should be made available to all members so that they can request the required germplasm.

Joint studies on adoption of technologies and impact assessment. The participants acknowledged the importance of conducting impact assessment studies to generate information on the impacts made by NARS-ICRISAT joint research. The members felt that the joint impact assessment studies conducted so far have implications for satisfying donors' demand about impact in farmers' fields, as well as identifying the constraints for nonadoption of certain technologies. The generated information would be useful in setting future research priorities and technology generation.

On-going impact studies in Indonesia, Nepal, India, Bangladesh, and Sri Lanka need to be strengthened. The success of the study proposals submitted by Vietnam-ICRISAT to the United Nations Development Program (UNDP) also inspired the member countries to develop such proposals for funding. Impact assessment activities in Vietnam, China, Thailand, and The Philippines will commence soon.

Others. Some member countries expressed the need to include other legumes (lentil, soybean, and mungbean) in the CLAN activities. It was agreed to include lentil in CLAN as necessary technical backing would be coming from ICARDA. Since no other international institutes have yet committed technical support for soybean and mungbean, it was decided that these crops can be included in the future.

Congratulations to J H (Tim) Williams on his 1 Oct 1998 appointment as Director, Peanut CRSP, Georgia, USA, following the retirement of David Cummins.

Genetics and Plant Breeding

A Promising Groundnut Variety, R 8808, Suitable for the Northern Dry Zone of Karnataka

B G Prakash, G M Sajjanar, and N Y Naykar
(Regional Research Station, Bijapur 586 101, Karnataka, India)

Karnataka is one of the major groundnut-growing states of the country. Groundnut is the main oilseed crop of the northern dry zone of Karnataka which includes Bijapur, Bellary, parts of Belgaum, Raichur, and Dharwad districts. Of the total groundnut area (340 000 ha) in the zone, 70% of the area is rainfed.

The R 8808 variety of groundnut was derived from pure line selection of a cross between ICGS 11 and Chico. R 8808 is a Spanish bunch variety which has an erect growth habit with a main axis height of 17.4 cm. It possesses medium-sized, green-colored leaves with round to elliptic shape and comes to 50% flowering in 38 days after sowing in the rainy season. The plants have 4-5 primary branches. The pods are two-seeded with a slight beak and slight constriction. The mean pod length is 24.1 mm and mean pod width 10.8 mm. The seeds are tan in color and round in shape. The average seed length and width are 13.2 mm and 6.7 mm, respectively. The other characters of this variety are provided in Table 1.

The R 8808 variety was tested for its performance along with 14 other varieties, including the control JL 24, during 1993, 1994, and 1995 rainy seasons without any irrigation at the Regional Research Station, Bijapur, India. R 8808 produced a high mean yield (1.2 t ha^{-1}) and high oil percentage (47.2%) compared with JL 24 yield (1.0 t ha^{-1}) and oil percentage (43.6%) (Table 1). R 8808 has slightly bold seeds and a higher shelling percentage than JL 24. R 8808 showed low bud necrosis and leaf spot disease incidence compared with the control. Another interesting feature of this variety is that it has good adaptation in Fe-deficient soils of the Bijapur area and shows little yellowing.

R 8808 also performed very well in farm trials in 1995-96 (Table 2) at Bijapur, Bellary, Belgaum, Raichur, and Dharwad. It produced 30% more pod yield than JL 24.

The variety has been released to farmers of the northern dry zone of Karnataka for cultivation under rainfed situations.

Table 1. Performance of R 8808 and control cultivar JL 24 in the 1993, 1994, and 1995 rainy seasons under rainfed conditions at Bijapur, Karnataka, India.

	Pod yield (t ha^{-1})				100-seed mass (g)				Shelling (%)				Oil content		
Variety	1993	1994	1995	Mean	1993	1994	1995	Mean	1993	1994	1995	Mean	1994	1995	Mean
R8808	1.7	1.2	0.7	1.2	26.1	31.0	31.0	29.3	65	67	57	63	45.5	48.9	47.2
Control															
JL24	1.7	0.5	0.7	1.0	26.0	30.0	29.0	28.3	64	53	54	57	43.7	43.5	43.6
SE	±0.05	±0.05	±0.01		±1.10	±0.30	±0.90		± 1.30	± 2..10	± 0.90		± 0.40	± 0.90	
CV(%)	5.10	12.00	33.30		6.60	9.80	13.00		3.50	12.50	6.80		1.40	3.80	

Table 2. Performance (t pods ha^{-1}) of R 8808 in farm trials in the northern dry zone of Karnataka in 1995 and 1996 rainy seasons.

	Locations						% increase
Variety	Bijapur	Bellary	Belgaum	Raichur	Dharwad	Mean	over control
R8808	1.7	0.8	0.7	1.7	1.4	1.3	30
JL 24 (control)	0.9	1.0	0.5	1.4	1.0	1.0	

Does Variability Exist in the Old Groundnut Cultivar TMV 2 Collected from Different Parts of Southern India?

K Chandran, K Rajgopal, and T Radhakrishnan
(National Research Centre for Groundnut, P O Box 5, Ivnagar Road, Junagadh 362 001, Gujarat, India)

The groundnut cultivar TMV 2, a mass selection from Gudhiatham bunch, was released in 1940 for cultivation in Tamil Nadu, India. Its short duration, high-yield potential, and wider adaptability made the cultivar popular and it is extensively cultivated in the southern states of India. During the last five decades it has undergone cycles of regeneration and there is a possibility of heterogeneity in its genetic composition (Annual Kharif Oilseeds Workshop 1986). The present study was carried out to find whether any variability for highly heritable qualitative traits had been acquired. To supplement the assessment of morphological characters, seed storage protein profiling of seeds was also studied as it is a useful technique for ascertaining the genetic homogeneity at molecular level (Ladizinsky and Hymowitz 1979).

Nineteen seed samples of cv TMV 2 were collected from groundnut growing tracts of Karnataka (NRCGs 7704, 7706, 7703, 7702, 7701, 7742, 7743, 7745, and

Table 1. Distribution of 23 accessions for 12 descriptors and their descriptor states.

Descriptor	Descriptor state	Number of accessions	List of accessions
Branching pattern	sequential	21	3578,6293,7047,7701,, 7702, 7704, 7706, 7707, 7708, 7709, 7710, 7711, 7731,7734, 7737, 7739, 7742, 7743, 7745, 7747, 7768
	irregular	2	4262, 7703
Stem hairiness	sparse	22	3578, 4262, 6293, 7047, 7701, 7702, 7703, 7704, 7706, 7707, 7708, 7709, 7710,7711, 7734, 7737, 7739, 7742, 7743, 7745, 7747, 7768
	profuse	1	7731
Stem pigmentation	present	23	All
Leaf color	light green	23	All
Leaflet hairiness			
a) upper surface	sparse and long	16	3578,4262,7047,7701, 7702, 7703, 7704, 7706,7708,7711,7737, 7739, 7742, 7743, 7745, 7768
	profuse and long	7	6293,7707,7709,7710, 7731, 7734, 7747
b) lower surface	sparse and long	16	3578,4262,7047,7701, 7702, 7703, 7704, 7706,7708,7711,7737, 7739, 7742, 7743, 7745, 7768
	profuse and long	7	6293,7707,7709,7710, 7731, 7734, 7747
Standard petal color	yellow	23	All
Peg color	present	23	All
Nature of pegs	multiple	23	All
Pod beak	none	23	All
Pod reticulation	moderate	23	All
Pod constriction	slight	23	All
Testa color	rose	23	All

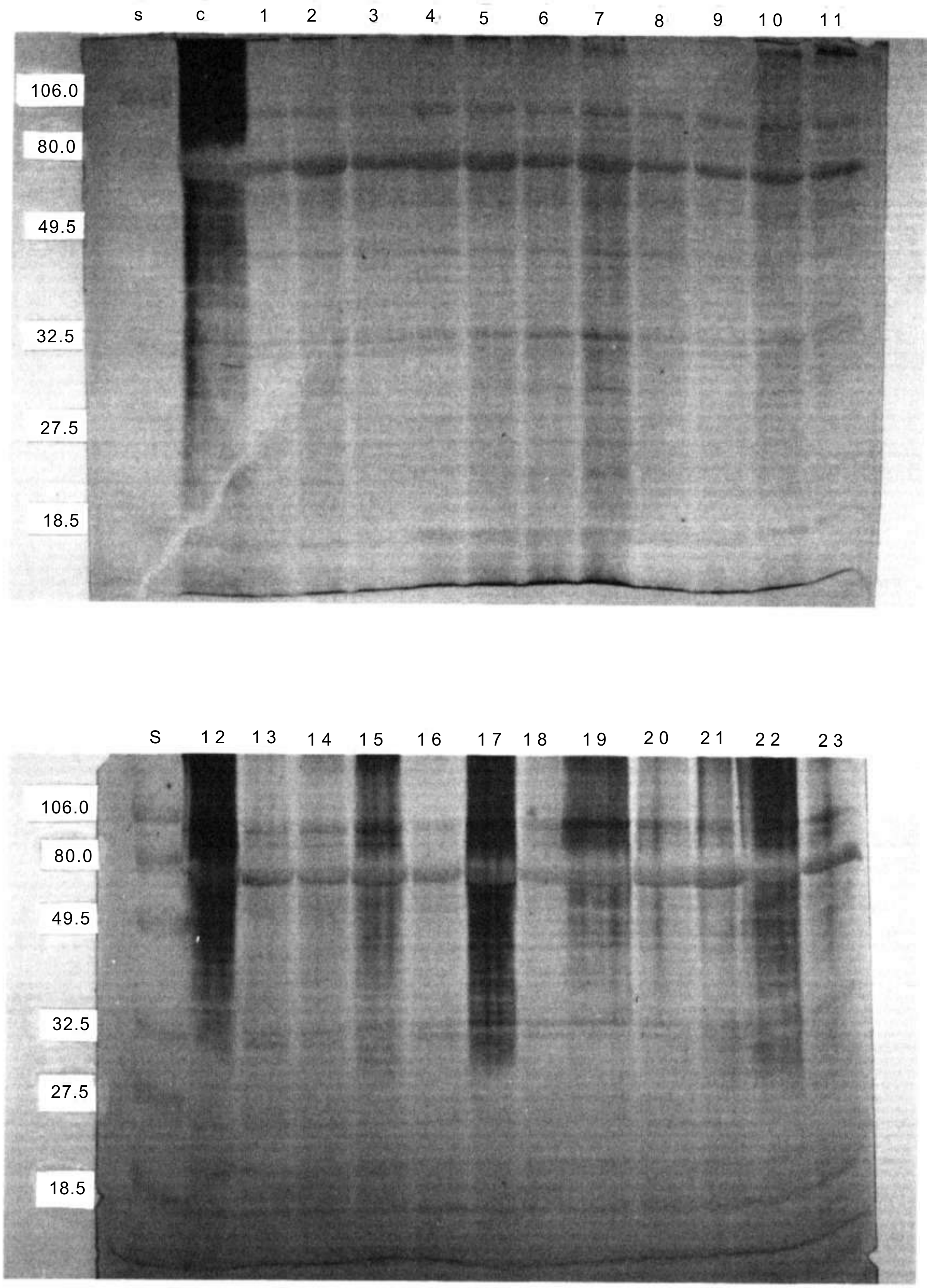


Figure 1. Eletrophoretic patterns of buffer-soluble storage proteins of seeds of TMV 2 accessions.
S.Mol.wt. (kDa) markers; C-TMV 2 breeder seed sample; 1-6293; 2-7707; 3-7704; 4-7706; 5-7703; 6-7702; 7-7701; 8-7709; 9-7710; 10-7711; 11-7708; 12-7731; 13-7742; 14-7737; 15-7734; 16-7743; 17-7739; 18-7745; 19-7747; 20-7768; 21-3578; 22-4262; 23-7047.

7747), Andhra Pradesh (NRCGs 7707, 7709, 7710, 7711, 7708, and 7768), Tamil Nadu (NRCGs 7737, 7734, and 7739), and Kerala (NRCG 7731) of peninsular India, and four accessions of unknown area of cultivation (NRCGs 6293, 3578, 4262, and 7047). They were sown in an augmented block design during the rainy season 1994 and 1995, at the National Research Centre for Groundnut, Junagadh. The collection was scored for branching pattern, stem hairiness, stem pigmentation, leaf color, peg color, standard petal color, leaf hairiness, nature of pegs, pod reticulation, constriction, beak and testa color, following the Groundnut Descriptor List (IBPGR and ICRISAT 1992). The seed storage protein bands were resolved on SDS-PAGE. The protein was extracted from defatted groundnut cake in 0.05 M Tris-HC1 buffer at pH 6.8 and was estimated using the Bradford method (1976). Equal amounts of protein (100 ug/well) were separated in 15% (T) polyacrylamide gel along with breeder seed and molecular weight markers as references. Electrophoresis was done at a constant current of 40mA and the gel was double stained with coomassie blue and silver stain.

The accessions showed similar descriptor states for a majority of the traits except for branching pattern, stem hairiness, and leaflet hairiness. The variation for branching pattern was limited to two accessions and for stem hairiness to one. Of the 23 accessions, 16 showed sparse long hairs on the upper surface and sparse short hairs on the lower surface of the leaflet. The remaining accessions had profuse long hairs on the upper surface and profuse short hairs on the lower surface. The seven variants for leaf hairiness included at least one accession from each of the states. The number of accessions with various descriptor states is given in Table 1.

The maximum resolution for seed protein profiles of the cultivars so far reported was 19 bands with molecular weights ranging from 18 to 66 kDa (Singh et al. 1994) but in the present study a better resolution of 24 bands (Fig. 1) was achieved. However, the banding pattern did not show any prominent variation among accessions despite the better resolution obtained. The number of bands in different molecular weight ranges were three bands lower than 18.55 kDa, five bands in the range 18.55-27.5 kDa, three in the range 27.5-32.5 kDa, six in the range 32.5-49.5 kDa, three in the range 49.5-80 kDa, and four between 80-106 kDa.

The study indicated uniformity for most of the traits including the electrophoretic pattern of storage proteins of seeds. From the results it appeared that the TMV 2 collected from different parts of south India had maintained homogeneity.

References

Annual Kharif Oilseeds Workshop of Groundnut. 1986. Proceedings of XXVIII Annual Kharif Oilseeds Workshop of Groundnut. Hyderabad, India: Directorate of Oilseeds Research.

Bradford, M.M. 1976. A rapid and sensitive method for quantitation of microgram quantities of protein utilizing the principle of protein-dye binding. Analytical Biochemistry 72:248-254.

IBPGR and ICRISAT. 1992. Descriptors for groundnut. International Board for Plant Genetic Resources, Rome, Italy; International Crops Research Institute for the Semi-Arid Tropics, Patancheru, India.

Ladizinsky, G., and Hymowitz, T. 1979. Seed protein electrophoresis in taxonomic and evolutionary studies. Theoretical and Applied Genetics 54:145-151.

Singh, A.K., Sivaramakrishnan, S., Mengesha, M.H., and Ramaiah, CD. 1991. Phylogenetic relations in section Arachis based on seed protein profile. Theoretical and Applied Genetics 82:593-597.

EMBRAPA Releases BRS 151 Amcndoim L 7, A Large-Seeded Groundnut Cultivar for the Northeast Region in Brazil

R C dos Santos (Leader of Groundnut Project, EMBRAPA, Agodao, CP 174, Campina Grande, PB, Brazil, CEP 58.107-720)

The Northeast region in Brazil occupies 18% of the area of the country, supports one-third of the population, and includes diverse agroecological, social, and economic situations. Its largest part has a semi-arid climate with the annual rainfall varying from 260 mm to 800 mm. Irregular rainy seasons, acid soils with low fertility, and midseason droughts commonly occur in this region.

Groundnut in the Northeast region occupies about 17% of the natural groundnut area and is grown by small-scale farmers. Valencia types are the main varieties accepted by the farmers. Many of them (80%) grow only cultivars with red testa color. The average pod yield is about 1.00 t ha^{-1}. Over the last five years, the area and production have shown an increasing trend reaching 7000 ha and 7500 t, respectively, in 1997. There is an increasing demand for shelled groundnut for natural

Table 1. Agronomic and nutritional characteristics of the BR 1 and BRS 151 Amendoim L 7 groundnut cultivars.

Characteristics	BR1	BRS 151 Amendoim L 7
Maturity	89	87
Days to flowering	22	21
Height of main stem (cm)	38-42	40-45
Stem and pegs colors	purple	green-purple
Seed color, shape, and size	red, round, medium	red, long, large
Pod beak, constriction, and reticulation	slight	moderate
Pods $plant^{-1}$	37	39
Seeds pod^{-1}	4	2
100-pod mass (g)	145-148	156-160
100-seed mass (g)	45-48	58-63
'Pops' (%)	9-12	10-12
Perfect seed (%)	84-95	85-92
Pod yield t ha^{-1} (rainy season)[1]	1.70	1.85
Pod yield t ha^{-1} (irrigated crop)[2]	3.50	4.50
Shelling percentage	72-75	70-73
Oil content in seed (%)	45	46
Protein content in seed (%)[3]	29	31
Protein content in defatted flour (%)	51	55
Water stress reaction[4]	Tolerant	Tolerant

1. Average from 27 trials carried out in the rainy season during 4 years.
2. Average from 8 trails carried out under irrigated conditions during 3 years.
3. (N x 5.46).
4. Water withheld for 30 days starting 15 days after emergence.

consumption in the region. The current demand exceeds 40 000 t in the regional market. The quality of the groundnut seeds produced in the Northeast region is excellent mainly because it is grown practically free of agrotoxics. Also, the high insolation in this region contributes to the flavor improvement of this crop.

In 1994, the Empresa Brasileira de Pesquisa Agropecuaria, Embrapa (Brazilian Company of Agricultural Research) released BR 1, a short-season cultivar with medium-sized seeds and red testa for the Northeast. The average pod yield of BR 1 is 1.70 t ha^{-1} with a shelling percentage of 72%. There is an increasing demand for a large-seeded groundnut cultivar. To meet this demand, in 1998 the Embrapa Agodao will release a new short-season groundnut cultivar, BRS 151 Amendoim L 7, which has large-seeded, elongated seeds with a red testa. This cultivar is a bunch type and was obtained by hybridization between a high-yield genotype (IAC TUPA) and a short-season cultivar from Senegal (55-437), using a modified pedigree method. In regional yield trials, where evaluation was made under different agroecological conditions in five states of the Brazilian northeast, BRS 151 Amendoim L 7 showed high yield potential, early maturity, and tolerance to drought. The average pod yield of this cultivar in the rainy season was about 1.85 t ha^{-1}. Although, this cultivar was developed for the dry region, its best performance was obtained under irrigated conditions (4.50 t ha^{-1}). As to the nutritional quality of the seed, BRS 151 Amendoim L 7 contains low oil and high protein in its defatted flour. The agronomic and nutritional characteristics of BR 1 and BRS 151 Amendoim L 7 are shown in Table 1.

Evaluation of Advanced Groundnut Breeding Lines for Resistance to Kalahasti Malady (*Tylenchorhynchus brevilineatus*)

R P Vasanthi, J Ramachandra Reddy, and P Harinath Naidu (Regional Agricultural Research Station, Acharya N G Ranga Agricultural University, Tirupati 517 502, Andhra Pradesh, India)

Kalahasti malady, locally called 'Chittikaya Tegulu' is a severe problem during postrainy seasons in some pockets of Chittoor, Nellore, and Prakasam districts in Andhra Pradesh. When this occurs in severe form, the affected pods are reduced in size with black discoloration on the outer shell. Yield losses of up to 50% can occur in severe cases. Reddy et al. (1984) reported that the stunt nematode, *Tylenchorhynchus brevilineatus*, was associated with affected pods in the endemic areas of Kalahasti malady. More than 1600 groundnut genotypes were screened against the malady and 33 genotypes were reported as resistant (Mehan and Reddy 1988). TCG 1518, a Virginia bunch genotype, was one with acceptable agronomic characters. TCG 1518

Table 1. Performance of 23 advanced breeding lines for yield, yield attributes, and Kalahasti malady resistance.

Genotype	Pod yield ($t\ ha^{-1}$)	Seed yield ($t\ ha^{-1}$)	Days to 50% flowering	Days to maturity	Shelling (%)	100 pod mass (g)	100-seed mass (g)	Sound mature kernel (%)	Score for Kalahasti malady
(TCG 1706 xTCG 1518)-9	3.19	2.23	34	110	70	85	40	70	2.5
(TCG 1706 x TCG 1518)-10	2.70	2.03	34	110	75	94	35	65	3.0
(TCG 1706 x TCG 1518) -14	3.35	2.35	34	110	70	75	25	54	2.5
(TCG 1706 x TCG 1518)-18	3.44	2.58	35	118	75	85	35	70	2.5
(TCG 1706 x TCG 1518)-8	3.53	2.65	35	118	75	95	35	83	2.5
(TCG 1706 x TCG 1518)-29	3.30	2.31	36	110	70	85	35	76	4.0
(TCG 1706 x TCG 1518)-36	2.75	2.06	35	110	75	90	35	87	3.0
(TCG 1709 x TCG 1518)-19	3.15	2.05	34	110	65	110	45	74	4.5
(TCG 1709 x TCG 1518) - 44	3.71	2.60	35	118	70	90	45	77	3.5
(TCG 1709 x TCG 1518) - 41	3.38	2.54	35	118	75	85	30	70	2.5
(TCG 1709 x TCG 1518)-7	3.94	2.56	34	110	65	70	30	79	2.5
(TCG 1709 x TCG 1518) -18	4.00	2.80	34	110	70	85	40	74	2.5
(TCG 1709 x TCG 1518)-54	3.27	2.29	35	110	70	85	40	75	2.0
(TCG 1709 x TCG 1518)-6	3.71	2.71	34	110	73	87	35	-72	3.5
(TCG 1709 x TCG 1518)-40	2.98	2.08	34	110	70	85	30	71	2.5
(TCG 1709 x TCG 1518)28	3.67	2.30	35	118	65	75	40	71	3.0
(TCG 1709 x TCG 1518)-8	3.43	2.23	35	118	65	70	30	67	2.0
(TCG 1709 x TCG 1518)-22	3.10	2.17	34	110	70	85	30	55	2.5
(TCG 1709 x TCG 1518) -21	3.09	2.30	34	110	75	85	40	78	2.5
(TCG 1709 x TCG 1518)-35	3.29	2.30	34	110	70	85	40	66	3.0
(TCG 1709 x TCG 1518)-15	3.60	2.55	35	110	71	79	30	69	2.5
(TCG 1709 x TCG 1518) -1 la	3.44	2.58	35	110	75	60	30	77	2.5
(TCG 1709 x TCG 1518)-23	3.33	2.33	35	110	70	55	25	61	2.5
Controls									
Tirupati 2 (TCG 1706)	2.86	2.14	30	110	75	78	35	79	3.0
Tirupati 3 (TCG 1518)	3.24	2.27	37	125	70	90	40	63	2.0
JL 24	2.76	1.95	34	110	70	80	35	77	4.0
CD (0.05)	0.49								
CV (%)	3.78								

matures in 125-130 days with a yield potential of 3000-4000 kg ha^{-1} during the postrainy season. This was released during 1990 as Tirupati 3 as a short term measure, for hotspot areas of Kalahasti malady. However, farmers require a variety with a shorter duration than Tirupati 3, one that matures in 105-110 days to fit into the cropping system of those areas.

A hybridization program was taken up between Tirupati 3 as donor parent and high-yielding Spanish bunch lines with a shorter duration of 105-110 days. In the present study, the advanced breeding lines developed through hybridization and selection were evaluated for their resistance to Kalahasti malady, their yield, and yield attributes along with three local control varieties, Tirupati 2, Tirupati 3, and JL 24. The experiment was laid out in a randomized block design with three replications during 1993-94 in a hotspot area at Andhra Pradesh State Seed Development Corporation Farm, Srikalahasti. A spacing of 30 cm between rows and 10 cm between plants was maintained. The normal recommended package of practices was followed. The lines were scored for Kalahasti malady at the time of harvest on a 1-5 scale [1-2 resistant (1-25% damage), 2.1-3 (moderately resistant (26-50% damage), 3.1-4 susceptible (51-75% damage), and 4.1-5 highly susceptible (more than 75%)]. The data on yield and yield attributes were also recorded.

Two genotypes (TCG 1709 x TCG 1518) -54 and (TCG 1709 x TCG 1518)-8 were resistant to Kalahasti malady with a disease score of 2.0. These two entries matured in 110 days with pod yields of 3.27 and 3.43 t ha^{-1}, respectively (Table 1). The susceptible control variety, JL 24, recorded a disease score of 4.0 with a pod yield of 2.76 t ha^{-1}. Seventeen genotypes matured in 110 days. (TCG 1709 x TCG 1518)-18, a moderately resistant genotype, gave the highest pod yield of 4.00 t ha^{-1} followed by (TCG 1709 x TCG 1518)-7 (3.94 t ha^{-1}). The resistant variety, Tirupati 3, gave a pod yield of 3.24 t ha^{-1}. Susceptible genotypes gave lower pod yields. One genotype, (TCG 1709 x TCG 1518)-19, though susceptible, recorded the highest 100 pod mass (100 g), highest 100 kernel mass (45 g), with a pod yield of 3.15 t ha^{-1} and shelling turnover of 65%.

The resistant genotypes, (TCG 1709 x TCG 1518)-54 and TCG 1709 x TCG 1518)-8 and moderately resistant genotypes, (TCG 1709 x TCG 1518)-18 and (TCG 1709 x TCG 1518)-7 may be very useful to farmers. However, before their recommendation to farmers, further testing of these varieties in farmers' holdings with high incidence of the disease will be necessary.

References

Reddy, D.D.R., Subramanyam, P., Sankara Reddy, G.H., Raja Reddy, C., and Siva Rao, D.V. 1984. A nematode disease of peanut caused by *Tylenchorhynchus brevilineatus.* Plant Disease 68:526-529.

Mehan, V.K., and Reddy, D.D.R. 1988. Investigations on a nematode disease of groundnut caused by *Tylenchorhychus brevilineatus.* Groundnut Pathology Progress Report no. 19. Patancheru 502 324, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics.

Evaluation of Advanced Groundnut Lines for Resistance to Late Leaf Spot

R P Vasanthi and P Harinath Naidu (Regional Agricultural Research Station, Acharya N G Ranga Agricultural University (ANGRAU), Tirupati 517 502, Andhra Pradesh, India)

Late leaf spot (LLS) (*Phaeoisariopsis personata*) is a major fungal disease of groundnut during the rainy season in India. Subramanyam et al. (1982) have reported that LLS in combination with rust have caused considerable yield loss (20-50%). Chemical control is expensive and may not be within the reach of dryland farmers. Resistant varieties have been identified and developed (Subramanyam et al. 1995) and used in a hybridization program. One resistant source, NC Ac 17090, was used as a donor parent. Selections were made in segregating generations and phenotypically uniform selections were included in the present study.

Twenty-six breeding lines, designated as TCGSs 132 to 157, and two control varieties, were studied in a randomized block design with three replications during the 1993 rainy season at the Regional Agricultural Research Station (ANGRAU), Tirupati. The genotypes were screened at 70 and 90 days after sowing (DAS) under natural field conditions, and mean scores of 90 DAS were reported. The genotypes were grown in three rows of 5 m length. A spacing of 30 cm between rows and 10 cm between plants within a row was adopted. Infector rows of susceptible genotype, TMV 2, were grown on either side of the test entry to accelerate the disease development and for uniform inoculum distribution. The data on yield and yield attributes were recorded.

Table 1. Reaction of 26 groundnut genotypes to late leaf spot, and their yield and yield attributes at Regional Agricultural Research Station, Tirupati, Andhra Pradesh, India.

Genotype	Late leaf spot[1]	Pod yield ($t\ ha^{-1}$)	Shelling outturn	100-pod mass (g)	100-kernel mass (g)	Sound mature kernel (%)
TCGS 132	5.0	1.02	60	63.0	24	80
TCGS 133	6.6	1.16	68	67.0	27	88
TCGS 134	3.6	1.11	68	83.0	31	83
TCGS 135	5.6	1.05	66	78.0	30	74
TCGS 136	5.6	1.29	71	73.0	27	89
TCGS 137	5.6	1.14	67	78.0	31	83
TCGS 138	6.0	0.87	71	70.0	28	83
TCGS 139	4.6	1.03	78	78.0	34	72
TCGS 140	5.6	1.31	65	63.0	26	79
TCGS 141	5.6	0.85	69	82.0	29	73
TCGS 142	6.6	1.39	69	77.0	32	76
TCGS 143	5.3	1.41	65	77.0	29	86
TCGS 144	5.0	0.94	67	73.0	25	83
TCGS 145	4.6	1.19	67	85.0	29	88
TCGS 146	5.6	0.87	67	65.0	25	77
TCGS 147	8.3	1.23	70	90.0	25	89
TCGS 148	6.3	1.53	71	73.0	33	90
TCGS 149	6.0	1.41	78	73.0	31	90
TCGS 150	8.0	1.89	71	90.0	36	90
TCGS 151	7.3	1.43	73	65.0	33	88
TCGS 152	6.0	1.35	73	78.3	31	89
TCGS 153	8.0	1.64	68	75.0	33	88
TCGS 154	6.6	1.42	70	78.0	30	86
TCGS 155	7.0	1.72	70	78.3	33	88
TCGS 156	5.3	1.48	70	78.3	30	90
TCGS 157	7.3	1.38	70	57.7	31	85
JL 24 (control)	8.0	1.20	71	77.7	31	84
Tirupati 1 (control)	8.6	1.22	77	58.3	25	94
SE		±0.12		±3.8	±1.0	
CD (P = 0.05)		0.36		10.6	2.7	
CV (%)		17		7.1	4.6	

1. Scored on a modified 9-point disease scale where 1 = no disease, and 9= 81-100% foliage damaged.

Table 1 shows seven genotypes (TCGSs 132, 134, 139, 143, 144, 145, and 156) were moderately resistant to late leaf spot (4-5 on a 1 to 9 scale). Among these, two genotypes (TCGSs 143 and 156) could significantly outyield the highest-yielding susceptible control, Tirupati 1 ($1.22 \pm 0.12\ t\ ha^{-1}$) with pod yield of 1.41 and 1.48 $t\ ha^{-1}$. TCGS 156 is also comparable with Tirupati 1 in shelling percentage and sound mature kernel percentage. On the contrary, the susceptible genotype, TCGS 150, gave the highest pod yield (1.89 $t\ ha^{-1}$), and was comparable with Tirupati 1 in ancillary traits. In spite of its high susceptiblity to LLS, TCGS 150 showed some tolerance to LLS. It can be further crossed with low-yielding LLS-resistant lines such as TCGS 139 to combine higher resistance with an improved genetic background. From this study it is clear that it is possible to develop high-yielding lines with moderate disease resistance (LLS). Wynne et al. (1991) reviewed the results of breeding programs for disease resistance and concluded that the lines developed through hybridization had moderate levels of resistance with high yield.

References

Subramanyam, P., McDonald, D., Gibbons, R.W., Nigam, S.N., and Nevill, D.J. 1982. Resistance to rust and late leafspot diseases in some genotypes of *Arachis hypogaea.* Peanut Science 9:6-10.

Subramanyam, P., McDonald, D., Waliyar, F., Reddy, L.J., Nigam, S.N., Gibbons, R.W., Ramanatha Rao, V., Singh, A.K., Pande, S., Reddy, P.M., and Subba Rao, P.V. 1995. Screening methods and sources of resistance to rust and late leafspot of groundnut. Information Bulletin no. 47, Patancheru 502 324, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics. 24 pp.

Wynne, J.C., Beute, M.K., and Nigam, S.N. 1991. Breeding for disease resistance in Peanut (*Arachis hypogaea* L.). Annual Review of Phytopathology 29:279-303.

Fixing the Sublethal Dose for Sodium Azide on Groundnut

R K Mathur, P Manivel, H K Gor, and B M Chikani (National Research Centre for Groundnut, P O Box 5, Ivnagar Road, Junagadh 362 001, Gujarat, India)

Both physical and chemical mutagens are being used in mutation breeding in groundnut. The lethal dose (LD_{50}) is the first information available to a plant breeder to initiate any mutation experiment. Mouly et al. (1986) reported that irradiation in the range of 20-30 kR, was close to LD_{50}, depending on the factors influencing the radiosensitivity at the time of mutagen treatment, whereas, in cases of chemical mutagens, each chemical has a different dose for LD_{50} and it may change from species to species. In the present study, the LD_{50} of sodium azide for groundnut was assessed.

Well-filled seeds of Spanish groundnut *(Arachis hypogaea* subsp fastigiata var vulgaris) cv Girnar 1 were used in this study. The seeds were presoaked in water for 12 h. The presoaked seeds (100 seeds per treatment) were treated with different concentrations of sodium azide: 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, and 0.8%, for 2 h and 4 h in a completely randomized design (CRD) replicated three times. After the chemical treatment, the seeds were v/ashed thoroughly in running tap water for half an hour. The seeds were rolled in germination paper and kept in an incubator for 72 h at 30°C and 80% relative humidity. The number of germinating seedy was counted and the percent germination calculated. Probit analysis was done to find out the LD_{50} using the procedure suggested by Shunmugasundaram and Mukunthan (1986).

Table 1. Germination percentage of groundnut for different concentrations of sodium azide with two treatment times.

	Germination (%)	
Concentration (%)	2 hours	4 hours
0.1	64	44
0.2	61	43
0.3	53	29
0.4	40	20
0.5	25	7
0.6	21	1
0.7	13	0
0.8	15	0
Control	87	66
Mean	42	23
SE	±4.96	±5.32
CV (%)	4.79	4.39

Significant differences between the percent germination for different concentrations and lengths of treatments of sodium azide were observed. Table 1 shows there was a sharp decline in the germination percentage with increasing concentration and the increase in treatment period from two to four hours also caused a reduction in the germination percentage. In the 2 h treatment the percent germination with 0.3% sodium azide was 53.33% whereas with 0.4% concentration it was 40.0%. Probit analysis indicated that 0.41% concentration of sodium azide for 2 h as LD_{50}. However, for a 4 h treatment the percent germination was below 50% even with the lowest concentration used in this study (0.1%). Hence, the probit analysis could not be done for the 4 h duration and still lower concentrations could be tried for the 4 hour treatment. There was no germination in 0.7% sodium azide and above for the 4 h treatment.

From the present study it was concluded that the LD_{50} for sodium azide on groundnut was 0.41% for a 2 h treatment and may be below 0.1 % for a 4 h treatment.

References

Mouly, C., Kale, D.M., and Patil, S.H. 1989. Mutation research on groundnut in India. Pages 141-153 in

Recent advances in genetics and cytogenetics (Farook, S.A., and Khan, I.A., eds.). Hyderabad, India: Premier Pub House.

Shunmugasundaram, M., and Mukunthan, N. 1986. Statistical technique in entomological studies. Pages 483-542 in Sugarcane entomology in India (David, H., Easwaramoorthy, S., and Jayanthi, R., eds.). Coimbatore, Tamil Nadu, India: Sugarcane Breeding Institute.

Groundnut Breeding Through Mutation Techniques in China

Qiu Qingshu, Li Zhengchao, Shen Fuyu, Wang Chuangtang, and Miao Huarong (Shandong Peanut Research Institute, Laixi, Shandong 266601, P.R. of China)

Studies on the application of mutation techniques in groundnut breeding were initiated in the 1960s in China. The main research units are located in Shandong, Guangdong, Jiangxi, and Henan provinces. Although the study duration is short and the study scope limited, great achievements have been made in groundnut mutation genetics and breeding.

The main physical and chemical mutagens, such as ^{60}Co, ^{32}P, lasers, and ethyl methano sulfonate (EMS) have been used to treat dry seeds of groundnut to induce genetic mutations. Eleven new groundnut varieties, developed through direct selection of mutants (DSM), have now been released. The methods of combination of induced mutation with hybridization (CIMH), for example utilization of the mutants as crossparents, or utilization of physical and chemical mutagens-treated crossparents (male or female or both of the parents), were also used to breed new varieties. Twenty-two new groundnut varieties have been produced through CIMH (Table 1).

By 1996, 14.7% of the new groundnut varieties in China were produced through the methods of induced mutation or CIMH. The cumulative cultivated area (CCA) of these varieties accounts for 19.5% of the total CCA of groundnut varieties (Table 2). Vast economic and social benefits have been obtained through the mutation techniques mentioned above.

Table 2. Number and cumulative cultivated area (CCA) of groundnut varieties derived from mutants and hybridization in China (1950-1996).

	Varieties		CCA (10 000 ha)	
Breeding methods	No.	%	Total	%
DSM and CIMH	33	14.7	923.0	19.5
Hybridization only	192	85.3	3810.3	80.5
Total	225	100.0	4733.3	100.0

At present, in addition to utilization of the mutation techniques in selecting new groundnut varieties, Chinese breeders are increasing studies on genetics and the mechanisms of induced mutation to obtain new breakthroughs in both applied and basic studies on groundnut breeding by mutation.

Table 1. Number of new groundnut varieties developed by various induced-mutation techniques in China (1950-1996).

Mutation techniques	Before 1970	1971-75	1976-80	1981-85	1986-90	1991-96	Total no.
^{60}Co	–	-	2	-	4	2	8
Laser	–	-	-	-	-	1	1
Chemical mutagens	–	-	1	-	-	1	2
CIMH[1]	2	5	2	4	6	3	22
Total no.	2	5	5	4	10	7	33

1. Combination of induced mutation with hybridization.

High-Yielding Groundnut Genotypes for the North West Frontier Province, Pakistan

Ayub Khan[1] **and Muhammad Rahim** (Agriculture Research Station (North), Mingora, Swat, Pakistan. 1. Correspondence address: Vill: Qaldara (Dargai Phattak) P O Dargai, Malakand Agency, NWFP, Pakistan)

Groundnut in Pakistan is cultivated on about 0.1 million ha that produce 0.11 million t pods. North West Frontier Province (NWFP), contributes 11 % to the country's production. The crop in NWFP is grown entirely on rainfed land, where yields are low due, in part, to limited research and development. The varieties developed are not particularly suitable for rainfed cultivation and few efforts have been made to develop methods for conserving soil moisture. Thus, the crop plant is exposed to biotic and abiotic stresses that restrict its cultivation in the Maiakand Division of NWFP. For instance, the lack of moisture at critical stages of growth, and hard and dry soil conditions at peg penetration into the soil, are major problems in the expansion of groundnut area. Recently, a modest program to address these problems has been commenced. Thirteen varieties which can give high yields under the prevailing conditions have been evaluated. These varieties were screened during 1995 and 1996 at the Agriculture Research Station (North), Mingora, Swat (1150 asl, 72°21'E and 34°46'N), in a replicated (4 replicate) trial with a randomized complete block design. The plot size was 5 m x 1.8 m with inter- and intrarow space of 45 cm and 15 cm, respectively. Twenty-five kg ha^{-1} N, and 60 kg ha^{-1} P_2O_5 were applied at sowing. To enhance fruit set gypsum was applied in the standing crop at the flowering stage as its calcium component helps pod formation. The average rainfall recorded during the crop duration (May-Oct) in 1995 was 436.8 mm and in 1996 was 454.4 mm. Data on yield and traits contributing to yield were recorded and are reported in Table 1.

Of the 13 varieties, four varieties had tolerance to drought. These varieties gave high yields in both years compared with other varieties included in this trial. The average yield in the trial was 3470 kg ha^{-1} in 1995 and 3614 kg ka^{-1} in 1996. The variation in pod yield is attributed to variation in rainfall between these two years. In 1995, pod yield ranged from 2578 to 4085 kg ha^{-1} (Table 1). Among others, ICGS 99, BARD 699, Swat Phalli 96, and ICGS 18 produced significantly greater pod yields (4085, 3958, 3939, 3936 kg ha^{-1} respectively), than the local control, Banki (2578 kg ha^{-1}). In 1996, pod yield ranged from 2778 to 4216 kg ha^{-1}. Swat Phalli 96 (4216 kg ha^{-1}), ICGS 18 (4147 kg ha^{-1}), BARD 699 (4016 kg ha^{-1}) and ICGS 99 (4063 kg ha^{-1})

Table 1. Performance of groundnut genotypes at the Agriculture Research Station (North) Mingora, Swat, Pakistan, sown during the rainy seasons, 1995 and 1996, under rainfed conditions.

	Pod yield (kg ha^{-1})							
Variety	1995	1996	Mean	Maturity (Days)	Shelling percentage	100-kernel mass (g)	20 pod length (cm)	SMK (%)
ICGS 18	3936	4147	4042	155	60	38	48	91
ICGS 94	3560	3560	3704	165	64	64	42	95
ICGS 98	2830	3148	2989	176	52	42	42	78
ICGS 99	4085	4063	4074	163	64	64	50	85
BARD 699	3958	4074	4016	167	52	48	45	71
ICGS 102	3804	3704	3754	165	60	52	49	90
ICG 4993	3000	2963	2982	169	44	76	55	95
ICG 6403	3260	3518	3389	177	72	67	55	81
HYQ(CG)S 28	2830	3148	2989	164	40	63	58	91
PK 90098	3680	3827	3754	165	66	42	40	98
ICGS 100	3650	3842	3746	169	64	51	42	94
Swat Phalli 96	3939	4216	4078	155	64	62	44	89
Banki (local control)	2578	2778	2678	174	58	37	53	79
LSD 5%	268	377	351	3.7	4.3	3.2	5.0	4.1

retained their superiority in the experiment. Based on the pooled pod yield over two years, Swat Phalli 96 (4078 kg ha^{-1}), ICGS 99 (4074 kg ha^{-1}), ICGS 18 (4042 kg ha^{-1}). and BARD 699 (4016 kg ha^{-1}) were again the highest-yielding genotypes. However, the superiority in yield of these genotypes was not supported by other yield-attributing traits except maturity duration. ICGS 18 (155 days), Swat Phalli 96 (155 days), ICGS 99 (163 days) and BARD 699 (167 days) were early-maturing genotypes compared with the local variety Banki (174 days) (Table 1). The highest average shelling percentage (72%) was observed in the case of ICG 6403. ICG 4993 had the largest 100-seed mass (76 g). However, both were low yielding. Sound mature kernel (SMK) percentage in the four high-yielding lines ranged from 71-91%, but the highest SMK percentage (98%) was recorded in the case of PK 90098. There is an urgent need for short duration, drought-tolerant groundnut varieties to expand cultivation of the crop in the North West Frontier Province.

Interspecific Hybridization in the Genus Arachis

P Vindhiya Varman (Regional Research Station, Tamil Nadu Agricultural University, Vridhachalam 606 001, Tamil Nadu, India)

Wild *Arachis* germplasm is a potential source of genes for resistance to pests and diseases, shelling outturn, high oil content, and quality. Hence, interspecific hybridization has begun at Tamil Nadu Agricultural University (TNAU), Regional Research Station, Vridhachalam. The program and progress made are briefly described.

Collection of wild germplasm

The following wild species have been collected from ICRISAT, Patancheru, and TNAU, Coimbatore, and maintained for utilization in hybridization (Table 1).

Interspecific hybridization

So far, diploid species (2 n = 40) viz., *Arachis cardenasii, A. correntina, A. helodes, A. stenosperma, A. duranensis,* and *A. kempff-mercadoi* have been used as the pollen parent in crosses with Spanish bunch cultivars VRI 2, and VRI 4 of *Arachis hypogaea* (2 n - 40).

The triploids (2 n - 30) resulting from crosses with the first four species were runner types, vigorous, profusely branched, with abundant flowers, and generally sterile. They rarely set seeds by restitution of gametes. The number of pods obtained per plant ranged from 9-13. The F_2 plants had varying ploidy levels with hexaploids being most frequent.

The natural hexaploids (2 n = 60) of VRI 2 x A. cardenasii and VRI 4 x A. cardenasii were obtained from the respective triploids. The plants were robust with thicker stems and leaflets compared with the triploids. The leaves were dark green with uneven surfaces. The hexaploids were utilized as pollen parents and hybridization with *Arachis hypogaea* cultivars is in progress.

The triploids of VRI 2 x *A. cardenasii* were used as pollen parents and backcrossed to VRI 2. The pollen fertility of the hybrids ranged from 75-93%. There was a spectrum of variation observed in the BC_1 F_2 generation. The height of the main stem ranged from 9-37 cm. The number of branches varied from 31-79. Similarly, the variation for number of pods per plant was from 19-92. They were mostly single-seeded and a few were double-seeded with a very deep constriction. Backcrossing of triploids of *A. correntina and A. stenosperma* is in progress.

Table 1. Wild species collected as a source of germplasm.

Section	Species[1]
1. Arachis	*A. batizocoi (3), A. duranensis (3), A. stenosperma (1), A. spegazzinii (1), A. ipaensis (1), A. kuhlmannii (1), A. otavioi (1), A. helodes (1), A. villosa (1), A. correntina (1), A. cardenasii (2), A. kempff-mercadoi (1), A. monticola (1)*
2. Erectoides	*A. paraguariensis (1), A. rigonii (2)*
3. Caulorrhizae	*A. pintoi (2)*
4. Rhizomatosae	*A. glabrata (2)*
5. Extranervosae	*A. marginata (1)*
6. Triseminale	*A. pusilla (1)*

1. Numbers in parentheses refer to number of accessions in each species.

Arachis monticola, the tetraploid (2 n = 40) was used as a pollen parent and hybridized with VRI 2. From 971 cross-pollinations 201 pods were obtained. Nineteen F_1 hybrids were studied. The hybrids were runners in growth habit and took 150-170 days to mature. The number of primary branches varied from 9-12, the secondary branches from 16-19, and the tertiary branches from 56-63. The mean pod number per plant was 135 of which 65 were double-seeded. The F_3 progenies are under evaluation to identify high-yielding Virginia runner types with thin shells and high shelling outturn.

Synthetic autotetraploid

An aqueous solution of colchicine (0.4%) was applied to *A. stenosperma* at the two-leaf stage between 0800-0900 h for three consecutive days. Of 15 seedlings treated, only four plants with doubled chromosomes were obtained. The induced autotetraploid is being utilized in hybridization with *A. hypogaea.*

Advanced generations

One hundred and twenty-five advanced generation progenies of stable interspecific tetraploids involving *A. cardenasii* are under evaluation. The progenies are mostly Virginia bunch and a few are Valencia type in growth habit. High levels of resistance to such foliar diseases as early leafspot (*Cercospora arachidicola*), late leaf spot (*Phaeoisariopsis personata*), and rust (*Puccinia arachidis*) are incorporated in these progenies. On a 1-9 scale (where 1 = no disease, and 9 = 81-100% foliage damaged) they recorded scores of 3 for all the three diseases compared with 7-8 for TMV 10 and Kadiri 3 (controls).

Virginia bunch culture VG 9516 (125 days) is currently included in national yield trials. VG 9513 and VG 9514 are extra early (100 days) Virginia bunch cultures which are included in multilocation trials in Tamil Nadu.

Acknowledgement. The author wishes to thank A K Singh, Senior Scientist, ICRISAT-Patancheru, for the supply of wild species. The financial support rendered by the Indian Council of Agricultural Research (ICAR) for this program is also gratefully acknowledged.

Kadiri 4: A High-Yielding, Short-Duration Groundnut Cultivar for the Postrainy and Summer Seasons: A Boon to Rayalaseema Farmers of Andhra Pradesh, India

C D R Reddy, P N Reddy, M V Reddy, P Ramesh Babu, A Munendra Babu, and M Lavakumar Reddy (Agricultural Research Station, Acharya N G Ranga Agricultural University, Kadiri 515 591, Andhra Pradesh, India)

In Rayalaseema, groundnut is the most important commercial rabi (Oct-Dec) and summer (Jan-Apr) oilseed crop, with a total area of 100 000 hectares. The crop is grown under limited irrigation conditions. Total production during these seasons in Rayalaseema is 190 000 t with a mean productivity of 1.9 t ha^{-1}. At present 20% of the rabi area is used for groundnut crops. Of late an almost equal area has been brought under sunflower cultivation. However, sunflower requires higher doses of fertilizers thereby increasing the input cost. There will be a large depletion of micro- and macronutrients from the soil if sunflower is rotated year after year. Damage to seed in the heads from insect pests and birds is very high and farmers can expect lower monetary returns. In the present scenario of protecting soil deterioration, maintaining the eco-soil environmental balance, and striving for sustainable crop production technologies, it is preferable to grow safer, economical, and more remunerative commercial crops such as groundnut. In this context there is scope for an increase in the rabi/summer groundnut area, production, and productivity in Rayalaseema districts by appropriate choice of a high-yielding and short-duration groundnut variety for rabi/summer.

K 150 was released as Kadiri 4 for general cultivation for rabi/summer in Andhra Pradesh by the State Varietal Release Committee during 1995. It is a Spanish bunch type maturing in 100 -105 days in rabi/summer. It is derived from a cross between Dh 3-30 and NC Ac 2230 and is a short-statured plant type with restricted growth. The average height of the main axis in rabi/summer is 15.5 cm. It has light green foliage with ovate to obovate leaflets and the pegs are strong and sturdy with uniformity at maturity and all the pods are clustered around the main tap root in the soil. Pods are medium in size with prominent reticulation and prominent beaks. Pod constriction is shallow. Pods are mostly 2-1 seeded and the testa is flesh coloured. The average shelling percentage is 72.3%, and it has 48% oil content.

K 150 was evaluated during 1990-93 rainy seasons at the Agricultural Research Station, Kadiri, along with controls (JL 24 and TMV 2). It recorded a mean pod yield of 1.72 t and kernel yield of 1.24 t. The average pod and kernel yield was 13% and 19% more than JL 24. In rabi seasons (1992-93 to 1993-94), it produced mean pod and kernel yields of 3.50 and 2.45 t which was 25.0% and 20.5% greater than JL 24. In adoptive minikit trials during rabi 1992-93, when evaluated at six locations in each of the four districts of Rayalaseema, the pod yield of K 150 ranged from 1.95 to 2.75 t with an increase ranging from 10% to 30% over JL 24. In front-line demonstration trials in farmers' fields conducted at three locations during the 1993-94 rabi season, K 150 produced an average pod yield of 3.66 t, which was 32% over JL 24. K 150 has a relatively high (0.50) harvest index compared with JL 24 (0.40). Because of its shorter duration, its water requirements during rabi/summer are low compared with other local varieties.

In national trials during 1991-92 to 1993-94, K 150 produced an average pod and kernel yield of 3.02 and 2.21 t, respectively, which was 24% and 26% greater than JL 24. K 150 showed field resistance to peanut bud necrosis disease. Based on its overall performance, K 150 was recommended for release in Zone-IV (Berhampore, Chiplima, Jhargram, and Kanke) for the rabi season, and has potential as a parent in hybridization programs.

Pathology

Management of Collar Rot Disease of Groundnut by Seed Treatment with Growth Regulators - an Alternative Approach

S Dasgupta, S K Raj, and S Das (Department of Plant Pathology, Faculty of Agriculture, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur 741 252, West Bengal, India)

Preemergence seed rotting, and damping off and mortality of seedlings known as collar rot, caused by *Aspergillus niger* van Teighem, are widespread in groundnut. Mature plants are also attacked by the fungus leading to the permanent wilting of branches or the entire plant. Several workers have tried to manage this disease by seed dressing with different fungicides (Sidhu and Chohan 1971, Whitehead and Thirumalachar 1971, Mathur and Sharma 1971, Aulakh and Chohan 1974). However, it was observed that seed dressing provided protection only for a limited period. Wadibhasme et al. (1991) reported that six foliar sprays of carbendazim (0.1%) + phosphamidon (0.2%) at 10-day intervals protected the crop from damping off. Application of fungicides to soil and plants can cause soil and air pollution hazards for animals, man, and beneficial rhizosphere microorganisms. The present experiment was, therefore, designed to identify a suitable growth regulator as an alternative to fungicide seed dressing against preemergence seed rotting and collar rot disease in groundnut.

Groundnut cultivar Phule Pragati (cv JL 24), susceptible to collar rot disease, was sown in 2 x 5 m^2 plots in a randomized block design with three replications. Five growth regulators, Chitosan (1.0%; 0.3%, and 0.1%); Cycocel (10^{-3} M and 10^{-4} M); indoleacetic acid (10^{-5} M); 2,4-dichlorophenoxyacetic acid (10^{-6} M), and 2,4,5-trichlorophenoxyacetic acid (10^{-6} M) were used in varying concentrations. Before sowing, seeds were surface-sterilized and then soaked for 24 h in solutions of required concentrations of growth regulators in distilled water. Seeds soaked in only distilled water were used as a control. In the field, land preparation was done by initial application of 12 t ha^{-1} compost during plowing. Recommended doses of NPK were used at sowing and earthing up of the crop. A seven-day-old culture of A. niger, grown in sand-maize meal medium, was mixed with double sterilized soil in a 1 : 1 ratio to obtain the inoculum mixture. Inoculation with A. niger was done at sowing.

Preemergence seed rotting was recorded after 15 days from sowing by counting the number of seeds germinated and the collar rot disease incidence was recorded up to 45 days after sowing by counting the plants infected. Growth characters were recorded 10 days before harvest and yields were recorded after harvest.

All growth regulators caused a significant reduction in collar rot incidence. Preemergence seed rotting was also significantly reduced by all growth regulators except Chitosan (1.0%) and 2,4,5-trichlorophenoxyacetic acid (10^{-6} M). Chitosan (0.3%) had the maximum reduction in preemergence seed rotting and Chitosan (0.1%) in collar rot incidence. These treatments also had a significant positive effect on nodule number, fresh weight of the plant (above ground), and pod yield per plant. Although the other growth regulators also reduced seed rotting and collar rot incidence, some of them had a deleterious effect on plant growth and plant

Table 1. Effect of seed soaking with growth regulators on preemergence seed rotting and collar rot disease incidence, growth characteristics and pod yield of groundnut.

Treatment	Concen-tration	Preemergence seed rotting (%)		Collar rot incidence (%)		Plant height (cm)	Root length (cm)	Number of nodules[1]	Number of leaflets plant^{-1}	Fresh mass of the plant[2] (g)	Pod yield plant^{-1}
Indoleacetic acid	10^{-5}M	27.5	(31.61)[3]	5.0	(12.87)	25.0	20.8	406	272	203.4	28.8
2,4-dichlorophenoxy acetic acid	10^{-6}M	27.5	(31.62)	10.0	(18.31)	18.6	19.6	309	228	182.0	22.0
2,4,5-trichlorophenoxy acetic acid	10^{-6}M	30.0	(33.19)	7.5	(15.76)	40.4	28.6	554	319	178.8	29.8
Cycocel	10^{-3}M	27.5	(31.55)	15.0	(22.69)	44.4	24.0	513	492	188.4	29.0
Cycocel	10^{-4}M	27.5	(31.59)	12.5	(20.67)	46.0	27.4	568	480	259.2	25.0
Chitosan	(1.0%)	30.0	(33.18)	5.0	(12.77)	34.6	32.0	886	330	240.8	29.5
Chitosan	(0.3%)	22.5	(28.30)	5.0	(12.88)	39.0	31.8	768	368	319.4	42.6
Chitosan	(0.1%)	25.0	(29.97)	2.5	(8.90)	39.4	25.0	657	337	274.8	37.2
Control (untreated)		32.5	(34.74)	25.0	(29.98)	40.2	27.0	605	357	201.8	19.1
SE		±1.82		±1.89		±2.42	±2.32	± 11.51	±9.41	± 12.13	±2.61
CD at 5%		3.85		4.00		4.75	4.91	24.40	19.95	25.71	5.53
CV (%)		7.05		13.55		8.18	10.40	2.42	3.27	6.55	10.98

1. Recorded on two plants.
2. Fresh mass of vegetative, above ground tissue.
3. Figures in parenthesis are average angular transformed values.

yield. For example, indoleacetic acid (10^{-5} M), 2,4-dichlorophenoxyacetic acid (10^{-6} M), and 2,4,5-trichlorophenoxyacetic acid (10^{6} M) adversely affected plant height, root length, and number of nodules and leaflets. From the present study, seed soaking in Chitosan (0.1%) solution appears to be more economic in controlling preemergence seed rotting and collar rot caused by *A. niger.*

The use of growth hormones in the management of diseases is not uncommon. In the case of sheath rot of rice, use of gibberelin reduces the disease incidence by conditioning the susceptible host cells so that they react similarly to the resistant host (Ghoshal and Purakayastha 1984). In the present study also, the growth regulators may have conditioned the host cells for a more vigorous and dynamic defence response to the pathogen.

References

Aulakh, K.S., and Chohan, J.S. 1974. Effect of seed treatment with fungicides during storage of groundnut in relation to collar rot incidence. Indian Phytopathology 27:371-374.

Ghoshal, A., and Purakayastha, R.P. 1984. Resistance of crop plants to fungal disease. Science and Culture 37:319-28.

Mathur, R.L., and Sharma, L.C. 1971. Field assay of seed dressing fungicides for germination of groundnut seed. Madras Agricultural Journal 58:199-202.

Sidhu, G.S., and Chohan, J.S. 1971. The field-scale testing of different fungicides for controlling collar-rot of groundnut in the Punjab. Journal of Research. Punjab Agricultural University, Ludhiana 8:211-213.

Wadibhasme, S.S., Ingole, O.V., and Wangikar, P.D. 1991. Chemical control of bud blight of groundnut caused by Aspergillus niger. Bioved 2:125-126.

Whitehead, M.D., and Thirumalachar, M.J. 1971. Effect of Aureofungin spray on the control of fungal diseases and *Aspergillus flavus* infestation in peanuts. Hindustan Antibiotic Bulletin 13:79-80.

Performance of ICRISAT's Groundnut Foliar Diseases-Resistant Breeding Lines in East Java, Indonesia

Nasir Saleh, Y Baliadi and N Nugrahaeni (Research Institute for Legumes and Tuber Crops (RILET), PO Box 66, Malang 65101, Indonesia)

The most important and widespread fungal diseases of groundnut in Indonesia are rust (*Puccinia arachidis)* and late leafspot (LLS) (*Phaeoisariopsis personata*). They cause heavy yield losses in groundnut and, therefore, are considered as limiting factors for the expression of groundnut yield potential. Heavy attacks of these diseases can suppress yield completely (McDonald et al. 1985, Subrahmanyan and McDonald 1984). However, crop losses are usually in the range of 40 to 70%, depending on inoculum level, host plant, crop growth stage, weather conditions at the time of infection, and cropping patterns adopted (Knauft et al. 1988).

Some fungicides are reported to reduce the LLS and rust diseases intensities and increase groundnut yield (Hardaningsih and Neering 1989, Hardaningsih et al. 1992). However, for socioeconomic reasons, chemical control is not practiced by farmers (Saleh 1995). Therefore, developing resistant cultivars is a very satisfactory means of reducing yield losses from the diseases. In Indonesia, research aimed at incorporating genetic resistance, and high yield, into cultivars with good agronomic and quality characters suited to different environments, is in progress.

A total of 65 foliar diseases-resistant lines, including interspecific derivatives, bred by ICRISAT were evaluated under field conditions to identify lines with high yield potential, and resistance to rust and LLS. The experiment was conducted at Jambegede Experimental Farm of the Research Institute for Legumes and Tuber Crops (RILET) during the dry season of May-October 1996. Two rows of each genotype were sown with 40 cm interrow and 10 cm intrarow spacings. The field was irrigated four times to keep the humidity suitable for rust and LLS development. The diseases were scored on a 1-9 scale following Subrahmanyan et al. (1995) 14 weeks after sowing.

LLS and rust incidences were high as revealed by the high scores of the diseases in the trial (range 4.5 to 8.0

Table 1. Diseases incidence and pod yield of selected groundnut genotypes, Jambegede, Indonesia, dry season 1996.

		Disease score[1]		Dry pod yield
Genotype	Pedigree	Late leaf spot	Rust	(g plant^{-1})
ICGV 94093	[(ICG(FDRS) 33 x EC 21135) x [(ICG(FD x J11)]	5.5	5.5	16.1
ICGV 94094	[(ICG(FDRS) 33 x EC 21135) x [(ICG(FD x J11)]	5.0	5.0	19.0
ICGV 94118	(J 11 x CS 52) x ICGV 86015)	5.0	5.0	17.1
ICGV 94124	(ICGV 87314 x NC Ac 343)	5.5	5.5	18.2
ICGV 95346	(Robut 33-1 x Pathology line)	5.0	5.0	18.9
ICGV 94097	(J 11 x CS 31)	5.5	5.5	26.0
ICGV 93218	(ICGV 87303 x ICGV 86031)	5.5	5.5	27.5
ICGV 87846	(CS 9 x ICGS 5)	5.0	5.0	17.1
ICGV 87860	(CS 11 x ICGS 4)	6.0	6.0	33.9
ICGV 87868	(Robut 33-1 x CS 9)	6.0	6.0	25.6
ICGV 88256	(CS 9 x ICGS 5)	5.5	5.5	46.7
ICGV 91223	[ICGV 87165 x (ICG 9516 x ICGS 30)]	5.0	5.0	20.0
ICGV 91227	(ICG 9764 x ICGS 50)	5.0	5.0	34.3
ICGV 91228	(ICG 9764 x ICGS 50)	4.5	4.5	32.0
Mahesa (Local control)		7.0	6.5	16.7
SE				±7.98
CV(%)				16.60

1. Score on a modified 9-point disease scale, where1 = 0% , 2 = 1 - 5% ,3 = 6 - 10%, 4 = 11 - 20%. 5 = 21 - 30%,6 = 31 -40%, 7 = 41-60%, 8=61-80%, and 9 = 81-100% foliage destroyed.

for both diseases). Among the 65 genotypes, ICGVs 94093, 94094, 94118, 94124, 95346, 94097, 93218, 87846, 88256, 91223, 91227, 91228, 87860, and 87868 were identified as moderately resistant to both LLS and rust (Table 1). ICGVs 87846, 88256, 91223, 91227, and 91228 were also reported resistant to both LLS and rust in the previous study (Nugrahaeni et al. 1997). The local control, Mahesa, scored 7.0 for LLS and 6.5 for rust. Mahesa was released for cultivation in 1991 and described as susceptible to leafspot and moderately resistant to rust (CRIFC 1993). ICGV 88256 also had significantly greater pod yield per plant than Mahesa. There are other high-yielding lines (ICGVs 87860, 91227,91228, and others) but the yield differences were not significant.

The resistant lines found from this experiment could be used as source for developing cultivars resistant to rust and LLS.

References

CRIFC. 1993. Description of Palawija (maize, sorghum, legumes and tuber crops) improved varieties. 1918-1992. Bogor, Indonesia: Central Research Institute for Food Crops. 155 pp. (in Indonesian).

Hardaningsih, S., and Neering, K.E. 1989. Pengendalian penyakit bercak daun dan karat pada kacang tanah. Pages 15-18 in Seminar Hasil Penelitian Tanaman Pangan Tahun 1989. Balittan Malang, Indonesia, (in Indonesian).

Hardaningsih, S., Saleh, N., and Neering. K.E. 1992. Pengendalian Kimiawi penyakit bercak daun dan karat kacang tanah di Tuban. Pages 77-81 in Risalah hasil penelitian kacang tanah di Tuban, Tahun 1991: seminar dilaksanakan di Tuban, 16 Nov 1991 (Adisarwanto, T., Sunardi, and Winarto, A., eds.). Malang, Indonesia: Balai Penelitian Tanaman Pangan Malang.

Knauft, D.A., Gorbet, D.W., and Norden,A.J. 1988. Yield and market quality of seven peanut genotypes as affected by leafspot disease and harvest date. Peanut Science 15: 9-13.

McDonald, D., Subrahmanyam, P., Gibbons, R.W., and Smith. D.H. 1985. Early and late leafspot of groundnut. Information Bulletin no. 21. Patancheru 502 324, A.P., India: International Crops Research Institute for the Semi-Arid Tropics. 19 pp.

Nugrahaeni, N., Purnomo, J., and Kasno, A. 1997. Evaluation of ICRISAT groundnut breeding lines on rainfed dryland at Muneng, Indonesia. Pages 17-29 in Yield improvement of legumes and cereal (groundnut, pigeonpea, chickpea, and sorghum): proceedings of Annual Review Meetings, CLAN/ICRISAT-CRIFC-AARD Collaborative Research, 1994-1996 (Mejaya, M.J., Nugrahaeni, N., Taufiq, A., Adisarwanto, T., and Suyamto, eds.). RILET Special Edition no. 11-1997. Malang, Indoensia: Research Institute for Legumes and Tuber Crops.

Saleh, N. 1995. Control of rust and leafspot diseases on groundnut. Pages 28-32 in On-farm research for-groundnut and pigeonpea production technique in Indonesia (Adisarwanto, T., Saleh, N., and Sumarno, eds.). Malang, Indonesia: Malang Research Institute for Food Crops.

Subrahmanyam, P., and McDonald, D. 1984. Rust disease of groundnut. Information Bulletin no. 13. Patancheru 502 324, A.P., India: International Crops Research Institute for the Semi-Arid Tropics. 15 pp.

Subrahmanyam, P., McDonald, D., Waliyar, F., Reddy, L.J., Nigam, S.N., Gibbons, R.W., Rao, V.R., Singh; A.K., Pande, S., Reddy P.M., and Rao. P.V.S. 1995. Screening methods and sources of resistance to rust and late leafspot of groundnut. Information Bulletin no. 47. Patancheru 502 324, A.P., India: International Crops Research Institute for the Semi-Arid Tropics. 20 pp.

Entomology

Indigenous Knowledge of Pest and Beneficial Arthropod Fauna on Sorghum and Groundnut in Burkina Faso

I O Dicko (Universite de Ouagadougou, 03 BP 7021 Ouagadougou-03, Burkina Faso)

Increasing insect pest damage, declining farmer income, and the necessity for environmental protection in developing countries, have compelled national governments and international donors to place a high priority on devising and implementing nonchemical pest control programs, including biological control. However, attempts to develop these programs are often made without prior evaluation of farmers' knowledge, appreciation, or acceptance. Farmers are excluded as it is thought that their indigenous knowledge systems are too simple and

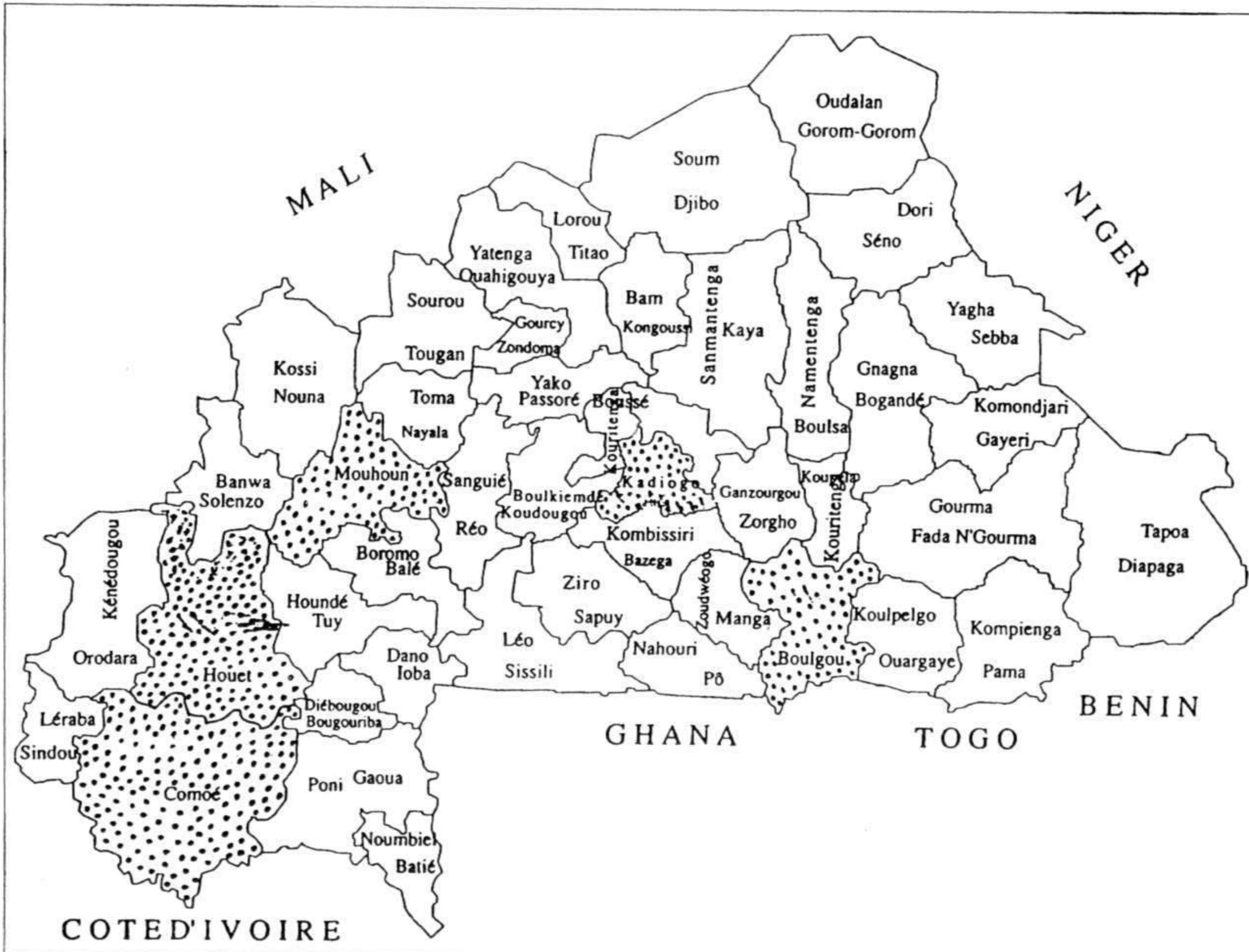


Figure 1. Geographical location of the five districts surveyed, Burkina Faso, 1996.

too static (Warren and Cashman 1988). As a result, few of the new programs, if any, have had a measurable impact on the improvement of small-farm pest management (Matteson et al. 1984).

The present study surveyed 244 farmers, 182 men and 62 women, selected from five sorghum and groundnut-producing districts in Burkina Faso (Fig. 1). The survey, carried out from July to December 1996, aimed at assessing indigenous knowledge of insect pest fauna on sorghum and groundnut, and their associated natural enemies. Overall control measures commonly used by farmers to protect their crops were also identified.

Results obtained indicated that farmers knew most of the key damaging insect pests on both crops. Ten pest groups were identified on sorghum and six on groundnut (Table 1). Except for jassids and thrips on groundnut, insect groups identified by farmers were also the major insect pests reported on sorghum by Young and Teetes (1977) and on groundnut by Lynch et al. (1986).

Table 2 shows that the farmers' knowledge of beneficial arthropods was totally restricted to predators. Despite great efforts made during the survey to describe in detail what a parasitoid is and does, not a single parasitoid appeared to be known to farmers. When asked if they had ever witnessed an insect laying eggs on, or exiting from another insect, farmers invariably answered either no or just seemed surprised by the question.

Of tens of predators reported to occur on sorghum and groundnut crops (Metcalf et al. 1962, Dicko 1989, Coderre and Vincent 1992), farmers knew only five predators: spiders, mantids, ants, predacious wasps, and earwigs.

Farmers do not perceive natural enemies, including the predators they know, as efficient control agents of insect pests of sorghum and groundnut. Consequently, they do not wish intentional introductions of predators or parasitoids to be made in their fields. Actually, they even solicited pesticides to get rid of spiders from their fields, as they believe spiders carry a skin disease known as "zona".

Farmers usually do not take active control measures against insect pests in sorghum and groundnut crops. When they do, insecticides are the most preferred control measure. According to farmers' own statements, most insecticides used were, unfortunately, acquired through the black market and were rarely pretested for efficacy and safety.

Results of this study indicated that, in contrast to their accurate knowledge of key pest insects, farmers in Burkina Faso know little of natural enemies and biological control. This study also suggests that, from the farmers' standpoint, insecticides are the most preferred measure for controlling insect pests, although there are at present no proven guarantees for their safe usage at the farm level. Therefore, it is urgent that farmers be

Table 1. Ranking of insect groups identified by farmers as major pests of sorghum and groundnut crops in Burkina Faso, 1996.

Sorghum		Groundnut	
Insect pest group	Rank	Insect pest group	Rank[1]
Aphids	1	Termites	1
Stem borers	2	Millipeds	2
Meloids	3	White grubs	3
Grasshoppers	4	Mylabris sp	4
Head caterpillars	5	Noctuid larvae	5
Poophilus sp	6	Grasshoppers	6
White grubs	7		
Termites	8		
Sorghum midges	9		
Mylabris sp	10		

1. Mean ranking by 244 fanners surveyed in five districts.

Table 2. Ranking of natural enemies (predators) identified by farmers as occurring in sorghum and groundnut fields in Burkina Faso, 1996.

Arthropod predator group	Rank[1]
Spiders	1
Mantids	2
Predacious wasps	3
Ants	4
Earwigs	5

1. Mean ranking by 244 fanners surveyed in five districts.

trained in the appropriate ways of selecting, handling, and applying pesticides. Not only will this help to prevent harmful poisoning, but also contribute to protecting the environment.

For biological programs to be more efficient, and to identify safer alternatives for controlling insect pests, appropriate training is also required to change the perception of farmers and increase their cognitive knowledge of natural enemies.

Acknowledgment. The financial support of the International Fund for Cooperation among French-speaking Universities, Fonds International de Cooperation Universitaire (FICU), is gratefully acknowledged.

References

Coderre, D., and Vincent, C. 1992. La lutte biologique: toile de fond de la situation Pages 3-18 *in* Gaetan Morin. Boucherville, Qu6bec, Canada: La lutte biologique.

Dicko, I.O. 1989. Occurrence and abundance of selected pest and beneficial arthropods in relation to peanut plant phenology, irrigation and insecticides. Ph.D. thesis, University of Georgia, Athens, Georgia, USA. 250 pp.

Lynch, R.E., Ouedraogo, A.P., and Dicko, I.O. 1986. Insect damage to groundnut in SAT Africa. Pages 175—183 *in* Agrometeorology of Groundnut. Proceedings of an International Symposium, 21-26 Aug 1985, held at ICRISAT Sahelian Center, Niamey, Niger. Patancheru 502 324, Andhra Pradesh, India: ICRISAT.

Matteson, P.C., Altieri, M.A., and Gagne, W.C. 1984. Modification of small farmer practices for better pest management. Annual Review of Entomology 29:383-402.

Metcalf, C.L., Flint, W.P., and Metcalf, R.L. 1962. Destructive and useful insects, their habits and control. 4th edn. New York, USA: McGraw-Hill. 1071 pp.

Warren, D.M., and Cashman, K. 1988. Indigenous knowledge for sustainable agriculture and rural development. Gatekeeper Series no. SA 10. London, UK: International Institute for Environment and Development. 46 pp.

Young, W.R., and Teetes, G.L. 1977. Sorghum entomology. Annual Review of Entomology 22:193-218.

Relative Toxicity of Some Plant Extracts to Groundnut Leaf Miner, Aproaerema modicella Dev.

K Sahayaraj[1], and **M G Paulraj**[2] (1. Department of Zoology, St. Xavier's College, Palayankottai 627 002, Tamil Nadu, India; and 2. Department of Botany, St. Joseph's College, Trichy 620 002, Tamil Nadu, India)

The leaf miner, *Aproaerema modicella* Dev. (Lepidoptera: Gelichiidae) is one of the most important pests of groundnut in south and southeast Asia. In these regions unrestrained application of chemical pesticides for pest control has created several complications. Among the alternative methods of control, use of plant products has proved ecologically sound and effective. Although studies on the role of neem *(Azadirachta indica)* products have been reported on groundnut (Ghewande et al. 1997), no attempt has been made to utilize *Pongamia glabra, and Calotropis giganta* effects on *A. modicella. Hence,* the present study was carried out to gain comprehensive information on the relative toxicity of three plant products to the last instar larvae of A. modicella.

A culture of *A. modicella* was maintained in the laboratory on field-collected groundnut leaves (cv TMV 7). The plant extracts tested here were prepared according to Nandagopal (1992) and Sahayaraj and Sekar (1996) with slight modifications. Ten grams each of the leaves of *A. indica, P. glabra, and C. giganta* were washed thoroughly (3-5 times) with tap water and once with distilled water. They were macerated individually in an all-glass pestle and mortar and extracted with a small quantity of distilled water. The extract was passed through muslin cloth and the final volume made up to 10 mL and this was treated as stock solution. Different concentrations (0.5, 1, 2, 4, and 6%), were prepared from the stock by adding distilled water. Equal and known amounts of groundnut leaves (cv TMV 7) were dipped in the different concentrations of the various plant extracts for 15 min. As a control, the leaves were dipped in distilled water only. The leaves were shade dried and were given to the last instar larvae of *A. modicella.*

Ten laboratory-reared last instar larvae were released in the plastic vials with treated leaves and covered with muslin cloth. Five replications were made for each treatment along with a set of controls. They were exposed continuously for a period of 4 days and the mortality was recorded at 24, 48, 72, and 96 h intervals. The corrected percentage of mortality under various treatments was calculated using Abbott's formula (Abbott 1925). The data were subjected to probit analysis to calculate LD_{50} and the fiducial limits (Finney 1971).

The results showed that all three plant extracts tested were toxic to the last instar larvae of *A. modicella.* It was clear that *C. giganta* was a more toxic compound than *P. glabra.* For example, 96 h after exposure, 75%, 72%, and 63% mortalities were observed in *C. giganta, A. indica* and *P. glabra,* respectively, with 6% concentration. Schmutterer (1990) and Ghewande et al. (1997) reported that the persistence of toxicity of neem-based products was 12 days. The percentage mortality increased with concentration and also with duration of exposure.

For 96 h exposure, the calculated LD_{50} values of neem were 1.223%, calotropis 2.429%, and pongamia 2.944%. From these LD_{50} and the upper and lower fiducial limit values, it was clear that pongamia was the least toxic plant product to the *A. modicella.* Schmutterer et al. (1983) reported that larval and pupal mortalities of leaf miners were not affected by the neem products (purified neem seed extracts). In contrast, in the present findings, neem leaf extract caused high mortality except in the 6% concentration and LD_{50} value was 1.986 times lower than calotropis and 2.407 times lower than pongamia plant extracts. From this it was clear that A. indica was the most toxic plant product followed by *C. giganta* and *P. glabra.* Though *C. giganta* caused higher mortality, its LD_{50} value was moderate. Hence further laboratory investigations are necessary to follow up these findings. Blackening of the body, breaking of cuticle and oozing out of body fluid, small-sized pupae, and death during moulting were the other direct effects observed on treated larvae. Being safer than conventional insecticides, the plant products will fit well in the pest management of groundnut crops.

Acknowledgment. This work was entirely supported by the Department of Science and Technology (DST), New Delhi (HR/OY/Z13/96). The authors also wish to thank Rev Dr S J Britto, S J, Principal, Dr R Selvaraj, Head of the Department of Botany, and Dr M P Gomez, Head of Zoology, St. Joseph's College, for facilities.

Table 1. Effect of three plant extracts on the mortality of the final instar larvae of Aproaerema modicella.

Plant	Concentration (%)	Mortality after 96 h (%)	LD_{50}	Regression equation	Variance
Neem	0.50	42	1.223	Y=0.655x+4.29	0.0181
	1.00	48			
	2.00	52			
	4.00	60			
	6.00	72			
Pongamia	0.50	20	2.944	Y=1.073X+3.42	0.0070
	1.00	30			
	2.00	46			
	4.00	54			
	6.00	63			
Calotropis	0.50	5	2.429	Y = 1.912 x + 2.35	0.0033
	1.00	35			
	2.00	45			
	4.00	60			
	6.00	75			

References

Abbott, W.S. 1925. A method of computing the effectiveness of an insecticide. Journal of Economic Entomology 18:265-267.

Finney, D.J. 1971. Probit analysis. 3rd edn. Cambridge, UK: Cambridge University Press. 333 p.

Ghewande, M.P., Nandagopal, V., and Desai, S. 1997. Groundnut research. Chapter 7 in Neem in sustainable agriculture (Narwal, S.S., Tauso, P., and Bisla, S.S., eds.). Jodhpur, Rajasthan: Scientific Publishers.

Nandagopal, V. 1992. Studies on integrated pest management in groundnut in Saurashtra. Ph.D. thesis, Saurashtra University, Rajkot, India. 246 pp.

Sahayaraj, K., and Sekar, R. 1996. Efficacy of plant extracts against tobacco caterpillar larvae in groundnut. International Arachis Newsletter 16:38.

Schmutterer, H. 1990. Properties and potential of natural pesticides from the neem tree, Azadirachta indica. Annual Review of Entomology 35:271-297.

Schmutterer, H., Saxena, R.C., and Rayde, J.V. 1983. Morphogenetic effects of partially purified fractions and methoholic extracts of neem seeds on the *Mythimina separata* (Walker) and *Chaphalocrosis medinalis* (Guenee). Journal of Applied Entomology 95:230-237.

Screening Groundnut Mutants for Resistance to *Spodoptera litura* and Thrips

M N Rajendra Prasad, M V C Gowda, and **R K Patil** (Department of Genetics and Plant Breeding, University of Agricultural Sciences, Dharwad 580 005, Karnataka, India)

Spodoptera litura (F.) is a polyphagous, foliage-feeding insect distributed throughout south and southeast Asia and Australia. In India, S. litura has been reported as an increasingly important pest of groundnut during the rainy season causing yield losses up to 71% in Karnataka and Andhra Pradesh (Amin 1983). Similarly, in the postrainy season, thrips (Thrips *palmi*, *Frankliniella schultzei*, and *Scirtothrips dorsalis*) attain pest status in groundnut as sap feeders or vectors of viruses causing widespread crop losses. Insecticides often fail to give effective control of these pests. The development of resistant groundnut cultivars has been proposed as a potential option for integrated pest management of groundnut in India. Though the research efforts have been successful in identifying the resistant germplasm to *S. litura* (Patil et al. 1991) and thrips (Wightman and Ranga Rao 1994), most of them possess other undesirable features, making them unsuitable for direct utilization. In our laboratory, on artificial mutagenesis with ethyl methane sulphonate (EMS), Dharwad Early Runner (DER) yielded many Valencia mutants. On subsequent mutagenesis with EMS, one of these mutants, VL 1, yielded many foliar diseases-resistant mutants (Motagi et al. 1996). Some of these mutants were apparently resistant to *S. litura* and thrips also. In the present study 22 mutants along with parents and controls (Table 1) were systematically screened for damage due to *S. litura* and thrips during the rainy and postrainy seasons of 1996.

Each genotype was sown in a 2-m row with an interrow spacing of 30 cm and intrarow spacing of 10 cm in a randomized block design during the rainy season 1996 for *S. litura* and the 1996 summer for thrips. The experiment was replicated twice and the

Table 1. Screening groundnut mutants for *S. litura* (rainy season) and thrips (postrainy season), University of Agricultural Sciences, Dharwad, Karnataka, India, 1996.

Genotypes	DS[1]	DT[2]	NT[3]
Mutants			
28-1	18.6	21.3	6.4
28-2	12.1	19.2	3.1
45	14.8	22.8	5.3
98-1	28.4	37.0	10.6
110	31.0	27.9	8.9
110 -1	27.6	31.3	8.8
172	29.3	15.6	0.9
Parents			
VL 1	40.5	34.7	9.3
DER	46.9	46.1	8.7
Controls			
JL 24	40.6	46.7	13.3
GBFDS 272	29.3	29.7	8.3
Mean (26 genotypes)	36.7	36.3	9.0
SEm	±3.4	±5.2	±1.0
CD 5%	9.6	15.2	3.0
CV (%)	18.6	20.8	16.9

1. DS = Damage due to *S. litura* (%).
2. DT=Damage due to thrips (%).
3. NT = Number of thrips.

crop was raised under unprotected conditions. Artificial infestation of *S. litura* was created by pinning an egg mass on each line. The top five leaflets on the main stem of five randomly selected plants were scored at 60 days as the damage was confined to the top leaves. The percent leaf area damaged was visually assessed and the mean calculated as per Leuk et al. (1967). The 45-50 day-old postrainy crop was screened under natural incidence of thrips. Five unopened terminal buds of five randomly selected plants in a row were taken and thrips (adults and nymphs) counted (Tappan and Gorbet 1979). Malformed yellow symptoms on leaves were visually assessed in the top five leaves on five randomly selected plants and the mean calculated.

The mutants 28-1, 28-2, 45, and 110 -1 indicated a high level of resistance to 5. litura based on percent leaf area damaged. Other mutants, 98-1, 110, and 172 were comparable with resistant control GBFDS 272. The mutants 28-1, 28-2, 45, 110, and 172 were resistant to thrips as indicated by damage and the number of thrips. Thus the mutants 28-1, 28-2, and 45 were found to be resistant to both *S. litura* and thrips.

The Spanish bunch mutants 28-2, 45, and 110 were earlier reported to be resistant to leaf spot and/or rust (Motagi et al. 1996), besides having good pod and kernel attributes. These mutants also mature earlier by 10 -15 days compared with GBFDS 272. Hence, the multiple resistance in these mutants could be exploited in future breeding programs.

References

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

Leuk, D.B., Hammons, R.O., Morgan, L.W., and Harvey, J.E. 1967. Insect preference for peanut varieties. Journal of Economic Entomology 60:1546-1549.

Motagi, B.N., Gowda, M.V.C., and Sheshagiri, R. 1996. Mutants resistant to foliar diseases in groundnut (*Arachis hypogaea L.*). Current Science 71:582-584.

Patil, R.K., Gowda, M.V.C., and Nadaf, H.L. 1991. Screening of Spanish bunch breeding lines of groundnut against *Spodoptera litura* (F.) damage. International Arachis Newsletter 10:26-27.

Tappan, W.B., and Gorbet, D.W. 1979. Relationship of seasonal thrips populations to economics of control on Florunner peanuts in Florida. Journal of Economic Entomology 72:772-776.

Wightman, J.A., and Ranga Rao, G.V. 1994. Groundnut pests. Pages 395-479 *in* The groundnut crop; a scientific basis of improvement (Smartt, J., ed.). London, UK: Chapman and Hall.

Suitability of Groundnut Aphid *Aphis craccivora* Koch. For Rearing Green Lacewing *Chrysoperla cornea* Stephens

V Balasubramani[1] and M Swamiappan[2] (1. Tamil Nadu Rice Research Institute, Aduthurai 612 101, Tamil Nadu, India. 2. Tamil Nadu Agricultural University, Coimbatore 641 003, Tamil Nadu, India)

Green lacewing *Chrysoperla cornea* Stephens, an important generalist predator used in biological control of insect pests in various cropping systems, is mass reared in laboratory conditions on the eggs of the rice moth *Corcyra cephalonica* Stainton (Patel et al. 1988). Inclusion of natural prey insects collected from the field will improve the predatory ability and reproductive potential of the predators. Differences in the larval development period have been reported for C. carnea reared on various prey insects (Balasubramani and Swamiappan 1994). Similarly, the host plant of the prey insect can also influence the development of the predator due to tritrophic interaction. In the present study, the suitability of *Aphis craccivora* Koch., reared on three different host plants, i.e., cowpea (*Vigna unguiculata*), groundnut (*Arachis hypogaea*), and green leaf manure plant (*Gliricidia maculata*), was tested.

First instar grubs of *C. carnea* hatching from a single batch of eggs were taken for the study and provided with the aphids in individual glass vials. Fresh aphids were provided daily and observations were made on the larval and pupal periods and the number of aphids consumed daily. The results showed that the development period of the C. carnea grub was significantly delayed when fed with A. craccivora from gliricidia (14.63 days) compared with cowpea aphids (10.75 days) and groundnut aphids (10.45 days). Similarly, the pupal period was also longer when fed with gliricidia aphids (9.50 days) (Table 1).

The predatory potential of *C. carnea* was significantly lower on the gliricidia aphids (373.1 aphids/grub)

Table 1. Developmental period of green lacewing fed with Aphis craccivora from different host plants[1].

Host plant	Larval period in days				Pupal period (days)	Egg to adult emergence period (days)
	I instar	II instar	III instar	Total		
Cowpea	3.6[b]	2.6[b]	4.6[b]	10.8[b]	7.6[C]	18.4[b]
Groundnut	3.6[b]	2.7[b]	4.2[C]	10.5[b]	8.2[b]	18.7[b]
Gliricidia maculata	4.3[a]	3.3[a]	7.1[a]	14.6[a]	9.5[a]	24. 1[a]

1. Means of 20 replications; means with same superscript within a column are not significantly different at P = 0.05.

than on the cowpea and groundnut aphids, irrespective of the grub stage (Table 2). The results revealed that there was a lesser preference for the aphid *A. craccivora* when collected from gliricidia. Groundnut was the preferred host having no effect on the predator larvae at tritrophic level, as the development was quicker and consumption rate was also higher.

Table 2. Predatory potential of C. *cornea* as influenced by host plants through the aphid *A. craccivora*[1].

Host plant	Number of aphids consumed/ *C. carnea* larva			
	I instar	II instar	III instar	Total
Cowpea	40.4[b]	87.7[b]	282.1[a]	387.8[b]
Groundnut	43. 1[a]	116.2[a]	283.9[a]	443.2[a]
Gliricidia maculata	34.1[c]	77.2[c]	244.3[b]	363. 1[c]

1. Means of 20 replications; means with same superscript within a column are not significantly different at *P* = 0.05.

Earlier reports indicated that *C. carnea* larvae were found to feed on *Aphis sambuci L..* living on *Sambucus nigra* L., but rejected it on *Philadelphus coronarius L..* Similarly *Aphis nerii B.* de F. living on *Nerium oleander* L. is considered a poor food for *C. carnea* (Canard and Principi 1984), due to the presence of toxic cordenolides ingested by the aphids and sequestered from the plant in their bodies (Rothschild et al. 1970). So the possibility of using A. craccivora, which is found in abundance every year on *Gliricidia maculata,* is limited because of toxic substances in the host plant. However, *A. craccivora* from cowpea and groundnut support the *C. carnea* grub for its complete development, without any adverse effect.

Acknowledgment. The financial support received from ASPEE Agricultural Research and Development Foundation, Bombay, is gratefully acknowledged.

References

Balasubramani, V., and Swamiappan, M. 1994. Development and feeding potential of the green lacewing *Chrysopela carnea* Stephens (Neuroptera: Chrysopidae) on different insect pests of cotton. Anzeiger fur Schadlingskunde Pflanzenschutz, Umweltschutz 67: 165-167.

Canard, M., and Principi, M.M. 1984. Development of chrysopidae. Pages 57-75 *in* Biology of Chrysopidae (Canard, M., Semeria, Y., and New, T.R., eds.). The Hague, Netherlands: W. Junk Publishers.

Patel, A.G., Yadav, D.N., and Patel, R.C. 1988. Improvement in mass rearing technique of green lacewing *Chrysopa scelestes* Banks (Neuroptera: Chrysopidae). Gujarat Agricultural University Research Journal 14:1-4.

Rothschild, M., von Evw, J., and Reichstein, T. 1970. Cardiac glycosides in the oleander aphid *Aphis nerii* (Homoptera: Aphididae). Journal of Insect Physiology 16:1411-1415.

White Grub Incidence in Groundnut in Some Parts of Tamil Nadu

S Raguraman, Y S Johnson, Thangaraj Edward, and A Palchamy (Agricultural Research Station, Tamil Nadu Agricultural University, Paramakudi 623 707. Tamil Nadu, India)

White grub, *Lanchnosterna (Holotrichia) serrata,* is a root pest of groundnut and causes 30 -100% losses (Amin 1987). Sporadic outbreaks of white grub occur regularly during the months of August to September and continue to February in some patches of Ramanathapuram, Sivagangai, and Virudhunagar districts of Tamil Nadu.

Table 1. Incidence of white grub in groundnut.

Village	Variety	Incidence of white grub (%)	
		Range	Mean ± SD
Ramanathapuram district			
Pandiyoor	Local	10-20	15.3 ± 3.7
Sayalkudi	Local/TMV 7	4-5	4.6 ± 0.5
T. Vepankulam	Local	2-5	3.5 ± 1.3
Melakidaram	Local	2-5	3.3 ± 1.3
S. Tharaikudi	Local	2-3	2.4 ± 0.5
Chirakikottai	TMV7	-	Nil
Nainarkoil	Local	-	Nil
Arasadivandal	TMV7	-	Nil
Vaniyavallam	Local	-	Nil
Pudur Valasai	Local	-	Nil
Sathirakudi	TMV 7/Local	-	Nil
Manjoor	Local/TMV 7	-	Nil
Naripaiyoor	Local	1-2	1.6 ± 0.5
Sivagangai district			
Perumpacheri	Local/TMV 7	-	Nil
Virudhunagar district			
T. Velangudi	Local	3-4	3.6 ± 0 5
Narikkudi	Local	5-10	7.2 ± 2.0
Pattamangalam	Local	4-5	4.4 ± 0.5
Valasai	Local	2-5	3.5 ± 1.3
Chinnakannanoor	Local	-	Nil
Melanthal	Local	3-5	4.0 ± 0.8
Kandukondan Manickam	Local	2-3	2.6 ± 0.5
Chathirampuliyankulam	Local	3-4	3.5 ± 0.5
Vellathakulam	Local	1-2	1.6 ± 0.5
Uchilankulam	Local	8-10	9.2 ± 0.8

This has been the major problem for farmers growing groundnut under rainfed conditions during recent years. Severe outbreaks of white grub occurred in the entire groundnut tract of these districts during 1995-96. Consequently, incorporation of phorate 10 G at 25 kg ha^{-1} during the last plowing was advised for 1996-97. A systematic survey was conducted in more than 800 ha during July 1996-March 1997 in the groundnut-growing areas of these districts where groundnut is sown in two seasons (Jun-Jul and Dec-Jan sowing). In 24 groundnut-growing villages, 10 farmers' fields were selected at random. From each field five 1 m^2 areas were marked, one in the middle and the others in the four corners and the mean percentage incidence was worked out. The incidence was noticed either during vegetative, flowering, or peg formation stages.

White grub incidence was up to 20% in Pandiyoor with a mean of 15.43%, 10% in Uchilankulam (mean = 9.2%) and Narikkudi (mean = 7.2%). Out of 24 villages, no incidence of white grub was observed in 9 villages and meager incidence was observed in other villages (Table 1). Further studies are needed to generate information on white grub taxonomy, distribution, biology, and management.

Reference

Amin, P.W. 1987. Insect pests of groundnut in India and their management. Pages 219-233 *in* Plant protection in field crops (Veerabhadra Rao, M., and Sithanantham, S., eds.). Hyderabad, India: Plant Protection Association of India.

Production and Management

Competitive Functions of Groundnut and Sesame with Different Fertilizers and Cropping Systems in the Coastal Saline Zone of West Bengal

D Maiti, D Mahalanobis, and M Ghosh (Department of Agronomy, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur 741 252, West Bengal, India)

Growing mixed crops or intercropping is an important feature of Indian agriculture, especially under rainfed conditions (Aiyer 1949). When species are intercropped, variables such as number of rows of each species, and levels of fertilizer application influence the interspecies competition, crop yields, and monetary benefits. For example, Samui et al. (1992) reported high yields of sesame when single rows were sown alternately with two rows of groundnut, and 80 kg P_2O_5 ha^{-1} added. However, no information is available on these aspects for the coastal saline soils of West Bengal. In this investigation sole and intercropping of groundnut and sesame crops grown under different applications of nitrogen and phosphorus were examined to find out whether there was any yield advantage resulting from intercropping.

The experiment was carried out at the Regional Research Station (Coastal Saline Zone), Kakdwip, Bidhan Chandra Krishi Viswavidyalaya, West Bengal, during the prerainy seasons of 1993 and 1994 in clay soil with pH 7.6, electrolytic conductivity (EC) 0.28 S m^{-1}, organic carbon 4.0%, available P_2O_5 30 kg ha^{-1}, and K_2O 200 kg ha^{-1}. The experiment was laid out in a split-plot design with three replications. Treatments included four cropping systems: sole groundnut (Girnar 1, CGS 4018), sole sesame B-67 (Tilottama), 2G : 1S, 1G : 2S; and four fertilizer levels (0+0, 30 N + 25 P, 60 N + 50 P, and 90 N + 75 P kg ha^{-1}). At the time of sowing 30 kg K_2O ha^{-1} was applied.

Land equivalent ratio of the 1:2 cropping system was greater, 1.104, at the levels of 60 N + 50 P followed by 1.057 at 90 N + 75 P levels of fertilizers (Table 1) but the LER was less than 1.00 at the application of low levels of fertilizer 30 N + 25 P and control. But LER of 2:1 cropping system was more at the 60 N + 90 P fertilizer levels and control than 30 N + 25 P and 90 N + 75 P levels of fertilizers. Results show that as a higher LER of 1.104 for the 1G : 2S cropping system was achieved it appeared to be a better cropping system than the 2G : IS cropping system.

A higher monetary advantage resulted from the groundnut and sesame intercropping system (2G : IS ratio) at the 60 N + 50 P fertilizer level (Table 2). Similarly, 2S : 1G row ratio had the highest net benefit at the same fertilizer level. Monetary advantage was highest (Rs 1136.26) with 1G : 2S cropping system compared

Table 1. Land equivalent ratio (LER) of groundnut and sesame under different levels of fertilizer and cropping systems (mean of two years data).

	Cropping system					
	(G+S)2:1			(G+S) 1:2		
Fertilizer levels (kg ha^{-1})	G	S	LER	G	S	LER
0+0	0.747	0.309	1.056	0.309	0.678	0.987
30 N + 25 P	0.678	0.315	0.993	0.281	0.679	0.961
60 N + 50 P	0.743	0.300	1.044	0.323	0.781	1.104
90 N + 75 P	0.645	0.305	0.950	0.243	0.813	1.057

Where C and S = Partial LER of groundnut and sesame.

Table 2. Monetary advantage of groundnut and sesame under different levels of fertilizer and cropping systems (mean of two years data).

Fertilizer levels (kg ha^{-1})	Cropping system	
	(G+S)2:l (Rs)	(G+S) 1:2 (Rs)
0+0	599.63	56.23
30 N + 25 P	-98.61	-295.53
60 N + 50 P	826.44	1136.26
90 N + 75 P	-897.76	677.71

Groundnut prices were Rs 12.00 kg^{-1} in 1993 and Rs 13.00 kg^{-1} in 1994. Sesame prices were Rs 8.00 kg^{-1} in 1993 and Rs 8.50 kg^{-1} in 1994.

Table 3. Relative yield total (RYT) of groundnut and sesame under different levels of fertilizer and cropping systems (mean of two years).

Fertilizer levels (kg ha^{-1})	Cropping system	
	(G+S) 2:1 (Rs)	(G+S) 1:2 (Rs)
0+0	0.644	0.417
30 N + 25 P	0.593	0.373
60 N + 50 P	0.638	0.446
90 N + 75 P	0.548	0.383

with the 2G : 1S cropping system with 60 N + 50 P addition. As monetary advantage is based on the value of LER as well as the value of the component crop, the highest monetary advantage resulted from 1G: 2S row ratio with 60 N + 50 P because this treatment combination recorded the highest LER value.

Intercropping systems of 2G: IS row ratio had a higher relative yield total (RYT) than the 1G : 2S row ratio at all levels of fertilizer (Table 3). Relative yield total was maximum with the 2G: IS ratio when no N + P fertilizer was added. In the case of the 1G . 2S row ratio RYT was maximum when the intercropping system received 60 N + 50 P.

References

Aiyer, A.K.Y.N. 1949. Mixed cropping in India. Indian Journal of Agricultural Science 19:439-543.

Chandrasekharan, N.R., Muhammad, S.V., Sivasubramanian, P., Rangaswamy, M., and Venngopalan, S. 1974. Mixed cropping with seasmum. Madras Agricultural Journal 61:510-15.

Samui, R.C., and Roy, A. 1990. Possibilities of increasing production of oilseeds through intercropping system. Journal of Oilseeds Research 7:14-21.

Samui, R.C., Maiti, B.K., Aasan, A.K.M.M., Roy, B., Sit, B., and Bandopadhyay, P. 1992. Dry matter production nutrient content and uptake by groundnut-sesamum intercropping systems at different levels of phosphorus application. Environment and Ecology 10:155-159.

Constraints in Groundnut *(Arachis hypogaea L.)* Cultivation in Khargone District (West Nimar), Madhya Pradesh, India

C M Mishra (JNKVV, Zonal Agricultural Research Station, Khargone, West Nimar 451 001, Madhya Pradesh, India)

India's new agricultural policy encourages large-scale cultivation of export-oriented crops. Groundnut is important as it has a high export potential for confectionery varieties. During the rainy season Khargone is an important groundnut-growing district in Madhya Pradesh but the average yield of groundnut is 0.8 t ha^{-1}, less than the national average of 1.0 t ha^{-1}. Therefore, a survey of agronomic practices in groundnut cultivation was undertaken to identify any constraints. The study was conducted during the 1996-97 rainy season.

Of 16 blocks of Khargone district, 5 blocks (Sendhwa, Rajpur, Jhirniya, Khargone, and Gogawa) were identified for study purposes in view of their large area under rainfed groundnut. Ten farmers were chosen randomly from each selected block, with three farmers sowing small (0-2 ha) areas, three sowing medium-sized (2-4 ha), and four sowing larger areas (0.4-1.1 ha). A well structured pretested interview schedule was used for the selected farmers in order to collect the required information by personal interviews. The various problems faced by the farmers in groundnut cultivation are listed in Table 1.

This reveals that 94% of the respondents felt the high cost of seeds and fertilizers, and 90% felt erratic and scattered rains, were the major problems in groundnut cultivation during the 1996-97 rainy season. Similar findings were reported by Mishra (1993a) for causes of low yield in rainfed groundnut.

More than three quarters of the respondents reported that lack of plant protection was the major constraint

Table 1. Responses of farmers on constraints in groundnut cultivation (n = 50).

Constraints	Number	%
Erratic rains (scattered rains)	45	90
Lack of awareness of improved technologies	30	60
Lack of contact with extension agents	32	64
High cost of seeds and fertilizers	47	94
Nonavailability of improved varieties and fertilizers in time	39	78
Lack of labor availability at weedings and uprooting of the crop	28	56
High cost of labor	30	60
Lack of plant protection measures	42	84
Lack of market center nearby	26	52
Lack of remunerative prices	37	74
Lack of credit facilities	41	82

(84%), while lack of credit facilities (82%), and nonavailability of improved varieties and fertilizers in time (78%) were the other constraints in groundnut cultivation. Similar findings were reported by Mishra (1993b) in his study of the causes for low yield in rainfed groundnut and of the extension programs needed to remove the constraints for high groundnut production. Nearly three quarters of the respondents (74%) felt the lack of remunerative prices as a constraint in groundnut cultivation. Less than two thirds of the respondents (64%) felt lack of contact with extension agents, high cost of labor (60%), and lack of awareness about improved technologies (60%), were major problems.

Just more than half of the respondents felt lack of labor availability for weeding and uprooting of the crop (56%), and lack of a market center nearby (52%), as constraints. By consultation with the progressive groundnut farmers and extension field agents the following suggestions are made to overcome the constraints in groundnut cultivation.

- Supply of improved varieties, fertilizers, and pesticides at subsidized prices.
- Ensuring timely availability of fertilizers and pesticides at village level.
- Strengthening cooperative sectors at village level so that inputs may be supplied in good time and the market developed.
- Creating awareness of improved technologies through mass media and by developing village leadership.

This study revealed that the majority of groundnut farmers were facing a range of constraints in groundnut cultivation and identified various suggestions to overcome these problems. Responsibility for promoting these findings should be taken by the extension machinery to increase the productivity of groundnut in West Nimar (Khargone) of Madhya Pradesh, India.

References

Mishra, C M. 1993a. Studies of the causes for low yield in rainfed groundnut. Bharatiya Krishi Anusandhan Patrika 8:201-205.

Mishra, C M. 1993b. Extension programmes needed to remove the constraints for high groundnut production. Indian Farming 43:5-6.

Effect of Nitrogen, Phosphorus, and Gypsum on Yield of Rainfed Groundnut (*Arachis hypogaea L.*)

G L Yadav, P K Sharma, and B L Sharma (Department of Agronomy, Agricultural Research Station, Rajasthan Agricultural University, Durgapura, Jaipur 302 018, Rajasthan, India)

Groundnut (*Arachis hypogaea L.)* is an important oil seed crop of Rajasthan. Being a leguminous crop, a major portion of the nitrogen (N) requirement is met through symbiotic fixation. However, to meet the N requirement during early growth, it is applied as a starter dose. Also, phosphorus is necessary for the proper functioning of the nodules, and being an oilseed

Table 1. Effect of nitrogen, phosphorus, and gypsum on pod yield and B/C ratio of groundnut.

Treatments	Pod yield (t ha^{-1})			Haulm yield (t ha^{-1})			B/C ratio for pod yield
	1993	1994	Mean	1993	1994	Mean	
N levels (kg ha^{-1})							
0	1.55	1.88	1.71	3.11	3.35	3.23	-
15	1.67	2.07	1.87	3.38	3.57	3.47	1.78
CD (P = 0.05)	1.06	1.56	0.89	1.65	NS	-	-
P_2O_5 levels (kg ha^{-1})							
0	1.53	1.81	1.68	3.12	3.19	3.16	-
30	1.68	2.13	1.91	3.37	3.73	3.55	5.74
CD (P = 0.05)	1.06	1.56	0.89	1.65	3.46	-	-
Gypsum levels (kg ha^{-1})							
0	1.48	1.83	1.66	3.01	3.26	3.14	-
250	1.74	2.11	1.93	3.47	3.66	3.57	2.96
CD (P = 0.05)	1.06	1.56	0.89	1.65	3.46	-	-

crop, groundnut has high sulfur requirement. About 70% of the total area under groundnut in the state is rainfed. Hence, it is necessary to find out the response of rainfed groundnut to nitrogen, phosphorus and gypsum (as a source of S) fertilizers.

Experiments were carried out at the Agricultural Research Station, Durgapura, Jaipur, during the postrainy seasons of 1993 and 1994 to study the response of groundnut to nitrogen, phosphorus, and gypsum under the rainfed conditions of the semi-arid eastern plain in Rajasthan. The treatments consisted of 2 levels each of nitrogen (0 and 15 kg ha^{-1}), phosphorus (0 and 30 kg ha^{-1} P_2O_5) and gypsum (0 and 250 kg ha^{-1}). These eight treatment combinations of N, P, and gypsum (0,0,0; 0,0,250; 0,30,0; 0,30,250; 15,0,0; 15,0,250; 15,30,0, and 15,30,250 kg ha^{-1}) were replicated four times in a randomized block design. The experimental field was loamy sand in texture with 0.18% organic carbon, 50.6 kg ha^{-1} available P_2O_5 and 240 kg ha-1 available K_2O. The soil pH was 8.0 and moisture content at 0.1 bar was 8.90%, at 0.33 bar was 3.47%, and at 15 bar was 2.41%. Available water was 6.49%. The soil was deficient in available sulfur having 2.3 mg kg^{-1} S. Gypsum (13% sulfur) was incorporated in the soil to 10 cm depth before sowing in the appropriate treatments and nitrogen and phosphorus were applied as basal placements. Groundnut kernels of var MA 10 Chitra were treated with 3 g ThiranV (tetramethyl thithiuram disulphide) and 25 ml chloropyrifos kg^{-1} of kernel and rhizobial culture. The crops were sown on 26 June 1993, and 29 June 1994. The total rainfall received during the season from June to October was 542.2 mm during 1993, with 42 rainy days, and 642.8 mm in 1994 with 39 rainy days.

Application of nitrogen at 15 kg ha^{-1} significantly increased the pod yield of groundnut by 0.12 t ha^{-1} over the control (0 kg N ha^{-1}) in 1993 and and 0.19 t ha^{-1} in 1994 (Table 1). Pooled results showed that a basal application of 15 kg N ha^{-1} increased the pod and haulm yield of groundnut by 0.16 t ha^{-1} and 0.24 t ha^{-1} over 0 kg N ha^{-1}. Patel (1983) reported a significant response of up to 12.5 kg N ha^{-1} in groundnut in his permanent plot experiments. This treatment was also found to be remunerative with a B/C ratio of 17.7.

Application of 30 kg ha^{-1} P_2O_5 as a basal dressing under rainfed conditions produced significantly higher pod and haulm yield during both years. Pooled data revealed that 30 kg ha^{-1} P_2O_5 increased the pod yield by 2.55 t ha^{-1} over the control. This might be due to a significant increase in pods $plant^{-1}$ and pod yield $plant^{-1}$ (Table 2). Under irrigated conditions, 60 kg ha^{-1} P_2O_5 as a basal application was found significantly better than other treatments tried (Singh et al. 1993). Incorporation of 250 kg ha^{-1} gypsum in the soil before sowing gave a significantly higher pod yield of 1.93 t ha^{-1} compared with 0 kg ha^{-1} gypsum (1.66 t ha^{-1}). Pod yield $plant^{-1}$ and pods

Table 2. Effect of nitrogen, phosphorus, and gypsum on yield-contributing characters of groundnut.

	Pods $plant^{-1}$			Pod yield $plant^{-1}$ (g)		
Treatments	1993	1994	Mean	1993	1994	Mean
N levels ($kg\ ha^{-1}$)						
0	14.68	17.70	16.19	19.79	22.98	21.38
15	16.28	19.41	17.84	21.44	24.72	23.08
CD (*P* = 0.05)	0.81	1.11	-	1.43	1.63	-
P_2O_5 levels ($kg\ ha^{-1}$)						
0	16.03	16.93	16.48	18.93	22.08	20.50
30	16.93	20.19	18.56	22.30	25.62	23.96
CD (*P* = 0.05)	0.81	1.11	-	1.43	1.63	-
Gypsum levels ($kg\ ha^{-1}$)						
0	14.43	17.73	16.08	19.64	22.81	21.22
250	16.53	19.38	17.95	21.59	24.89	23.24
CD (*P* = 0.05)	0.81	1.11	-	1.43	1.63	-

$plant^{-1}$ also increased significantly with the application of 250 kg ha^{-1} gypsum (Table 2). The treatment was found to be highly remunerative with a 29.6 B/C ratio. Similar results were reported by Sharma et al. (1992) under irrigated conditions. The combined effect of N, P, and gypsum was found to be nonsignificant.

References

Patel, J.C. 1983. Fertiliser use in groundnut cultivation in Saurashtra (Gujarat). Pages 122-124 *in* Recent advances in groundnut production research: proceedings of the Summer Institute, 9-30 May 1983, Junagadh, Gujarat, India.

Sharma, P.K., Gill, O.P., and Sharma, B.L. 1992. Effect of source and mode of sulphur application on yield of groundnut *(Arachis hypogaea).* Indian Journal of Agronomy 37:489-492.

Singh, B., Singh, B., and Khandelwal, R.B. 1993. Effect of phosphatic fertilizers, gypsum and their mode of application on yield, oil and protein content of groundnut *(Arachis hypogaea).* Indian Journal of Agronomy 38:56-59.

Effect of Varieties and Plant Spacing on Growth and Yield of Groundnut in Surguja, Madhya Pradesh

R K Mishra, A K Tripathi, S K Choudhary, and R B Sharma (Zonal Agricultural Research Station, PO Box 3, Ambikapur 497 001, Madhya Pradesh, India)

Groundnut is an important oilseed crop of the tribal belt of Surguja, which is predominantly rainfed and monocropped. These uplands being sandy loam soil, are well drained, porous, and ideally suited to groundnut cultivation. The net profit from groundnut is higher than that from upland rice or minor millets and the genotype (crop geometry) plays a prime role in obtaining higher yield (Kalra et al. 1984). The objective of the present study was to study genotype and optimum spacing requirements for higher productivity under rainfed conditions in the Surguja area.

The experiment was a split-plot design, with three varieties released in India (J 11, JL 24, and Dh 29) as main plots, and four spacings (30 x 15 cm, 30 x 20 cm, 45 x 15 cm, and 45 x 20 cm) as subplots. The crops were sown on 28 June 1990 and 4 July 1991. All three varieties of groundnut take 32-33 days to flowering and 108-110 days to maturity. The variety Dh 29 is a Virginia bunch type and the other two varieties (J 11 and JL 24) are Spanish bunch type. A uniform application of 20 kg ha^{-1} N, 60 kg ha^{-1} P_2O_5 and 30 kg ha^{-1} K_2O was applied before sowing. The seasonal rainfall of 987 mm in 1989-90 and 1142 mm in 1990-91 was favorable for crop growth and yield.

The variety Dh 29 gave a significantly higher pod yield (Table 1) compared with J 11 and JL 24. This was due to superiority in yield attributes such as number of branches per plant, number of pods per plant, pod mass per plant, and 100-mass weight. The variety Dh 29 gave the highest yield of 2.0 t ha^{-1} compared with JL 24 (1.2 t ha^{-1}) and J 11 (1.1 t ha^{-1}). The higher yield of this variety is attributed to larger kernel size (Ahmed et al. 1986).

The plant spacing of 30 x 15 cm resulted in significantly higher pod yield and also increase in other yield attributes compared with other spacings. The results are in conformity with the finding of Kalra et al. (1984), and Agasimani et al. (1984). The varieties J 11 and JL 24 gave higher pod yield (Table 2) at 30 x 15 cm, whereas Dh 29 gave significantly higher yield with 30 x 20 cm spacing, due to its capacity to produce a higher number of branches, and pods per unit area under 30 x 20 cm plant spacing. The interactions between varieties and plant spacing were found to be significant. The pod

Table 1. Yield and yield attributes as influenced by varieties and spacings in groundnut in Surguja, 1989-90 and 1990-91.

	Pod yield ($t\ ha^{-1}$)			Branches $plant^{-1}$		Pods $plant^{-1}$		100-mass weight (g)		Pod mass $Plant^{-1}$	
Treatment	89-90	90-91	Mean	89-90	90-91	89-90	90-91	89-90	90-91	89-90	90-91
Variety											
J 11	1.2	1.0	1.1	5	5	10	9	28.3	28.8	7.4	6.4
JL24	1.3	1.2	1.2	5	5	11	10	29.2	29.2	8.1	7.3
Dh 29	2.0	2.1	2.1	6	6	12	12	33.2	33.7	12.4	13.2
CD at 5%	0.12	0.16	0.14	0.38	0.47	0.83	0.79	4.8	2.1	1.4	2.2
Spacing											
30 x 15 cm	1.7	1.6	1.7	5	4	9	9	30.6	30.9	7.9	7.8
30 x 20 cm	1.6	1.5	1.6	5	5	11	11	30.2	30.3	9.3	9.1
40 x 15 cm	1.3	1.3	1.3	6	5	11	11	30.2	30.3	9.8	9.9
40 x 20 cm	1.2	1.2	1.2	6	6	12	12	30.2	30.3	11.0	10.6
CD at 5%	0.11	0.08	0.08	0.23	0.19	1.3	0.94	NS	NS	0.93	0.72

Table 2. Interaction between variety and plant spacing in respect of pod yield (t ha-1) of groundnut in Surguja, 1989-90 and 1990-91.

	Variety							
	J 11		JL24		Dh29		Mean	
Spacing	89-90	90-91	89-90	90-91	89-90	90-91	89-90	90-91
30 x 15 cm	1.6	1.3	1.6	1.4	2.2	2.2	1.8	1.6
30 x 20 cm	1.2	1.0	1.3	1.2	2.4	2.4	1.6	1.5
45 x 15 cm	1.1	1.0	1.2	1.1	1.7	2.0	1.3	1.4
45 x 20 cm	1.0	0.9	1.1	1.0	1.6	1.7	1.2	1.2
Mean	1.2	1.0	1.3	1.2	2.0	2.1	1.6	1.4
CD at 5% V x S	1989-90	1990-91						
	0.16	0.14						

yields of J 11 and JL 24 were correspondingly decreased with the increase in plant spacing beyond 30 x 15 cm, whereas, decrease in pod yield was observed in Dh 29 with wider spacing, i.e., 45 x 15 cm and 45 x 20 cm, compared with 30 x 20 cm spacing.

The study showed that groundnut genotype Dh 29 is suitable for sowing at 30 x 20 cm spacing, while for J 11 and JL 24, a spacing of 30 x 15 cm should be adopted to achieve the higher pod yield.

References

Agasimani, C.A., Palled, Y.B., Naik, H.D., and Kulkarni, G.K. 1984. Response of groundnut cultivars to different spacings. Indian Journal of Agronomy 29:209-212.

Ahmed, S., Rafey, A., Singh, R.K., and Verma, U.K. 1986. Response of groundnut varieties to different spacing. Indian Journal of Agronomy 31:248-251.

Kalra, G.S., Thorat, S.T., and Pawar, A.B. 1984. Response of improved groundnut varieties to different spacings under irrigated conditions. Indian Journal of Agronomy 29:40-42.

Sulfur and Organic Manure Fertilization of Groundnut in Red Alfisol Soil in Indonesia

Abdullah Taufiq and Sudaryono (Research Institute for Legume and Tuber Crops (RILET), PO Box 66, Malang 65101, Indonesia)

Chlorotic symptoms on leaves of groundnut occur commonly in red Alfisol soils in Indonesia. These symptoms reduce groundnut yields by about 20% (Adisarwanto et al. 1992). The low availability of soil Fe is suspected to promote the chlorotic symptoms, and it is induced by high soil pH and calcium content. Papastylianou (1989) reported that chlorotic symptoms of groundnut grown on Alfisol soils positively correlated with $CaCO_3$, and the reverse was true when it correlated with DTPA-extractable Fe. Some researchers reported that the chlorotic symptoms could be alleviated by spraying of 0.5% $FeSO_4$ (Suryantini 1994), or application of 135 to 405 mg K kg^{-1} soil (from K_2SO_4) (Barak and Chen 1984), and by application of sulfur, $FeSO_4$, and manure (Houng 1994). In soils with soil pH >7, sulfur reacted with Ca to form insoluble $CaSO_4$ (Jones et al. 1991). Lowering of soil pH and inactivation of macro-cation Ca by application of sulfur and organic manure were the focus of the present research. The study aimed to find an alternative nutrient management procedure to overcome chlorotic symptoms and to increase groundnut productivity on red Alfisol soils in Indonesia.

The research was carried out on red Alfisol soil at Tuban district during the 1996-97 rainy season using three rates of cattle manure (0, 5, 10 t ha^{-1}) by five rates of S (0, 100, 200, 300, 400 kg S ha^{-1}) in a factorial complete block design. The same treatments were tested on the same soil in pots in the RILET's glasshouse, using a completely randomized design, replicated five times. A local groundnut variety of Tuban was used in this experiment. Basal fertilizers were 33.75 kg N ha^{-1}, 36 kg P_2O_5 ha^{-1} and 45 kg K_2O ha^{-1}. Characteristics of red Alfisol soil from Tuban are listed in Table 1.

Table 1. Chemical analysis of red Alfisol soil at Tuban, East Java, Indonesia, 1996-97.

Soil characteristics	Value	Remark[1]
pH(H_2O)	8.4	alkaline
C-org (%)	1.51	low
P-Bray 1 (mg kg^{-1})	1.75	low
$S\text{-}SO_4$ (mg kg^{-1})	20.18	medium
exch-K(me/100g)	0.77	high
exch-Ca (me/100 g)	10.83	high
exch-Mg(me/100g)	2.56	high
DTPA-extractable Fe (mg kg^{-1})	1.42	low

1. Based on Landon (1984).

The results showed that 3.5 months after application of 100 to 400 kg S ha^{-1}, the reduction in soil pH varied from 0.2 to 0.5 units in the glasshouse, and 0.4 to 0.6 units in the field experiment (Table 2). Reduction in soil pH negatively correlated with $S\text{-}SO_4$ content of soil ($r = -0.88$; $p = 0.04$). In soils with soil pH >7, sulfur reacted with Ca to form insoluble $CaSO_4$ (Jones et al. 1991). A decrease in soil pH increased DTPA-extractable Fe and reduced Ca availability (Table 3).

Table 2. Effect of sulfur on soil pH and $S\text{-}SO_4$ in red Alfisol soil after 3.5 months of application, 1996-97.

	pH-H_2O (1:2.5)		$S\text{-}SO_4$ (mg kg^{-1})	
S (kg ha^{-1})	Glasshouse	Field	Glasshouse	Field
0	8.1	8.2	1.14	9.23
100	8.1	7.7	36.27	19.60
200	7.9	7.8	68.81	16.90
300	7.8	7.7	94.01	28.70
400	7.6	7.6	90.45	29.11

Table 3. Effect of sulfur on DTPA-extractable Fe and exchangeable Ca in red Alfisol soil after 3.5 months of application, 1996-97.

	Glasshouse		Field	
S (kg ha^{-1})	DTPA-Fe (mg kg^{-1})	Exch-Ca (me / 100 g soil)	DTPA-Fe (mg kg^{-1})	Exch-Ca (me/ 100g soil)
0	4.08	8.77	4.62	8.41
100	4.44	9.07	4.76	8.21
200	4.53	8.51	4.94	7.61
300	5.62	8.30	5.48	8.37
400	5.72	8.19	5.35	8.09

Application of 5 and 10 t ha^{-1} cattle manure increased organic-C both in the glasshouse (7.14 to 9.34%) and field experiments (3.76 to 11.2%). However, its effect on soil pH was not consistent (Table 4).

In the glasshouse experiment, addition of either sulfur or cattle manure increased pod yield and there was no interaction between sulfur and cattle manure (data

Table 4. Effect of cattle manure on soil organic-C and pH in red Alfisol soil after 3.5 months of application, 1996-97.

Manure ($t\ ha^{-1}$)	C-organic (%) Glasshouse	C-organic (%) Field	pH-H_2O (1:2.5) Glasshouse	pH-H_2O (1:2.5) Field
0	1.82	1.33	7.8	7.9
5	1.95	1.38	8.0	7.9
10	1.99	1.48	7.9	7.7

Table 5. Effect of sulfur and cattle manure application on pod yield of groundnut in red Alfisol soil at Tuban district during the rainy season 1996-97.

	Cattle manure ($t\ ha^{-1}$)		
	0	5	10
S ($kg\ ha^{-1}$)	Pod yield ($t\ ha^{-1}$)		
0	1.65 c	2.06 abc	1.74 c
100	1.94 abc	2.41 a	1.86 c
200	1.93 abc	1.98 abc	1.80 c
300	1.78 bc	1.57 c	1.79 c
400	2.00 abc	1.82 c	2.37 ab
SED ±0.14			
CV(%) 13.7			

(Figures with the same letters were not significantly different at DMRT 5%).

not presented). However, in field experiments, interaction between sulfur and cattle manure was observed (Table 5). The highest gain in pod yield (46%) was obtained with application of 100 kg ha^{-1} sulfur and 5 t ha^{-1} of cattle manure.

These results showed that the high soil pH of red Alfisol soil was one of the factors limiting groundnut yield, but additional elemental sulfur effectively decreased the soil pH and increased the availability of sulfur in the soil. Application of 100 kg S ha^{-1} combined with 5 t ha^{-1} manure increased groundnut pod yield significantly.

References

Adisarwanto, T., Kasno, A., Saleh, N., Heriyanto, Gowda, C.L.L., Foster, J., Singh, V.P., and Fujisaka, S. 1992. Survei diagnostik pertanaman kacang tanah di daerah Tuban, Jawa Timur (Diagnostic survey of groundnut plant in Tuban district). Pages 1-10 in Risalah Hasil Penelitian Kacang Tanah di Tuban Tahun 1991: Seminar dilak sanakan di Tuban, 16 Nov 1991 (Adisarwanto, T., Sunardi, and Winarto, A., eds.). Malang, Indonesia: Balai Penelitian Tanaman Pangan Malang.

Barak, P., and Chen, Y. 1984. The effect of potassium on iron chlorosis in calcareous soils. Journal of Plant Nutrition 7:125-133.

Houng, K.H. 1994. Effect of S on chlorosis and yield of peanut grown on calcareous soils in the Hualien area of Taiwan. Pages 241-250. in ecology and management of problem soils in Asia. FFTC, RRC. 417 pages.

Jones, J.B., Wolf, B., and Mills, H.A. 1991. Plant analysis handbook: a practical sampling, preparation, analysis, and interpretation guide. Athens, Georgia, USA: Micro-Macro Pub., Inc. 213 pages.

Landon, J.R. 1984. Booker tropical soil manual: a handbook for soil survey and agricultural land evaluation in the tropics and subtropics. New York, USA: Longman, Inc. 450 pages.

Papastylianou, I. 1989. Effect of selected soil factors on chlorosis of peanut plants grown in calcareous soils in Cyprus. Plant and Soil 117:291-294.

Suryantini. 1994. Inokulasi rizobium dan pemberian Fe pada kacang tanah di tanah Alfisol (Rhizobium inoculation and iron fertilization on groundnut). Laporan Intern Balittan Malang. 14 pages.

Food Quality

A Simple and Economical Procedure for Transmethylation of Fatty Acids in Groundnut Oil for Analysis by GLC

J B Misra and R S Mathur (National Research Centre for Groundnut, PB no. 5, Junagadh 362 001, Gujarat, India)

Analysis of fatty acid composition of groundnut oil is an important activity in research programs aimed at improving the quality of groundnut oil. The food industry now prefers groundnut varieties with a high oleic (O)/ linoleic (L) ratio as the finished products obtained from such groundnuts have a longer shelf life (Worthington etal. 1972).

Fatty acid analysis of oils is carried out by converting the constituent fatty acids into their methyl esters and their subsequent separation, identification, and quantitative analysis by gas liquid chromatography (GLC). Use of borontrifluoride (BF_3), a Lewis acid, as a methylating agent is very common. This method was originally developed by Metcalfe and Schimitz (1961) and now has a few variants in vogue. However, care has to be taken when BF_3 is used as a transmethylating agent as the reaction mixture has to be heated at elevated temperatures in a sealed vial, which often explodes. Moreover, BF_3 is a hazardous (carcinogenic) and costly chemical and the ready-made reagent (12 to 14% BF_3 in dry methanol), being unstable, has a short shelf life. The other popular transmethylation procedures are variants of the original method developed by Luddy et al. (1968)

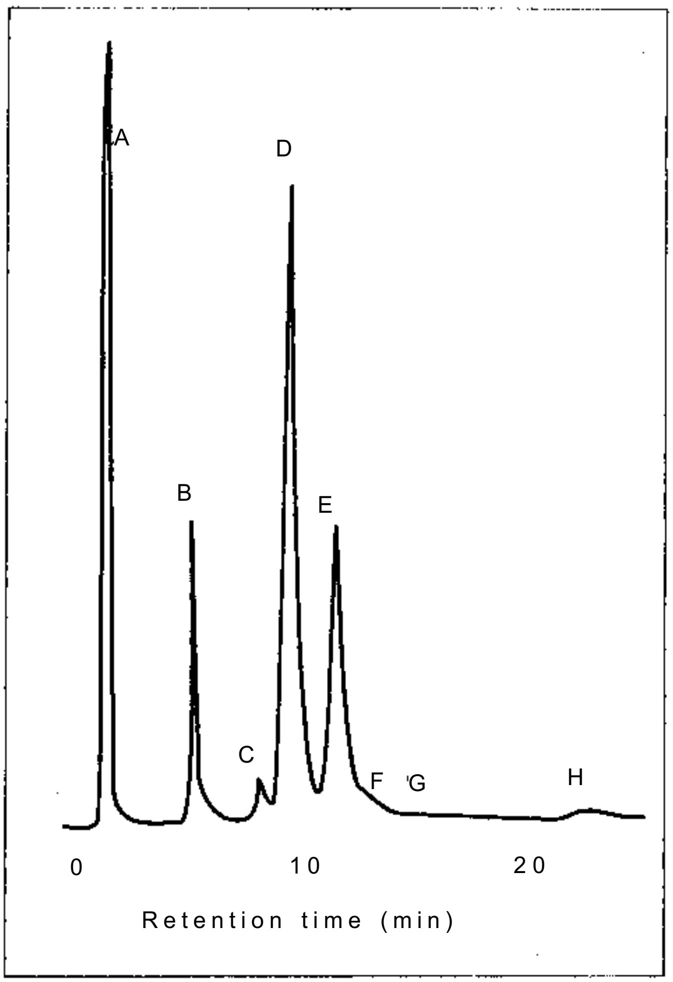


Figure 1. Gas-liquid chroma togram of methyl esters of fatty acids from groundnut oil (peaks: A, solvent; B, palmitic; C, stearic; D, oleic; E, linoleic; F, linolenic; G, arachidic; and H, behenic).

which makes use of sodium methylate. This method has several steps and entails use of sodium metal which reacts very rapidly with moisture and hence requires handling with extreme care. Yet another method often used is that developed by Mason and Waller (1964), which, besides making use of a rather uncommon chemical 2,2-dimethoxy propane, has several steps.

For analyzing a large number of samples a rapid and less cumbersome procedure is needed. Morover, for laboratories in developing countries the high cost of imported chemicals may prohibit handling of a large number of samples. The procedure described here makes use of cheap and easily available chemicals for transmethylation of fatty acids in groundnut oil. These chemicals are: hexane, methanol, sodium hydroxide, sodium chloride, and sodium sulphate (anhydrous). The method can be applied on groundnut seeds directly and also on the extracted oil. The method works on the principle of extraction of oil in hexane followed by transmethylation of fatty acids catalyzed by a weak base (sodium methoxide) and then the phasing out of undesirable chemicals and materials into an aqueous phase leaving behind methyl esters in hexane. The stepwise procedure is as follows:

1. Remove testa from 3-4 seeds.
2. Grind blanched seeds into a fine meal using a glass pestle and mortar.
3. Transfer about 100 mg meal to a 15 mL centrifuge tube.
4. Add 3 mL of hexane, mix on a vortex mixer 4-5 times at short intervals and then allow to stand overnight.
5. Centrifuge to settle the pellet. Then transfer the supernatant to a 15 mL culture tube and discard the residue.
6. Add 3 mL of sodium methoxide (80 mg NaOH in 100 mL methanol) to the supernatant, mix thoroughly on a vortex mixer and leave at room temperature for 30 min.
7. Add 3 mL of 8% aqueous sodium chloride. Shake gently 1-2 times.
8. Remove the hexane layer containing methyl esters to another culture tube and add to it about 100 mg anhydrous sodium sulphate. Use 0.5 to 1 mL of the hexane layer containing the methyl esters for injection into the GLC.

If the starting material is groundnut oil, take 1-2 drops of oil and add 3 mL of hexane and then proceed from step 6.

Separation conditions on GLC:

Oven temperature	190°C
FID detector temperature	240°C
Injector temperature	240°C

Gas flow:

Carrier (nitrogen)	40 mL min^{-1}
Fuel (hydrogen)	30 mL min^{-1}
Zero air	300 mL min^{-1}

The separation profile of methyl esters obtained by following the procedure described here for the oil of genotype NRCG 2750 is shown in Figure 1. A value of 2.1 was calculated for the O/L ratio as the ratio of the heights of the oleic and linoleic acid peaks. This value was equal to that obtained by the conventional method using BF_3 The separation conditions, however, did not give good peaks for fatty acids with chain lengths beyond C 18.

BF_3 catalyzes methylation of fatty acids containing hydroxy and epoxy groups and the cyclopropene ring in addition to common fatty acids. Sodium methylate catalyzes methylation of phosphoglycerides, waxes, cholesterol and cerebrosides besides glycerides. Since groundnut oil comprises mainly triglycerides and does not contain such uncommon fatty acids (Young 1996), use of BF_3 or sodium methylate may not be of any special advantage. The method outlined here gives a good separation of methyl esters of oleic and linoleic acids and hence may be used for oleic/linoleic ratio analysis of large numbers of samples.

References

Luddy, F.E., Braford, R.A., Herb, S.F., and Magidman, P. 1968. A rapid and quantitative procedure for the production of methyl esters of butter oil and other fats. Journal of American Oil Chemists' Society 45:1549-1552.

Mason, M.E., and Waller, G.R. 1964. Dimethoxypropane induced transmethylation of fats and oils. Analytical Chemistry 36:583-586.

Metcalfe, L.D., and Schimitz, A.A. 1961. The rapid preparation of fatty acid esters for gas chromatographic analysis. Analytical Chemistry 53:363-364.

Worthington, R.E., Hammons, R.O., and Allison, J.R. 1972. Varietal differences and seasonal effects on fatty acid composition and stability of oil from 82 peanut genotypes. Journal of Agricultural and Food Chemistry 20:727-730.

Young, C.T. 1995. Peanut oil. Pages 377-392 in Bailey's industrial oil and fat products: edible oil and fat products: oils and oilseeds. Vol. 2 (Hui, Y.H., and Bailey, A.E., eds.). 5th edn. USA: John Wiley & Sons., Inc.

Chemical and Physical Characteristics of Argentinian Groundnut Milk

A G Lopez[1], N R Grosso[2], G Vargas[1], and C A Guzman[1] (1. Instituto de Ciencia y Tecnologia de los Alimentos, Facultad de Ciencias Exactas Fisicas y Naturales (UNC), IMBIV-CONICET. Ciudad Universitaria, 5000 Cordoba, Argentina. 2. Quimica Biol6gica, Facultad de Ciencias Agropecuarias (UNC, IMBIV-CONICET), Avda. Valparaiso s/n, CC 509, 5000 C6rdoba, Argentina)

Runner-type groundnut accounts for over 80% of the total production area in Argentina. The main cultivar grown in C6rdoba is Florman bred in Argentina from Florunner. Colorado Irradiado, a cultivar with small, red seeds, makes up most of the rest of the production (Grosso and Guzman 1995). Plant protein beverages are desirable in developing countries where cows' milk may be costly, unavailable, or not consumed due to dietary constraints or religious beliefs. Furthermore, cows' milk has cholesterol and lactose that could be a problem for some people. The chemical, physical, and sensory properties of groundnut milk are affected by processing conditions (Lee and Beuchat 1992), and they could be affected by the type and origin of groundnut. As the characteristics of oilseed beverages from Argentina have not been investigated this work was designed to determine the physical and chemical composition of Argentinian groundnut milk.

Sound, mature seeds of Florman and Colorado Irradiado cultivars of groundnut from C6rdoba were used. The seeds were submerged in distilled water (water:groundnut, 2:1) containing 0.5% (w/v) $CaCO_3$ in glass jars, sealed, and soaked for 5 min at room temperature. The seed mixture was then cooked for 10 min. After draining and washing with distilled water, the groundnuts were mixed with distilled water

Table 1. Physical characteristics and chemical composition of Argentinian groundnut milk.

Physical and chemical characteristics	Cultivars: Colorado Irradiado	Cultivars: Florman
pH	7.12 ± 0.10 a[3]	7.15 ±0.07 a
Viscosity (cps)	3.30 ± 0.09 a	3.21 ± 0.06 a
Density (g mL^{-1})	0.99 ± 0.08 a	0.93 ± 0.08 a
Total solids (g $100mL^{-1}$)	9.15 ± 0.13 a	9.10 ±0.13 a
Protein (g 100 mL^{-1})	2.97 ± 0.05 a	2.84 ± 0.06 b
Lipid (g 100 mL^{-1})	4.24 + 0.10 a	4.27 ±0.18 a
Ash(g 100 mL^{-1})	0.20 ± 0.03 a	0.18 ± 0.03 a
Carbohydrate (g 100 mL^{-1})	0.81 ± 0.06 a	0.91 ± 0.06 a
Total dietary fiber (g 100 mL^{-1})	0.93 ± 0.09 a	0.89 ± 0.08 a
Insoluble dietary fiber (g 100 mL^{-1})	0.66 ± 0.06 a	0.64 ± 0.08 a
Soluble dietary fiber (g 100 mL^{-1})	0.27 ± 0.03 a	0.25 ± 0.08 a
Fatty acids		
(g/100 g of total fatty acids)		
16:0	11.23 ± 0.37 a	10.29 ±0.55 a
18:0	2.29 ± 0.19 a	2.59 ±0.21 a
18:1	38.61 ± 1.57 a	45.18 ± 1.08 b
18:2	41.98 ± 0.44 a	35.67 ± 1.45 b
20:0	1.25 ± 0.07 a	1.04 ±0.16 a
20:1	1.44 ± 0.12 a	1.55 ±0.17 a
22:0	2.14 ± 0.30 a	2.71 ± 0.23 a
24:0	1.06 ± 0.17 a	0.96 ±0.21 a
O/L (18:1/18:2) ratio[1]	0.92 ± 0.05 a	1.27 ± 0.09 b
IV[2]	106.56 ± 0.51 a	101.87 ± 1.45 b

1. O/L = Oleic to linoleic ratio.
2. IV - Iodine value.
3. Means with the same letter within each row are not significantly different at P =0.05.

(water:groundnut, 4:1), ground in a mill and filtered through muslin cloth. The groundnut milk was pasteurized at 120°C in an autoclave for 30 min and stored at 5°C until analyzed. The pH, density, and viscosity were determined by a method of the AOAC (1980). The total solid content was determined by drying 80 mL of groundnut milk at 60°C for 3 days (Lee and Beuchat 1992). Protein, ash, and lipid contents were examined from total solids. Nitrogen and ash contents were determined according to AOAC (1980). Ash was produced by incineration in a muffle furnace at 525°C. The nitrogen content was estimated by the Kjeldahl method and converted to protein percentage by using the conversion factor 6.25. Oil was extracted from total solids for 16 h with petroleum ether (boiling range 30-60°C) in a Soxhlet apparatus. Oil percentages were determined by weight difference. Insoluble and soluble fiber were determined by the method of Asp et al. (1983). Carbohydrate content (excluding fiber) was estimated by difference. Fatty acid methyl esters were prepared from the oil of groundnut milk by transmethylation with a 3% solution of sulfuric acid in methanol (Jellum and Worthington 1966). These fatty acid methyl esters of total lipids were analysed on a Shimadzu GC-R1A gas chromatograph equipped with flame ionization detector (FID). AT-WAX superox II capillary column (30 m x 0.25 mm i. d.) was used. Column temperature was programmed from 180°C (held for 10 min) to 240°C (4°C min^{-1}). Iodine values were calculated from fatty acid percentages (Grosso and Guzman 1995) using the formula: (% oleic x 0.8601) + (% linoleic x 1.7321) + (% eicosenoic x 0.7854). All reported values are the means of triplicate analysis. Significant differences among mean values were evaluated using a t-test.

Chemical and physical characteristics are presented in Table 1. Significant differences in viscosity, pH, density, and total solids were not found between groundnut milks made from Florman and Colorado Irradiado seeds. The protein level of Florman groundnut milk was lower than that prepared from Colorado Irradiado. The protein content in Florman seeds is lower agreeing with previously reported results (Grosso and Guzman 1995). Lipid, ash, and carbohydrate contents did not show significant differences. A good level of total dietary fiber, which is a important component for the human diet, was found in the beverage. Fatty acid composition is similar to values previously reported in the Florman and Colorado Irradiado groundnut cultivars (Grosso and Guzman 1995). Oleic and linoleic acids, oleic to linoleic ratio (O/L) and iodine values were significantly different between the groundnut milks of Florman and Colorado Irradiado cultivars. Florman groundnut milk showed higher oleic acid and lower linoleic acid. Therefore, the oleic to linoleic ratio (O/L) was higher and iodine value (IV) was lower in this cultivar. A lower level of linoleic acid could be better for stability over a longer period of storage. Groundnut milk prepared with Argentinian groundnut cultivars showed higher total solids and protein levels and slightly lower lipid percentages than those found by Lee and Beuchat (1992). This variation could be due to type and origin of groundnut cultivars and different conditions of cultivation.

Acknowledgements. This research work was supported by Consejo de Investigaciones Cientificas y Tecnologicas de la Provincia de Cordoba (CONICOR), Secretaria de Ciencia y Tenica de la Universidad Nacional de Cordoba (SECYT), and Consejo Nacional de Investigaciones Cientificas y Tecnica (CONICET).

References

AOAC (Association of Official Analytical Chemists). 1980. Official methods of analysis of the Association of Official Analytical Chemists. 13th edn. (Horwitz, W., ed.). Washington, DC, USA: AOAC. 1018 p.

Asp, N.G., Johansson, C.G., Hallmer, H., and Siljestrom, M. 1983. Rapid enzymatic assay of insoluble and soluble dietary fiber. Journal of Agricultural and Food Chemistry 31:476-482.

Grosso, N.R., and Guzman, CA. 1995. Chemical characteristics of Argentinean groundnut cultivars. International Arachis Newsletter 15:17-18.

Jellum, M.D., and Worthington, R.E. 1966. A rapid method of fatty acid analysis of oil from individual corn (*Zea mays L.*) kernels. Crop Science 6:251-253.

Lee, C, and Beuchat, L.R. 1992. Chemical, physical and sensory characteristics of peanut milk as affected by processing conditions. Journal of Food Science 57:401-405.

Induced Genetic Variation for Seed Quality Traits in Groundnut

S L Dwivedi', S N Nigam[1], and M V R Prasad[2]
(1. International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru 502 324, Andhra Pradesh, India; 2. Cashew Rehabilitation Project CP 177, Nampala, Mozambique)

Fatty acid composition of groundnut seed oil largely determines its potential application in industrial and food uses. Oleic (O) and linoleic (L) fatty acids together account for 75-80% of the total fat in groundnut (Dwivedi et al. 1993). Although both are nutritionally important, linoleic acid is also associated with reduced shelf life of the oil or seed products (Worthington and Hammons 1977).

Induced mutants with altered fatty acids are reported in several oilseed crops. These include mutants with a high concentration of palmitic and stearic fatty acids in sunflower (Osorio et al. 1995), high stearic and low linoleic fatty acids in soybean (Wilcox et al. 1984, Graef et al. 1985), a low linoleic fatty acid in linseed (Rowland and Bhatty, 1990), reduced polyunsaturated fatty acids and increased oleic fatty acid in rapeseed (Auld et al. 1992), and a low linoleic fatty acid in groundnut (Sharma et al. 1985).

Although a naturally-occurring mutant of groundnut (F 435) with extremely low linoleic (2%) and high oleic (80%) fatty acids was reported from the University of Florida, USA (Norden et al. 1987), its availability for exploitation is restricted. Recently, SunOleic 95R cultivar with an O/L ratio of 29 has been released in the USA (Gorbet and Knauft 1997).

The present study was therefore initiated to enlarge genetic variation in O/L ratio by induced mutagenesis in groundnut.

Dry seeds (1000) of JL 24 (a widely grown early-maturing Spanish cultivar in India) and ICGV 88448 (a large-seeded late-maturing Virginia breeding line) were soaked in distilled water for 16 h and then exposed to

Table 1. Mean oil (g kg^{-1} seed) and fatty acids (g kg^{-1} oil) contents of selected groundnut mutants and controls, rainy (1993-96) and postrainy (1992/93-95/96) seasons, ICRISAT-Patancheru.

Genotype[1]	Oil	Palmitic	Oleic	Linoleic	Eicosenoic	Behenic	Lignoceric	TSF	O/L ratio
ICGV 96230	501.0*	83.6*	611.6*	201.5*	11.5	30.5	13.2	175.2	3.33*
ICGV 96234	501.1*	80.2*	625.6*	190.8*	11.9	29.9	13.2	171.5	3.51*
ICGV 96235	474.7*	121.3*	374.3*	400.7*	11.5	35.7*	17.9*	212.6*	0.94*
ICGV 96236	461.5*	118.8*	387.5*	389.7*	11.5	35.3*	17.0*	223.0*	1.03*
ICGV 96237	465.7*	122.9*	377.4*	398.4*	11.6	35.7*	17.3*	212.5*	0.95*
ICGV 96238	503.5*	105.9*	520.2*	266.3*	13.8*	38.6*	14.8*	200.2	1.96*
ICGV 96239	518.3*	105.0*	519.3*	272.1*	12.7*	35.4	13.8	195.8*	1.94*
ICGV 96240	505.7*	106.4*	518.0*	266.3*	13.4*	38.8*	15.4*	201.6	1.97*
Control									
ICGV 88448	487.5	93.9	544.5	262.5	11.3	31.2	12.3	180.3	2.08
JL 24	469.3	126.2	389.7	383.1	9.6	34.2	13.0	217.9	1.03
SE	±4.09	± 1.86	± 12.81	± 11.0	±0.72	± 1.29	±0.39	±6.26	± 0.098

1. ICGVs 96230, 96234.96235, 96236, and 96237 originated from ICGV 88448 and ICGVs 96238, 96239, and 96240 from JL 24.;
* Significant at 0.0S probability level.

0.3% (vol/vol) ethyl methan sulfonate (EMS) solution with intermittent shaking for 8 h. The seeds were then rinsed with running tap water for 30 minutes and sown in the field. The M_1 generation was bulk harvested. The M_2 and subsequent generations were handled following standard breeding procedure. Twenty-five M_3 progeny bulks with altered fatty acid composition were selected. These mutants were advanced to four generations and evaluated for oil and fatty acid composition. Fourteen phenotypically uniform mutants along with ICGV 88448 and JL 24 were evaluated in a replicated trial for seed quality traits during the rainy (1996) and postrainy (1995/96 and 1996/97) seasons at ICRISAT-Patancheru, India.

Sound mature seeds were analysed for oil and fatty acids contents. Total saturated fat (TSF = palmitic acid + stearic acid + arachidic acid + behenic acid + lignoceric acid) and O/L ratio were also determined. The oleic desaturation ratio (ODR = oleic acid / (oleic acid + linoleic acid)) was used to measure the activity of desaturation enzyme.

Eight seasons data (M_3 - M_7 generations and replicated trial) on oil and individual fatty acid contents, with unequal replications, were analysed following the residual maximum likelihood (REML) method in GENSTAT (Thompson and Welham 1993).

EMS treatment caused significant differences among mutants in oil content, palmitic, oleic, linoleic, eicosenoic, behenic, and lignoceric acids contents, TSF, and O/L ratio. Stearic and arachidic acids were not affected by EMS.

Mean oil and individual fatty acids contents, TSF, and O/L ratio of the selected mutants and controls are presented in Table 1. In comparison with controls (ICGV 88448 and JL 24), oil content significantly increased in ICGVs 96230, 96234, 96238, 96239, and 96240 and decreased in ICGVs 96235, 96236, and 96237. Differences in oil content also brought significant changes in fatty acid composition. Increased oil content led to high oleic and O/L ratio and low palmitic and linoleic acids in ICGVs 96230, 96234, 96238, 96239, and 96240. Behenic and lignoceric acids in ICGVs 96238 and 96240, and TSF in ICGV 96239 also increased significantly. On the contrary, although ICGVs 96235, 96236, and 96237 had reduced oil content, they showed increases in palmitic, linoleic, behenic, and lignoceric acids, and TSF, and decreased oleic acid and O/L ratio.

The ratio of linoleic acid/(oleic acid + linoleic acid) indicates the proportion of substrate desaturation from oleic to linoleic acids (Velasco et al. 1997). Genotypes with a high oil content had a lower oleic desaturation ratio (ODR = 0.234 to 0.344) compared with those with a low oil content (ODR- 0.501 to 0.517). Low oil content in ICGVs 96235, 96236, and 96237 is probably associated with a high ODR ratio which results in a lower O/L ratio and, therefore, shorter shelf life of the groundnut product/oil.

References

Auld, D.L., Heikkinen, M.K., Erickson, D.A., Sernyk, J.L., and Romero, J.E. 1992. Rapeseed mutants with reduced levels of polyunsaturated fatty acids and increased levels of oleic acid. Crop Science 32:657-662.

Dwivedi, S.L., Nigam, S.N., Jambunathan, R., Sahrawat, K.L., Nagabhushanam, G.V.S., and Raghunath, K. 1993. Effect of genotypes and environments on oil content and oil quality parameters and their correlation in peanut (*Arachis hypogaea L.*). Peanut Science 20:84-89.

Graef, G.L., Miller, L.A., Fehr, W.R., and Hammond, E.G. 1985. Fatty acid development in a soybean mutant with high stearic acid. Journal of the American Oil Chemists Society 62:773-775.

Norden, A.J., Gorbet, D.W., Knauft, D.A., and Young, C.T. 1987. Variability in oil quality among peanut genotypes in the Florida breeding program. Peanut Science 14:7-11.

Osorio, J., Fernandez-Martinez, J., Mancha, M., and Garces, R. 1995. Mutant sunflowers with high concentration of saturated fatty acids in the oil. Crop Science 35:739-742.

Rowland, G.G., and Bhatty, R.S. 1990. Ethyl methan sulphonate induced fatty acid mutations in flax. Journal of the American Oil Chemists Society 67:213-214.

Sharma, N.D., Santha, I.M., Patil, S.H., and Methta, S.L. 1985. Fatty acid and amino acid composition of groundnut mutants. Qualitas Plantarum Plant Foods for Human Nutrition 35:3-8.

Thompson, R., and Welham, S.J. 1993. RMEL estimation of variance components and analysis of unbalanced designs. Pages 539-583 in Genstat 5, Release 3 - Reference Manual. Oxford, UK: Clarendon Press.

Velasco L., Fernandez-Martinez, J.M., and De Haro, A. 1997. Induced variability for C 18 unsaturated fatty acids in Ethiopian mustard. Canadian Journal of Plant Science 77:91-95.

Wilcox, J.R., Cavins, J.F., and Nielsen, N.C. 1984. Genetic alteration of soybean oil composition by a chemical mutagen. Journal of the American Oil Chemists Society 61:97-100.

Worthington, R.E., and Hammons, R.O. 1977. Variability in fatty acid composition among Arachis genotypes: A potential source of product improvement. Journal of the American Oil Chemists Society 54.105A-108A.

New publications from ICRISAT

Copies of titles are available from: Distribution Unit, PIM Division, International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru 502 324, Andhra Pradesh, India.

Prices. Per-copy prices are listed separately for

- highly-developed countries (HDCs), expressed in US dollars
- less-developed countries (LDCs), also expressed in US dollars
- India and other countries in the Indian subcontinent, expressed in Indian rupees at a rate equivalent to the LDC price.

Air bookpost postage and handling charges are included in these prices.

HDCs include Australia, Brazil, Canada, Dubai, European countries, Iran, Iraq, Japan, Kuwait, Libya, Mexico, New Zealand, Saudi Arabia, South Africa, and USA.

Payment. Prepayment is required in US dollars, or the following negotiable currencies: Deutsche marks, Dutch guilders, French and Swiss francs, Pounds Sterling, and Yen, or Indian rupees, payable to ICRISAT by banker's draft, demand draft, or money order.

Free copies. Single free copies are available only to the following

- Organizations that formally exchange publications with ICRISAT Libraries
- Libraries of selected agricultural universities and research institutions in semi-arid tropical countries
- Journal editors who review ICRISAT publications
- National program staff who collaborate with ICRISAT research programs.

Discount. Book trade discounts are available on request. Other orders for five or more copies of a *single publication* are discounted by 20%.

Air/Surface mail. Experience shows that surface packages are often delayed for months, do not always reach their destinations, and may be damaged. Therefore all publications are despatched by air bookpost.

Order codes. Please use ICRISAT order codes when ordering publications. These are given with each entry below.

Food from Thought no. 6. 1997. A series of narratives on the practical application of research conducted by ICRISAT and its collaborators. A triple alliance towards prosperity. ICRISAT-NGO collaboration boosted the morale of the groundnut farmers of Amravati and its neighboring districts in Maharashtra, India. 8 pp. Order code FTE 006. Single copies free.

SATCRIS listings

The following two listings of 1997 and 1998 publications have been generated from ICRISAT's electronic bibliographic database SATCRIS—the Semi-Arid Tropical Crops Information Service. The list of "Other legume-related publications" excludes publications on Chickpea and Pigeonpea. These appeared in the International Chickpea and Pigeonpea Newsletter. Copies of entries followed by JA or CP numbers can be obtained by writing to

Senior Manager
Library and Documentation Services
ICRISAT
Patancheru 502 324, Andhra Pradesh, India
S.SRINIVAS@CGNET.COM

Groundnut publications

Adomou, M., Ntare, B.R., and Williams, J.H. 1997. Stability of pod yields and parameters of a simple physiological model for yield among peanut lines in northern Benin. Peanut Science 24:107-112. (JA 1936)

Ae, N., and Otani, T. 1997. The role of cell wall components from groundnut roots in solubilizing sparingly soluble phosphorus in low fertility soils. Pages 265-270 in Plant nutrition for sustainable food production and environment. Proceedings of the XIII International Plant Nutrition Colloquium, Tokyo, Japan, 13-19 Sep 1997 (Ando, T., Fujita, K., Mae, T., Matsumoto, H., Mori, S., and Sekiya, J., eds.). Plant and Soil 196.

Anitha, V. 1997. Applied ecology of white grubs in groundnut in Andhra Pradesh. Ph.D. thesis, Acharya N G Ranga Agricultural University, Hyderabad, Andhra Pradesh, India.

Aoki, T., Matsuo, K., Suga, T., and Ohta, S. 1997. Arachisprenols: polyprenols possessing a geranyl residue from *Arachis hypogaea.* Phytochemistry 46: 715-720.

Araujo, W.F., and Ferreira, L.G.R. 1997. Effect of water stress during different stages of peanut. Pesquisa Agropecuaria Brasileira 32:481-484.

Athar, M., and Mahmood, A. 1997. Effect of peanut plants incorporated as green manure on the growth and grain yield of succeeding wheat. Journal of Agronomy and Crop Science 179:135-138.

Baidu-Forson, J., Ntare, B.R., and Waliyar, F. 1997. Utilizing conjoint analysis to design modern crop varieties: empirical example for groundnut in Niger. Agricultural Economics 16:219-226. (JA 1912)

Bajracharya, J. 1997. Effect of storage containers and seed moisture content on the germinability and vigour of groundnut seed under ambient condition of storage. Nepalese Journal of Agriculture 18-28:99-102.

Baydar, H., and Yuce, S. 1997. Studies on morphological and physiological aspects of yield differences between groundnut *(Arachis hypogaea L.)* varieties. Turkish Journal of Agriculture & Forestry 21:141-148.

Bell, M.J., and Wright, G.C. 1998. Groundnut growth and development in contrasting environments. 1. Growth and plant density responses. Experimental Agriculture 34:99-112.

Bell, M.J., and Wright, G.C. 1998. Groundnut growth and development in contrasting environments. 2. Heat unit accumulation and photo-thermal effects on harvest index. Experimental Agriculture 34:113-124.

Bell, M.J., McLaughlin, M.J., Wright, G.C, and Cruickshank, A. 1997. Inter- and intra-specific variation in accumulation of cadmium by peanut, soybean, and navybean. Australian Journal of Agricultural Research 48:1151-1160.

Bhanukiran, Y., Rao, P.A., and Rao, K.T. 1997. Effect of certain chemicals and their combinations on natural enemies of *Spodoptera litura* (F.) in groundnut. Pesticide Research Journal 9:238-240.

Bittencourt, S.R.M., and Vieira, R.D. 1997. Use of reduced concentrations of tetrazolium solutions for the evaluation of the viability of peanut seed lots. Pages 75-82 *in* Proceedings of the International Seed Testing Association. Seed Science and Technology 25. Reckenholz, Switzerland: International Seed Testing Association's Secretariat.

Branch, W.D. 1997. Registration of Georgia Non-Nod peanut genetic stock. Crop Science 37:1412.

Branch, W.D., Williams, D.E., and Williams, E.J. 1997. Inheritance of black-pod color in peanut. Journal of Heredity 88:156-158.

Brown, R.H, and Byrd, G.T. 1997. Transpiration efficiency, specific leaf weight, and mineral concentration in peanut and pearl millet. Crop Science 37:475-480.

Chaves, J.C.D., Gorreta, R.H., Demoner, C.A., Casanova Junior, G., and Fantin, D. 1997. Horse peanut (*Arachis hypogaea*) as an alternative for intercropping in coffee plantations. Boletim Tecnico no. 55. Londrina, Brazil: Instituto Agronomico do Parana. 20 pp.

Chauhan, Y.S., and Senboku, T. 1997. Evaluation of groundnut genotypes for heat tolerance. Annals of Applied Biology 131:481-489. (JA 2086)

Chen Miaw Fan, and Lin Chan Pin. 1997. DNA probes and PCR primers for the detection of a phytoplasma associated with peanut witches'-broom. European Journal of Plant Pathology 103:137-145.

Cheng Hong Yan, Zheng Guang Hua, Jing Xin Ming, Kuang Tin Yun, Tang Pei Song, Tao Kar Ling, Zhou Ming De, and Duan Nai Xiong. 1997. Storage of peanut seeds with low moisture content for 11 years in ambient temperature. Plant Genetic Resources Newsletter 110:35-40.

Cheng, M., Jarret, R.L., Li, Z., and Demski, J.W. 1997. Expression and inheritance of foreign genes in transgenic peanut plants generated by Agrobacterium-mediated transformation. Plant Cell Reports 16:541-544.

Chengalrayan, K., Mhaske, V.B., and Hazra, S. 1997. High-frequency conversion of abnormal peanut somatic embryos. Plant Cell Reports 16:783-786.

Cheong, Y.K., Oh, Y.S., Park, M.S., Lee, Y.I., Choi, S.Y., and Park, K.H. 1997. Mutagenesis of peanut (*Arachis hypogaea L.*) as affected by moisture content of seed and gamma-ray dosage. Korean Journal of Breeding 29:124-131.

Cheong, Y.K., Oh, Y.S., Park, M.S., Lee, Y.I., and Park, K.H. 1997. Morphological characteristics, of mutants induced by gamma-ray treatment in peanut (*Arachis hypogaea L.*). Korean Journal of Breeding 29:132-138.

Chiou, R.Y.Y., Ku, K.L., and Chen, W.L. 1997. Compositional characterization of peanut kernels after subjection to various germination times. Journal of Agricultural and Food Chemistry 45:3060-3064.

Culbreath, A.K., Todd, J.W., Gorbet, D.W., Shokes, F.M., and Pappu, H.R. 1997. Field response of new peanut cultivar UF 91108 to tomato spotted wilt virus. Plant Disease 81:1410-1415.

Dahal, K.C., Neupane, R.K., and Shrestha, M. 1997. Varietal research report on groundnut, 1993/94. PAC Working Paper no. 191. Dhankuta, Nepal: Pakhribas Agricultural Centre. 12 pp.

Deck, S.H., and Phipps, P.M. 1997. Development and implementation of a bulletin board system for information transfer to the Virginia peanut and cotton industry. Applied Engineering in Agriculture 13:415-419.

Deka, N.C., Gogoi, P.K., Baroova, S.R., and Rajkhowa, D.J. 1997. Effect of sowing dates on groundnut varieties in Upper Brahmaputra valley zone of Assam. Annals of Agricultural Research 18:21-24.

Dubey, S.C. 1997. Influence of age of plants, temperature and humidity on web blight development in groundnut. Indian Phytopathology 50:119-120.

El-Hassan, S.M., Naidu, R.A., Ahmed, A.H., and Murant, A.F. 1997. A serious disease of groundnut caused by cowpea mild mottle virus in the Sudan. Journal of Phytopathology 145:301-304. (JA 1953)

Galgaro, L., Valls, J.F.M., and Lopes, C.R. 1997. Study of the genetic variability and similarity among and within Arachis villosulicarpa, *A. pietrarellii* and *A. hypogaea* through isoenzyme analysis. Genetic Resources and Crop Evolution 44:9-15.

Ge DaoKuo, and Jin ZhiQing. 1997. The impacts of global climate change on groundnut production in China. Jiangsu Journal of Agricultural Sciences 13: 55-59.

Ghatak, S., Sounda, G., Maitra, S., Saren, B.K., Roy, D.K., and Panda, P.K. 1997. Effect of irrigation and potassium on growth and productivity of summer groundnut. Environment and Ecology 15:469-473.

Gorbet, D.W., and Knauft, D.A. 1997. Registration of 'SunOleic 95R' peanut. Crop Science 37:1392.

Grosso, N.R., Zygadlo, J.A., Lamarque, A.L., Maestri, D.M., and Guzman, C.A. 1997. Proximate, fatty acid and sterol compositions of aboriginal peanut (*Arachis hypogaea L.*) seeds from Bolivia. Journal of the Science of Food and Agriculture 73:349-356.

Hadjichristodoulou, A., Dwivedi, S.L., Wynne, J.C., Nigam, S.N., Alexandrou, G., Theodorides, C, and Mouzouris, M. 1997. Registration of ICGV 88438, ICGV 89214, and ICGV 91098 peanut germplasm. Crop Science 37:1985. (JA 1933)

Harari, A.R., Ben-Yakir, D., Chen, M., and Rosen, D. 1997. Life- and fertility-tables of *Maladera matrida* (Coleoptera: Scarabaeidae). Environmental Entomology 26:1073-1078.

Harari, A.R., Ben-Yakir, D., Chen, M., and Rosen, D. 1997. Population dynamics of *Maladera matrida* (Coleoptera: Scarabaeidae) in peanut fields in Israel. Environmental Entomology 26:1040-1048.

Harch, B.D., Basford, K.E., DeLacy, I.H., and Lawrence, P.K. 1997. The analysis of large scale data taken from the world groundnut (*Arachis hypogaea L.*) germplasm collection. I. Two-way quantitative data. Euphytica 95:27-38.

Hashem, F.M., Saleh, S.A., Berkum, P. van, and Voll, M. 1997. Survival of *Bradyrhizobium* sp. (Arachis) on fungicide-treated peanut seed in relationship to plant growth and yield. World Journal of Microbiology & Biotechnology 13:335-340.

He GuoHao, and Prakash, C.S. 1997. Identification of polymorphic DNA markers in cultivated peanut (*Arachis hypogaea L.*). Euphytica 97:143-149.

Holbrook, C.C., Wilson, D.M., Matheron, M.E., and Anderson, W.F. 1997. Aspergillus colonization and aflatoxin contamination in peanut genotypes with resistance to other fungal pathogens. Plant Disease 81: 1429-1431.

International Crops Research Institute for the Semi-Arid Tropics. 1997. Groundnut elite germplasm ICGV-SM 83005. Plant Material Description, International Crops Research Institute for the Semi-Arid Tropics. 73. Patancheru, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics. 4 pp.

International Crops Research Institute for the Semi-Arid Tropics. 1997. Groundnut variety ALR 2. Plant Material Description, International Crops Research Institute for the Semi-Arid Tropics. 72. Patancheru, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics. 3 pp.

International Crops Research Institute for the Semi-Arid Tropics. 1997. Groundnut elite germplasm ICGV-SM 85048. Plant Material Description, International Crops Research Institute for the Semi-Arid Tropics. 74. Patancheru, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics. 4 pp.

International Crops Research Institute for the Semi-Arid Tropics. 1997. Groundnut elite germplasms ICGV 92196, ICGV 92206, ICGV 92234, and ICGV 92243. Plant Material Description, International Crops Research Institute for the Semi-Arid Tropics. 76. Patancheru, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics. 4 pp.

International Crops Research Institute for the Semi-Arid Tropics. 1997. Groundnut elite germplasm 1CGV-SM 86715. Plant Material Description, International Crops Research Institute for the Semi-Arid Tropics. 75. Patancheru, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics. 4 pp.

Isleib, T.G., Rice, P.W., Bailey, J.R., Mozingo, R.W., and Pattee, H.E. 1997. Registration of 'NC 12C' peanut. Crop Science 37:1976.

Jain, L.L., Panda, R.K., and Sharma, C.P. 1997. Water stress response function for groundnut (*Arachis hypogaea L.*). Agricultural Water Management 32: 197-209.

Jakkula, L.R., Knauft, D.A., and Gorbet, D.W. 1997. Inheritance of a shriveled seed trait in peanut. Journal of Heredity 88:47-51.

Kanyand, M., Peterson, C.M., and Prakash, C.S. 1997. The differentiation of emergences into adventitious shoots in peanut, *Arachis hypogaea L.* Plant Science 126:87-95.

Kashiwaba, K., Matsuda, T., and Chonan, N. 1997. Electron microscopy of lipid accumulation in the developing cotyledon of groundnuts (*Arachis hypogaea L.*). Japanese Journal of Crop Science 66:51-61.

Khetmalas, M.B., and Bal, A.K. 1997. Oleosins of *Arachis hypogaea L.* (peanut) root nodule oleosomes (lipid bodies). International Journal of Plant Sciences 158:136-141.

Kim, S.D., Lee, S.W., and Park, C.H. 1997. Seed development and germinability of unripened seed in peanuts. Korean Journal of Crop Science 42:333-337.

Klerk, A. de, McLeod, A., Faurie, R., and Wyk, P.S. van. 1997. Net blotch and necrotic warts caused by Streptomyces scabies on pods of peanut (*Arachis hypogaea*). Plant Disease 81:958.

Kokalis-Burelle, N., Porter, D.M., Rodriguez-Kabana, R., Smith, D., and Subrahmanyam, P., (eds.) 1997. Compendium of peanut diseases. St. Paul, Minnesota, USA: APS Press. 100 pp.

Kokalis-Burelle, N. 1997. Compendium of peanut diseases. The disease compendium series of the American Phytopathological Society. St. Paul, Minnesota, USA: APS Press, American Phytopathological Society. 94 pp.

Krishna, A., Devi, M.U., Gopal, K., and Rao, K.V. 1997. Response of winter-season groundnut (*Arachis hypogaea*) to calcium, sulphur and zinc. Indian Journal of Agricultural Sciences 67:429-430.

Krishna, K.R. 1997. Phosphorus uptake and utilization efficiency in peanut. Peanut Science 24:1-6. (JA 1317)

Lacorte, C, Aragao, F. J.L., Almeida, E.R., Mansur, E., and Rech, E.L. 1997. Transient expression of GUS and the 2S albumin gene from Brazil nut in peanut (*Arachis hypogaea L.*) seed explants using particle bombardment. Plant Cell Reports 16:619-623.

Lauriano, J.A., Campos, P.S., Ramalho, J.C., Lidon, F.C., Guedes, M.E., and Matos, M. do C. 1997. Partial decline of Arachis hypogaea L. photosynthesis triggered by drought stress. Photosynthetica 33:81-90.

Law, I.J., and Kfir, R. 1997. Effect of mannose-binding lectin from peanut and pea on the stem borer Chilo partellus. Entomologia Experimentalis et Applicata 82:261-265.

Lee, H., and Chuang, T.Y. 1997. Distribution and seasonal variation of aflatoxin-producing strains of *Aspergillus flavus* in peanut fields at Penghu. Plant Pathology Bulletin 6:58-66.

Li Zhijian, Jarret, R.L., and Demski, J.W. 1997. Engineered resistance to tomato spotted wilt virus in transgenic peanut expressing the viral nucleocapsid gene. Transgenic Research 6:297-305.

Lien Hoa, N.T., Phung, N.T.T., Lieu, P., Hien, T.M., Vu, N.K., Toan, P.V., and Dang, V.H. 1997. On-farm experiments on rhizobial inoculants for groundnut in Vietnam. Pages 249-258 in Extending nitrogen fixation research to farmers' fields: proceedings of an International Workshop on Managing Legume Nitrogen Fixation in the Cropping Systems of Asia, ICRISAT Asia Center, Patancheru, Andhra Pradesh, India, 20-24 Aug 1996 (Rupela, O.P., Johansen, C, and Herridge, D.F., eds.). Patancheru, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics.

Lin Lu, and Fu Jia Rui. 1997. Differences in BAPAase activity between the cotyledon and hypocotyl of groundnut embryos during seed development and germination. Acta Phytophysiologica Sinica 23:29-33.

Liphadzi, M.S., Thomas, R.M., and Hammes, P.S. 1997. Competition between intercropped maize (Zea mays L.) and groundnut *(Arachis hypogaea L.).* Applied Plant Science 11:31-38.

Littlefield, T.A., Colvin, D.L., Brecke, B.J., and McCarty, L.B. 1997. Effect of nicosulfuron mixtures and time of application on peanut *(Arachis hypogaea*) cultivars. Weed Technology 11:1-6.

Lu, K.C., Yeh, M.S., Yang, K.S., and Lu, H.S. 1997. Effects of genotype, population density and harvest date on yield and quality of peanut. Journal of Agricultural Research of China 46:116-131.

McDonald, D., Reddy, D.V.R., Sharma, S.B., Mehan, V.K., and Subrahmanyam, P. 1997. Diseases of groundnut. Pages 63-124 in Pathology of food and pasture legumes (Allen, D.J., and Lenne, J.M., eds.). Wallingford, UK: CAB International. (JA 2012)

Mehan, V.K., and Gowda, C.L.L. 1997. Aflatoxin contamination problems in groundnut in Asia: proceedings of the first Asia Working Group Meeting, Hanoi, Vietnam, 27-29 May 1996. Patancheru, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics. 104 pp.

Mishra, B. 1997. Highlights of collaborative groundnut research. Sarlahi, Nepal: Oilseed Research Programme.

Mohanty, S.K., Pani, S.K., Kar, M., and Baisakh, N. 1997. Effect of herbicides on increase in productivity of groundnut *(Arachis hypogaea).* Indian Journal of Agricultural Sciences 67:296-298.

Morris, J.B., Dunn, S., Pinnow, D.L., Hopkins, M.S., and Pittman, R.N. 1997. Meristem culture for virus elimination and peanut interspecific hybrid preservation. Crop Science 37(2):591-594.

Moss, J.P., Singh, A.K., Reddy, L.J., Nigam, S.N., Subrahmanyam, P., McDonald, D., and Reddy, A.G.S. 1997. Registration of ICGV 87165 peanut germplasm line with multiple resistance. Crop Science 37:1028. (JA 1849)

Mudalagiriyappa, Agasimani, C.A., Veeranna, K.K., and Nanjappa, H.V. 1997. Nutrient recovery and balance sheet of nitrogen and phosphorus as influenced by sources of phosphate solubilizers and phosphate on groundnut crop. Mysore Journal of Agricultural Sciences 31:143-148.

Muthukumarasamy, M., and Panneerselvam, R. 1997. Amelioration of NaCl stress by triadimefon in peanut seedlings. Plant Growth Regulation 22:157-162.

Nautiyal, P.C., Ravindra, V., and Misra, J.B. 1997. Response of dormant and non-dormant seeds of groundnut *(Arachis hypogaea)* genotypes to accelerated ageing. Indian Journal of Agricultural Sciences 67:67-70.

Nayak, P.K., and Patra, G.J. 1997. Genetic divergence in a collection of groundnut germplasm. Environment and Ecology 15:249-254.

Nigam, S.N., Dwivedi, S.L., Ramraj, V.M., and Chandra, S. 1997. Combining ability of response to photoperiod in peanut. Crop Science 37:1159-1162. (JA 1941)

Osuji, G.O., and Madu, W.C. 1997. Regulation of peanut glutamate dehydrogenase by methionine sulphoximine. Phytochemistry 46:817-825.

Pande, S., Olorunju, P.E., Miningou, A., Ntare, B.R., and Waliyar, F. 1997. Rosette disease of groundnut and its management in west and central Africa. Arachide Infos 7:13-17. (JA 2056)

Patel, H.R., Valand, G.B., Shekh, A.M., and Patel, J.G. 1997. Weather in relation to late leaf spot disease development in two groundnut cultivars. Annals of Agricultural Research 18:16-20.

Rajagopal, V. 1997. A handbook on drought tolerant crop species of India. New Delhi, India: Society for Plant Physiology and Biochemistry. 244 pp.

Rajgopal, K., Chandran, K., Bhagat, N.R., and Bhalodia, P.K. 1997. Morphological characterization of Valencia and Virginia bunch peanut *(Arachis hypogaea* L.) germplasm. Plant Genetic Resources Newsletter 109:27-29.

Ramraj, V.M., Vyas, B.N., Godrej, N.B., Mistry, K.B., Swami, B.N., and Singh, N. 1997. Effects of 28-homobrassinolide on yields of wheat, rice, groundnut, mustard, potato and cotton. Journal of Agricultural Science 128:405-413.

Randhur Kharub, Harvir Singh, and Rohilla, H.R. 1997. Seasonal abundance of insect-pests and mite of groundnut (*Arachis hypogaea*) under irrigated condition. Indian Journal of Agricultural Sciences 67:282-284.

RARS (Regional Agricultural Research Station). 1997. Chickpea pigeonpea and groundnut research report 1996/97, RARS, Nepalgunj. Khajura, Nepalgunj, Nepal: Regional Agricultural Research Station. 39 pp.

Rashid, A., Rafique, E., and Ali, N. 1997. Micronutrient deficiencies in rainfed calcareous soils of Pakistan. II. Boron nutrition of the peanut plant. Communications in Soil Science and Plant Analysis 28:149-159.

Ravinder Singh, Hemlata Gautam, Vani Jayaraman, Girija Nair, and Hasi Das. 1997. Vegetative tissue lectins of peanut (*A. hypogaea*). Indian Journal of Biochemistry & Biophysics 34:72-75.

Ray, S.P., Chaudhary, B.P., and Chaudhary, LB. 1997. A report on outreach research on groundnut (1996/97) *in* Review and Planning Workshop on ORP/NARC/CLAN/ICRISAT Research Programme, Khumaltar, Lalitpur, Nepal 7-8 Jul 1997. Sarlahi, Nepal: Oilseed Research Programme.

Reddy, D.V.R., Delfosse, P., Lenne, J.M., and Subrahmanyam, P. 1997. Groundnut virus diseases in Africa: summary and recommendations of the Sixth Meeting of the International Working Group, Pretoria, South Africa, 18-19 Mar 1996. Patancheru, India: International Crops Research Institute for the Semi-Arid Tropics. 60 pp.

Reddy, P.M., Reddy, B.R., and Reddy, B.S. 1997. Weed management in groundnut-pigeonpea intercropping system. Annals of Agricultural Research 18:1-4.

Rijal, D.K., and Dahal, K.C. 1997. Groundnut varietal research report: results of on-station and on-farm trials (1995/96). PAC Working Paper no. 198. Dhankuta, Nepal: Pakhribas Agricultural Centre. 13 pp.

Royal, S.S., Brecke, B.J., Shokes, F.M., and Colvin, D.L. 1997. Influence of broadleaf weeds on chlorothalonil deposition, foliar disease incidence, and peanut (*Arachis hypogaea*) yield. Weed Technology 11:51-58.

Royal, S.S., Brecke, B.J., and Colvin, D.L. 1997. Common cocklebur (*Xanthium strumarium)* interference with peanut (*Arachis hypogaea*). Weed Science 45:38-43.

Samui, R.C., and Ahasan, A.K.M.M. 1997. Response of summer groundnut (*Arachis hypogaea*) to level and method of phosphorus application. Indian Journal of Agricultural Sciences 67:164-165.

Santos, R.C. dos , Melo Filho, P. de A., Brito, S. de F.M. de, and Moraes, J. de S. 1997. Phenology of groundnut genotypes of the Valencia and Virginia botanical types. Pesquisa Agropecuaria Brasileira 32: 607-612.

Sarkar, R.K., Kishor, S., Chakraborty, A., Banik, P., and Bala, B. 1997. Effect of planting pattern and intercropping of pulses and oilseed with groundnut (*Arachis hypogaea*) in coastal land. Indian Journal of Agricultural Sciences 67:161-163.

Saxena, M., and Saxena, D.R. 1997. Effect of foliar application of benzimidazole and dithiocarbamate fungicides on macro- and micro-nutrient content of groundnut leaves. Plant Disease Research 12:62-64.

Singh, A.K., Mehan, V.K., and Nigam, S.N. 1997. Sources of resistance to groundnut fungal and bacterial diseases: an update and appraisal. Information Bulletin no. 50. Patancheru 502 324, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics. 48 pp.

Singh,A.L., and Chaudhari, V. 1997. Sulphur and micronutrient nutrition of groundnut in a calcareous soil. Journal of Agronomy and Crop Science 179:107-114.

Singsit, C., Adang, M.J., Lynch, R.E., Anderson, W.F., Aiming Wang, Cardineau, G., and Ozias-Akins, P. 1997. Expression of a *Bacillus thuringiensis* cryIA(c) gene in transgenic peanut plants and its efficacy against lesser cornstalk borer. Transgenic Research 6:169-176.

South Africa, Landbouweekblad, Cape Town. 1997. High yields in cultivar experiments (soyabean, sunflower and groundnut). Landbouweekblad 979:10-13.

Stalker, H.T. 1997. Peanut (*Arachis hypogaea L.*). Field Crops Research 53:205-217.

Subrahmanyam, P. 1997. Bacterial leaf spot. Page 43 *in* Compendium of peanut diseases. (Kokalis-Burelle, N., Porter, D.M., Rodriguez-Kabana, R., Smith, D.H., Subrahmanyam, P., eds.). St. Paul, Minnesota: American Phytopathological Society. (JA 1706)

Subrahmanyam, P. 1997. Olpidium root discoloration. Page 23 *in* Compendium of peanut diseases. (Kokalis-Burelle, N., Porter, D.M., Rodriguez-Kabana, R., Smith, D.H., Subrahmanyam, P., eds.). St. Paul, Minnesota: American Phytopathological Society. (JA 1708)

Subrahmanyam, P. 1997. Parasitic flowering plants. Pages 70 -71 in Compendium of peanut diseases. 2nd edn. (Kokalis-Burelle, N., Porter, D.M., Rodriguez-Kabana, R., Smith, D.H., Subrahmanyam, P., eds.). St. Paul, Minnesota: American Phytopathological Society. (JA 1709)

Subrahmanyam, P. 1997. Rust. Pages 31-33 in Compendium of peanut diseases. (Kokalis-Burelle, N., Porter, D.M., Rodriguez-Kabana, R., Smith, D.H., Subrahmanyam, P., eds.). St. Paul, Minnesota: American Phytopathological Society. (JA 1721)

Subrahmanyam, P., van Wyk, P.S., Kisyombe, C.T., Cole, D.L., Hildebrand, G.L., Chiyembekeza, A.J., and van der Merwe, P.J.A. 1997. Diseases of groundnut in the Southern African Development Community (SADC) region and their management. International Journal of Pest Management 43:261-273. (JA 1949)

Subrahmanyam, P., and Hildebrand, G.L. 1997. Responses of peanut genotypes to fungicidal control of early leaf spot in Malawi. Peanut Science 24:73-77. (JA 1965)

Sudheendra Ashtaputre, and Srikant Kulkarni. 1997. Estimation of yield losses due to late leaf spot of groundnut. Plant Disease Research 12:182-183.

Uheda, E., Akasaka, Y., and Daimon, H. 1997. Morphological aspects of the shedding of surface layers from peanut roots. Canadian Journal of Botany 75: 607-611.

Upadhyaya, H.D., and Nigam, S.N. 1998. Epistasis for vegetative and reproductive traits in peanut. Crop Science 38:44-49. (JA 1981)

Upadhyaya, H.D., Nigam, S.N., Rao, M.J.V., Reddy, N.S., Yellaiah, N., and Reddy, A.G.S. 1997. Registration of ICGV 86143 peanut germplasm. Crop Science 37:1986. (JA 1877)

Upadhyaya, H.D., Nigam, S.N., Rao, M.J.V., Reddy, A.G.S., Yellaiah, N., and Reddy, N.S. 1997. Registration of five Spanish peanut germplasm lines with fresh seed dormancy. Crop Science 37:1027. (JA 1873)

USA, Oklahoma Agricultural Experiment Station USA, and Oklahoma Cooperative Extension Service. 1997. Partners in progress... peanut research at OSU supported by the Oklahoma Peanut Commission, 1997. Report, Oklahoma Agricultural Experiment Station, no. P-963. Stillwater, Oklahoma, USA: Oklahoma State University, Division of Agricultural Sciences and Natural Resources. 28 pp.

Venkateswarlu, B. 1997. Development of high nitrogen-fixing selections in groundnut - stategy and progress. Pages 289-296 in Extending nitrogen fixation research to farmers' fields: proceedings of an International Workshop on Managing Legume Nitrogen Fixation in the Cropping Systems of Asia, ICRISAT Asia Center, Patancheru, Andhra Pradesh, India, 20-24 Aug 1996 (Rupela, O.P., Johansen, C, and Herridge, D.F., eds.). Patancheru, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics.

White, A.D., and Coble, H.D. 1997. Validation of HERB for use in peanut (*Arachis hypogaea*). Weed Technology 11:573-579.

Wolf, S.P., Bowen, K.L., and Mack, T.P. 1997. Augmentation of southern stem rot in peanuts by larval feeding of the lesser cornstalk borer (Lepidoptera: Pyralidae). Journal of Economic Entomology 90:1341-1345.

Xu, Q.F., Hong, J.B., Wu, H.Z., and Feng, W. 1997. Study on using entomopathogenic fungus *Beauveria brongnartii* to control white grubs in peanut fields. Chinese Journal of Biological Control 13:23-25.

Other legume-related publications

Allen, D.J., and Lenne, J.M. 1998. The pathology of food and pasture legumes. Wallingford, Oxon, UK Patancheru, Andhra Pradesh, India: CAB International International Crops Research Institute for the Semi-Arid Tropics. 772 pp.

Armes, N.J., Wightman, J.A., Jadhav, D.R., and Rao, G.V.R. 1997. Status of insecticide resistance in *Spodoptera litura* in Andhra Pradesh, India. Pesticide Science 50:240-248.

Bhattarai, S., Maskey, S.L., and Karna, R.L. 1997. On-farm experiments on rhizobial inoculants in Nepal. Pages 235-242 *in* Extending nitrogen fixation research to farmers' fields: proceedings of an International Workshop on Managing Legume Nitrogen Fixation in the Cropping Systems of Asia, ICRISAT Asia Center, Patancheru, Andhra Pradesh, India, 20-24 Aug 1996 (Rupela, O.P., Johansen, C., and Herridge, D.F., eds.). Patancheru, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics.

Castro, S., Vinocur, M., Permigiani, M., Halle, C., Taurian, T., and Fabra, A. 1997. Interaction of the fungicide mancozeb and Rhizobium sp. in pure culture and under field conditions. Biology and Fertility of Soils 25:147-151.

Fageria, N.K., Baligar, V.C., and Jones, C.A. 1997. Growth and mineral nutrition of field crops. Books in Soils, Plants, and the Environment no. 57. New York, USA: Marcel Dekker, Inc. 636 pp.

Khurana, A.L., Namdeo, S.L., Patel, B.J., and Dudeja, S.S. 1997. On-farm experiments on rhizobial inoculants - problems and possible solutions. Pages 217-226 *in* Extending nitrogen fixation research to farmers' fields: proceedings of an International Workshop on Managing Legume Nitrogen Fixation in the Cropping Systems of Asia, ICRISAT Asia Center, Patancheru, Andhra Pradesh, India, 20-24 Aug 1996 (Rupela, O.P., Johansen, C, and Herridge, D.F., eds.). Patancheru, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics.

Sattar, M.A., Khanam, D., Ahmad, S., Haider, M.R., Podder, A.K., and Bhuiyan, M.A.H. 1997. On-farm experiments on rhizobial inoculants in Bangladesh: results, problems, and possible solutions. Pages 201—216 *in* Extending nitrogen fixation research to farmers' fields: proceedings of an International Workshop on Managing Legume Nitrogen Fixation in the Cropping Systems of Asia, ICRISAT Asia Center, Patancheru, Andhra Pradesh, India, 20-24 Aug 1996 (Rupela, O.P., Johansen, C., and Herridge, D.F., eds.). Patancheru, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics.

Thein, M.M., and Hein, M. 1997. Rhizobial inoculants production and their on-farm use in Myanmar. Pages 227-234 in Extending nitrogen fixation research to farmers' fields: proceedings of an International Workshop on Managing Legume Nitrogen Fixation in the Cropping Systems of Asia, ICRISAT Asia Center, Patancheru, Andhra Pradesh, India, 20-24 Aug 1996 (Rupela, O.P., Johansen, C, and Herridge, D.F., eds.). Patancheru, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics.

Verma, R.J., Mehta, D.N., Raval, P.J., and Dube, H.C. 1997. Aflatoxin contamination in oil seeds, oil cakes and oil samples. Indian Phytopathology 50:77-82.

Wal, J.M. 1997. Allergenicity of genetically altered oilseeds. OCL - Oleagineux, Corps Gras, Lipides 4:120-122.

Information for IAN contributors

Publishing objectives

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

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

What to contribute?(ICRISAT)

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

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

How to format contributions?

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

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

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

Africa and Asia

IAN Scientific Editor
ICRISAT-Patancheru
Patancheru 502 324
Andhra Pradesh, India

Fax +91 40 241239
E-mail newsletter@icrisat.cgiar.org
Tel +91 40 596161

Americas, Europe, and Oceania

IAN Scientific Editor
c/o Peanut CRSP
1109 Experiment Street
Griffin, GA 30223-1797, USA

Fax +770 229 3337
E-mail crspgrf@gaes.griffin.peachnet.edu
Tel +770 228 7312

Peanut CRSP

The Peanut Collaborative Research Support Program
The University of Georgia, College of Agricultural Environmental Sciences
1109 Experiment Street, Griffin, GA 30223-1797, USA

ICRISAT

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

ISSN 1010-5824 334-98