Groundnut in ICRISAT programmes

L'arachide au sein des programmes de l'ICRISAT

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Source: "Grain Legumes: evolution and genetic resources" J. Smartt, Cambridge Univ. Press, 1990, p.31

Groundnut (*Arachis hypogaea* L.) is one of the three legume crops for which ICRISAT is mandated to develop and improve. ICRISAT is also designated as a world repository of germplasm with over 14 000 accessions of cultivated groundnut and 450 accessions of wild *Arachis* species currently held in public trust. Groundnut is an annual crop and its seeds are a rich source of edible oil and protein. Groundnut is grown in over 100 countries with a total estimated area of 21.8 million ha and production in shell of 28.5 million t. Asia (25 countries) with 63.4% of the area produces 71.7% of the world groundnut production. It is followed by Africa (46 countries) with 31.3% of the area and 18.6% of the production, and North-Central America (13 countries) with 3.7% of the area and 7.5% of the production. Important groundnut producing countries are China, India, and Indonesia in Asia ; Nigeria, Senegal, and Sudan in Africa ; USA in North-Central America, and Argentina in South America.

Exploiting oil and protein cakes

Groundnut is grown under both subsistence and commercial systems. Under commercial cultivation, it is grown mainly as a sole crop with high levels of inputs whereas under subsistence conditions both sole crop and mixed or intercropping can be seen. About 70 % of the world's groundnut is produced in the semi-arid tropics, the exclusive agroecosystem focus of ICRISAT. About two thirds of the total world production is crushed for cooking oil. The remaining one third is eaten directly as boiled or roasted nuts and as confectionery, an increasing trend over the years. Groundnut haulms are used as fodder and the cake remaining after the extraction of oil is used in animal feeds.

Average productivity of groundnut (pod in shell) in the world is about 1.31 t/ha. In USA, where most of the cultivation is commercial, an average yield of 2.63 t/ha is obtained and pod yields in excess of 4.0–5.0 t/ha are not uncommon. Average productivity at the subsistence system in Africa and Asia, however, remains very low. In addition, a big gap exists between the realized yield and potential yield of groundnut at both subsistence and commercial systems. Several abiotic and biotic factors limit the realized yield of groundnut at the farm level. Genetic improvement and improved management practices can help bridge this gap. ICRISAT's research is directed at these problems.

Constraints to alleviate in Africa and Asia

The major abiotic factors affecting groundnut production include drought, high temperature, low soil fertility, low soil pH, and iron chlorosis. Among the biotic factors, foliar diseases, virus diseases, bacterial wilt disease, aflatoxin contamination, nematodes, foliar insect pests, and soil insect pests are important. Some of these stress factors operate globally whereas others are of regional importance. ICRISAT's research in alleviating some of these constraints is briefly described below.

In the rainfed subsistence agriculture drought is the major cause for low and erratic pod yield in groundnut. Field techniques to screen genotypes for drought tolerance have been standardized. Genotypes with superior performance under mid- and end-of-season droughts have been developed and made available to national programmes. Collaborative basic studies indicated genotypic variation in transpiration, water use efficiency (WUE), partitioning of dry matter to pods (P), and rate of recovery from mid-season drought. It was also established that specific leaf area (SLA) can be used as a selection criterion to identify genotypes with high WUE. However, negative relationship between WUE and P suggests that selection for high WUE might enhance dry matter production but not necessarily pod yield. Studies related to DNA-polymorphism for WUE and P are in progress.

Few resistance to diseases

Rust, ELS[1] and LLS[2] occur in combination in varying proportions wherever

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[1] ELS: early leaf spot
[2] LLS: late leaf spot

groundnut is grown They can cause substantial yield loss either singly or in combination Cultivars with high levels of resistance to rust and moderate levels of resistance to LLS have been developed and released to farmers in Asia Some resistant varieties are under going on-farm tests in Africa The success with ELS resistance breeding has been limited Wild *Arachis* species are a reservoir of high levels of resistances to several stress factors including foliar diseases Interspecific hybridization is being pursued to improve upon the level of resistance to foliar diseases in cultivated groundnut Studies on mechanism of resistance and components of resistance are in progress Following epidemiological studies, a weather-based advisory scheme for control of leafspots is being developed On-farm studies indicate that varieties with moderate levels of resistance to foliar diseases give higher economic returns with limited fungicide control than the full fungicide control of susceptible cultivars

PBNV[3] in south Asia, PStV[4] in east and southeast Asia, GRV[5] in Africa and PCV[6] in west Africa are the major virus diseases of groundnut Basic research on diagnostic aids, characterization, nucleotide sequencing, and biodiversity among virus strains is in progress in collaboration with advanced institutions Very high quality polyclonal antisera have been produced for some of these viruses Except for GRV and PBNV, genetic resistance for other viruses in cultivated groundnut does not exist Some of the wild *Arachis* species are highly resistant to these viruses but they are incompatible with cultivated groundnut Interspecific hybridization followed by embryo rescue and regeneration is in progress The work on genetic transformation focuses on transferring coat protein genes of these viruses in groundnut plants Transformation efforts for PCV (Indian isolate) and groundnut rosette assister virus genes have shown initial success In GRV, where a high level of resistance exists in cultivated groundnut, resistant varieties have been developed and made available to the national programmes in Africa In the case of PBNV, where only tolerance to virus exists in cultivated groundnut, the virus tolerance has been combined with vector (*Thrips palmi*) resistance to develop varieties with field tolerance to the disease

Bacterial Wilt of groundnut is largely confined to east and southeast Asia and can be very devastating in some fields Cultural control methods and resistant cultivars developed by the national programmes in the region are available With the establishment of the Groundnut Bacterial Wilt Working Group in 1990, ICRISAT is playing a crucial coordinating role among the national programmes of the region and advanced institutions in UK, USA, and Australia

A random risk with aflatoxins

The contamination of groundnut by aflatoxins is a serious problem in most groundnut producing countries The aflatoxin producing fungi, *Aspergillus flavus* and *A parasiticus*, can invade groundnut seed in the field before harvest, during drying and during harvest, and in storage The semi-arid tropical environment is more conducive to preharvest aflatoxin contamination when the crop experiences drought before harvest, whereas in wet and humid areas, postharvest contamination is more prevalent Aflatoxin contamination can be minimized by adopting some cultural, produce handling, and storage practices However, these practices largely remain non-adopted by the small farmers for various reasons Genetic variation is available in preharvest seed infection, *in vitro* seed colonization, and aflatoxin production Through resistance breeding, these resistances have been transferred in superior agronomic backgrounds However, none of these resistances including cultural practices offers complete freedom from aflatoxin contamination Further efforts are in progress to combine these resistances in a single genotype to provide a combined defence against the invading pathogen New developments in molecular biology and genetic engineering in advanced institutions in USA are likely to provide long lasting succour against this problem which is a serious health hazard to humans and animals

In Asia and west Africa nematode diseases are important Their importance in southern Africa is not well established The current research on nematodes at ICRISAT includes studies on the influence of cropping system and cultural practices on population densities of nematodes, etiology of pod and root lesion nematode disease, diagnostic surveys in southern Africa and Asia, and germplasm screening for resistance to economically important nematodes

Pests: for an integrated management

In Asia , Spodoptera, Helicoverpa, leaf miner, and red hairy caterpillar are the important defoliating pests of groundnut The former two are economically important in the post-rainy season and the latter two in the rainy season However, these insects are not pests of groundnut in Africa except where excessive insecticides are applied to the crop Sucking pests, jassids, thrips, and aphids can cause yield losses as virus vectors and as a result of their feeding activities They are important both in Asia and Africa The problem of Spodoptera in Asia is induced by excessive insecticide application which has resulted in high level of resistance to insecticides in Spodoptera larvae and in general destruction of natural enemies of these pests The integrated pest management package for Spodoptera consists of effective monitoring using pheromone traps, following the thresholds, encouraging natural enemies, growing trap crops, and collecting egg masses Following these practices, the use of insecticides in Spodoptera control can be minimized or even completely eliminated This technology has been highly successful in southern India and in north Vietnam Screening of germplasm and breeding lines has led to the identification of sources with high levels of resistance to thrips and jassids and moderate levels of resistance to Spodoptera and leaf miner Breeding lines with multiple resistance/tolerance to insect pests and superior agronomic characteristics have been made available to the national programmes

Soil pests of groundnut have not received enough research attention Initial research on white grub has just begun at ICRISAT

The groundnut research portfolio at ICRISAT represents a continuum in research from basic to applied to adaptive- in partnership with developing national programmes and advanced institutions, while maintaining a sharp focus on production systems. A major proportion of multidisciplinary research efforts is invested in constraints alleviation. In addition, the genetic enhancement research also aims at improving yield potential and seed quality, genetic diversification of the breeding populations, and developing a better understanding of adaptation of the crop. ☐

(1) ICRISAT (1995). ICRISAT Asia Region Annual Report 1994. 224 pp.

(2) ICRISAT Southern and Eastern Africa Region. (1995). Annual Report 1994. P O Box 776, Bulawayo, Zimbabwe: ICRISAT Southern and Eastern Africa Region.

[3] PBNV: Peanut Bud Necrosis Virus
[4] PStV: Peanut Stunt Virus
[5] GRV: Groundnut Rosette Virus
[6] PCV: Peanut Clump Virus