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Research on Groundnut by ICRISAT with Special Emphasis on Problems in Asia

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Legumes Program

Over the 10-year period from 1976 to 1986, groundnut production in Asia increased by about 6 million t, reflecting an average annual growth rate of 5%. Nearly half of this increase came from expansion of the area cultivated. Demand for groundnut in Asia is expected to increase at a compound rate of about 4% annually, and as the prospects for increasing the cultivated area are limited, it will be necessary to increase yield per unit area. Fortunately, there is considerable scope for increasing farmers' yields, as the present average yield of just over 1 t ha^{-1} dried pods is well below the potential 6 to 8 t ha^{-1} that can be achieved on research farms when yield constraints are removed.

Constraints to production have been identified as:

- Damage by diseases and pests
- Unreliable rainfall patterns, with recurring drought
- Nutritional stresses
- Poor agronomic practices, with limited use of fertilizers
- Lack of high-yielding adapted cultivars

At ICRISAT we are integrating plant breeding, plant pathology, entomology, microbiology, physiology, and cytogenetics research to produce high-yielding adapted cultivars with stable resistance or tolerance to the major stresses presently limiting production. Our groundnut scientists cooperate with economists, cropping systems specialists, and agronomists to develop crop management systems suited to small farmers. The world collection of groundnut and wild *Arachis* germplasm provides the basis for improvement of the crop.

Drought and several of the major diseases and pests of groundnut are worldwide problems and are being studied intensively at ICRISAT. Problems more specific to particular regions are being worked on in ICRISAT regional programs or through cooperative research with national programs. The program at ICRISAT Center works closely with the ICRISAT Regional Groundnut Program for Southern Africa, set up in Malawi in 1982, and the West African Program, set up in 1986. There is a regular flow of improved germplasm between the Center and the regional programs, and effective variety evaluation networks have been established.

In Asia, variety evaluation is coordinated through the AGLN. Links have been established with national scientists in most groundnut-growing countries of Asia, and there is cooperation with other international and regional organizations. Information is exchanged through the *International Arachis Newsletter,* meetings are held, and visits are arranged.

Diseases

Foliar diseases. The world collection of over 12 000 accessions has been screened for resistance to rust and late leaf spot diseases. There are 78 lines with good resistance to rust, 34 lines with resistance to late leaf spot, and 31 lines with resistance to both diseases. Interspecific hybrid derivatives with high resistance to rust and/or late leaf spot have also been bred. The sources of rust and late leaf spot resistance have been used in a breeding program, and lines combining the resistances with good agronomic characters are now in international trials. Two cultivars, ICG (FDRS) 4 and 10, are likely to be released soon in India.

An epidemic of early leaf spot at ICRISAT Center in 1987, and the establishment of a collaborative field resistance screening project at Pantnagar in northern India, have accelerated work on this disease. Significant levels of resistance have been found in 15 germplasm lines, and some interspecific hybrid derivatives are showing promise in preliminary trials. Some lines also show resistance to rust and late leaf spot. Several of the sources of resistance have been used in a breeding program.

Studies continue on the influence of environmental factors and agronomic practices on the development of foliar diseases. Stability of resistance to early leaf spot, and possible occurrence of different races of the pathogen, will be studied through collaborative research with the Institut de recherches pour les huiles et oleagineux (IRHO) in France in 1989.

Diseases caused by soil fungi. Field screening of germplasm lines under naturally occurring outbreaks of a pod rot complex caused by *Fusarium* spp, *Macrophomina phaseolina, and Rhizoctonia solani* has identified several resistant lines, some of which also have resistance to pod and seed invasion by *Aspergillus flavus.*

More recently, field screening of germplasm and breeding lines against *Sclerotium* *rolfsii* with artificially enhanced inoculum levels has identified susceptible and moderately resistant material; *S. rolfsii* stem and pod rots are most serious in groundnuts grown on Vertisols, and it is important that advanced breeding lines be checked to eliminate unduly susceptible material before release.

Aflatoxin contamination. Factors influencing the invasion of groundnut pods and seeds by the aflatoxigenic *A.flavus* have been studied in relation to genetic resistance and cultural control measures. The importance of drought in relation to preharvest contamination has been confirmed, and drought stress has been used to enhance resistance screening methods. Several germplasm lines with resistance to seed invasion by *A.flavus* have been identified and used in a breeding program, and some breeding lines have good levels of resistance. Crosses have been made to combine seed-coat resistance to *A. flavus* infection with low capacity to support aflatoxin production. A data base on published information on aflatoxin in groundnut is in preparation.

Bacterial wilt. In cooperation with Indonesia, the People's Republic of China, and ACIAR, an international collaborative approach to research on bacterial wilt disease will be initiated.

Virus diseases. Bud necrosis disease (BND) caused by tomato spotted wilt virus (TSWV) is economically important in South and East Asia. Several high-yielding germplasm and breeding lines with resistance to the thrips vector of BND have been tested for resistance to TSWV, and lines ICGV 86029 and 86031 were shown to be tolerant. Peanut mottle virus (PMV) is distributed worldwide and can cause significant yield losses. Several germplasm and breeding lines showing non-seed transmission and tolerance to PMV have been identified. Serological tests have been developed for the detection of peanut clump virus. Solarization was found to be effective in controlling this disease. PStV is currently recognized as one of the most important groundnut diseases in Southeast Asia. Screening for resistance to PStV through international cooperation is in progress in Indonesia.

Pests

Particular emphasis has been placed on the development of pest control strategies that do not involve the use of pesticides, or at least rationalize their use. The primary aim is to introduce pest resistance into zonally adapted varieties. Germplasm lines with resistance to the major pests that attack the leaves and stems of groundnut plants (jassids, thrips, and leaf miner), and to some soil insects that attack below-ground parts (termites and pod borers), have been identified and are being used in breeding programs. Progress has been made in defining the mechanisms of pest resistance.

Investigations on the feasibility of combining host plant resistance and natural control by the use of parasites and predators are under way, the aim being to keep pest populations down to levels that do not reduce yields. The effects of cropping patterns (monocrop, multicrop, intercrop, etc) on pest populations are also under investigation. Studies are being conducted to determine the damage thresholds of *Spodoptera litura.* Collaboration between entomologists and virologists has led to an increased understanding of the role of thrips as the vector of TSWV. Bruchid *(Caryedon serratus)* is a serious storage pest of groundnut in peninsular India, and all lines prepared for release are screened against this pest.

Drought

Research on the physiological basis for genetic differences in drought response has had considerable impact on drought screening at ICRISAT Center. Drought-tolerant lines have been identified and used in breeding for improved drought resistance. Some lines with resistance to foliar diseases have also shown drought tolerance. The greatest opportunity for improving genotypes for use in drought-prone areas lies in capitalizing on the ability to recover from mid-season drought. This attribute is therefore being used in screening breeding materials. Research is focused on root respiration and growth, the mechanisms determining recovery from drought, and water use efficiency. Photoperiod also influences drought responses, and genotypes are being screened for photoperiod insensitivity.

Nutrient Stresses

Biological nitrogen fixation is not usually a limiting factor to groundnut production in locations with a history of groundnut cultivation. Genotypic differences in the rate of nitrogen fixation are dominated by leaf area effects (90% of variance); the differences directly attributable to genotypes are small (2-6%).

Iron chlorosis has been shown to be caused by two mechanisms, high soil pH and periodic waterlogging. Genotypic differences in susceptibility to iron deficiency exist, and limited screening of breeding lines has been initiated.

Calcium deficiency is a major limiting factor for groundnut production in some countries. Research was initiated to investigate reported genotypic differences in the calcium uptake efficiency of pods. Consistent and significant genotype x drought x gypsum interactions have been demonstrated.

Breeding for Adaptation to Specific Environments

Breeding for adaptation to specific environments is still the major breeding activity at ICRISAT Center. Most of the progress so far has been made in breeding cultivars under non-stress situations, or where stresses can be overcome by management. Using these cultivars as base material, and other improved breeding lines with resistance/tolerance to single-stress factors, it is now intended to develop lines with multiple resistances.

Early-maturing varieties are advantageous in areas where the growing season is short, or the crop is grown under a residual soil-moisture regime or in multiple cropping systems. Time-to-maturity is dependent upon temperature regime, solar radiation, moisture, and other factors during the growth period. Use of cumulative heat units (degree days) has been effective in determining maturity. Several early-maturing cultivars have been developed, and are being evaluated in international trials. In addition to supplying stable cultivars, the ICRISAT program also supplies segregating populations from crosses made to combine desired traits with adaptation factors from cultivars bred in client scientists' countries.

Progress has been made in the development of medium- and late-maturing cultivars. Two lines, ICGS 11 (ICGV 87123) and ICGS 44 (ICGV 87128), have been released for postrainy-season cultivation in India. Cultivars awaiting release for rainy-season cultivation are ICGS 1 (ICGV 87119), ICGS 5 (ICGV 87121), and ICGS 11 (ICGV 87123). Progress has also been made in developing cultivars for confectionery purposes, and several lines have shown good performance in international trials.

Agronomy and Crop Production

Scientists in ICRISAT's Groundnut Group cooperate with those of the Center's RMP in providing cultivars and advice to enable national program scientists to put together management systems appropriate to local conditions. Practical experience in this area will be provided in the report by the Legumes Program's LEGOFTEN unit.

Chickpea Research at ICRISAT

C. Johansen

Legumes Program

Chickpea research at ICRISAT aims to enhance the capabilities of national programs to increase the production and profitability of chickpea, particularly for low-income farmers. Efforts are directed towards both genetic and management improvement. ICRISAT staff contributing to this research are not only from the relevant disciplines within the Legumes Program (breeding, agronomy, entomology, and pathology) but also from the RMP (economics, soils, and agronomy), the Genetic Resources Unit (GRU), and the Biochem-