SUMMARY
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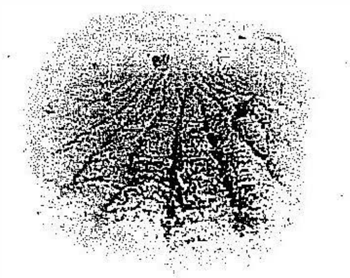
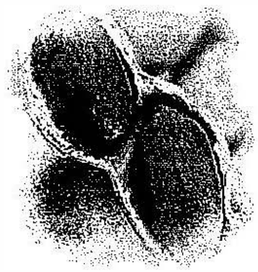
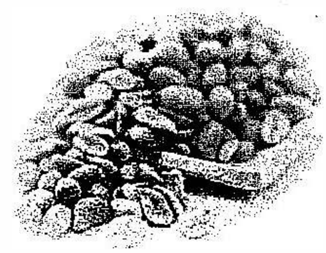
Prospects and Emerging Opportunities for Peanut Quality and Utilization Technology

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Current Status of Foliar Diseases Resistance Breeding in Groundnut at ICRISAT Center, India

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Introduction

Groundnut (*Arachis hypogaea* L.) is the 6th most important oilseed crop and the 13th most important food crop in the world. It is grown in an area of 26.4 million ha with a total production of 37.1 million metric tones and an average productivity of 1.4 metric tones ha^{-1}. Developing countries account for 96%of the global area and 92% of the global production of the crop. Groundnut is grown under both high input and subsistence farming conditions. High yields are realized under high input irrigated condition, where diseases and pets are controlled. Yields in excess of 4 t ha^{-1} are not uncommon under such conditions. However, under subsistence farming, where the crop is grown with minimal inputs or no inputs under rainfed conditions, the crop yields remain below 1 t ha^{-1}. The crop suffers from drought, diseases, insect pests and low fertility under subsistence farming. Among foliar fungal diseases, early leaf spot caused by *Cercospora arachidicola*, late leaf spot caused by *Phaeoisariopsis personata* and rust caused by *Puccinia arachidis* occur worldwild wherever the crop is grown. Together, these diseases can cause more than 70% loss in yield besides adversely affecting the quality of the produce (pods, seeds and haulms). The two leaf spots have co-existed with the crop since the very beginning, but rust became a serious threat since 1970s when it spread around the world rapidly, All the three diseases can be effectively controlled by fungicides but their use, besides being out of reach of poor farmers in subsistence farming, is not environment friendly. A concerted search for genetic resistance to two leaf spots started in early 1970s. Many researchers reported sources of resistance to leaf spots in cultivated groundnut. But the level of resistance to leaf spots in these sources was not high enough to encourage breeders to use them extensively in their breeding programs. However, high level of resistance or immunity was located in 1974 in wild *Arachis* species –for early leaf spot in *A. chacoense* and to late leaf spot in *A.cardenasii* (Abdou et al., 1974). This stimulated an interspecific hybridization-breeding program in 1970s, mainly at NC State University (USA), ICRISAT (India) and Tamil Nadu Agricultural University (India) to harness resistance genes from wild *Arachis* species to develop leaf spots resistant cultivars. Interspecific hybrids developed from these programs suffered from linkage drag as they had long duration, low shelling outtum and undesirable pod and seed characteristics and as such they had a little direct use in cultivation. However, they were used as a source of foliar diseases resistance in regular breeding programs.

Past and present of the foliar diseases resistance breeding

After the establishment of groundnut improvement program at ICRISAT in 1976, the foliar diseases resistance breeding received a great impetus. The natural disease pressure of late leaf spot and rust at ICRISAT, Patancheru, India and efficient field and laboratory screening techniques developed by pathologists allowed a large-scale field screening of more than 13000 accessions of the worlds' germplasm collection originating from 89 countries and maintained in the institute's gene bank. This resulted in identification of 169 cultivated accessions resistant to rust, 69 resistant to late leaf spot, 4 resistant to early leaf spot and 42 resistant to both the rust and late leaf spot (Singh et., 1997). However, most of these resistant accessions of cultivated groundnut are agronomically inferior. The level of resistance to rust in these accessions was high and only low to moderate to late and early leaf spots. Screening of wild *Arachis* species at the same time also resulted in identification of many accessions in species belonging to the section *Arachis – A. batizocoi, A. duranensis, A. spegazzinii, A. correntia, A. cardenasii, A. chacoense* and *A. villosa* that showed near immunity to rust and very high levels of resistance to leaf spots (Subrahmanyam et al., 1983). The characterized sources of species exhibit rate-reducing mechanisms of disease development. They have increased pathogen incubation periods, decreased infection frequencies and reduced pustule sizes, spore production and spore germinability. In the first phase of diseases resistance breeding utilizing these resistant sources (PI 259747, PI 298115, EC 76446(292) and NC Ac 17133(RF) and others), the resultant selected breeding lines had high pod and haulm yields accompanied with undesirable pod and seed characteristics, low shelling outturn and longer duration. Although resistance to rust in these lines was high, the resistance to late leaf spot was diluted from moderate levels to low levels. The first generation foliar diseases resistant releases in India and elsewhere included ICGS(FDRS) 4, ICGS (FDRS) 10 and Girnar 1. However, in spite of high pod and haulm yields under heavy disease pressure, these varieties, due to reasons stated earlier, did not find favor with farmer in India. In the second phase of breeding, advanced generation foliar diseases resistant breeding lines were used in hybridization to develop new resistant cultivars with better agronomic traits. The resultant advanced breeding lines released in India (ICGV 86590, ICGV 86699, ALR 2, BS 9702) have, in addition to resistance to trust, tolerance to late leaf spot and high yield, better pod and seed characteristics including shelling outturn. However, significant reduction in crop duration still remains an unresolved issue. Further, the resistance level to late leaf spot still remains low. Presently, the emphasis in breeding program is to improve the level of resistance to late leaf spot while maintaining the level of rust resistance in agronomically superior breeding lines in the desired maturity group. In 2003-2004 trails, new breeding lines ICGV 02429 and ICGV 02466 in the Virginia bunch group showed 38% and 49% increase in yield over the susceptible control ICGS 76. These varieties also showed higher levels of resistance to rust and late leaf spot (a 3 score for rust and a 5 score for late left spot on a 1-9 scale, where 1= no disease and =≥ 81% foliage damaged) compared to the resistance check ICGV 86699 (a 3 score for rust a 5.5 score for late leaf spot). In the Spanish group, ICGV 02410 and ICGV 02415 yielded 68% and 60% more than the susceptible check JL 24 and had higher levels of resistant control ICGV 86590 (a 2 score for rust and a 7 score for late leaf spot). Resistance to rust in cultivated groundnut is recessive and appears to be governed by a few major genes and many modifiers. Both additive and non-additive gene effects have been reported for rust. Both two-gene and five-locus genetic model have been used to explain the inheritance of resistance to LLS. The resistance to early leaf spot is quantitative in nature and is governed predominantly by additive gene effects. Efforts have been made to detect QTLs associated with the components of resistance to rust and LLS. However, not many could be detected and those detected could explain a phenotypic variation of only 10-19% (ICRISAT unpublished data). More efforts are needed to develop a dense linkage map in cultivated groundnut with different types of makers (STMs, SSRs, AFLPs etc.). This will help to map QTLs that could explain higher amounts of phenotypic variation for various components of resistance to rust and LLS.

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