Table 2. Distribution of groundnut viral diseases in the southern states of India in a survey conducted in February 1990.

Location/State	% plants infected with TSWV	V.C.	Mottle
Karnataka			
Raichur	6.5;52[1]	3	-
Nirmanvi	-	-	-
Sindhanoor	1.4	-	-
Gajangoda	2	-	-
Dharwad	<1	<1	-
Ankola	<1	-	-
Basvanpura	-	-	-
Tamil Nadu			
Bhavanisagar	4.7%	-	-
Aliyarnagar	1	<1	-
Kottur	<1	<1	-
Vridhachalam	-	-	Present[2]
Andhra Pradesh			
Jakkalavaripalli	<1	-	-
Guttivaripalli	<1	<1	-
Tummuru	-	-	-
Kothapatnam	-	-	-
Chirala	-	-	-

TSWV = Tomato spotted wilt virus, VC = Veinal chlorosis.

1. December-sown and wider-spaced (45 x 25 cm) crop.
2. Two suspected plant samples with mottle symptoms confirmed peanut mottle virus through ELISA test.

The observations in different ICRISAT collaborative trials indicated a wide range of thrips injury (1.5% to 55%). The data in Table 1 indicate that thrips damage on the Bhavanisagar crop was due to *Frankliniella*, while the damage at Aliyarnagar was caused by *Thrips palmi*. The incidence of bud necrosis disease caused by tomato spotted wilt virus in general was very low across the locations (<1%) except in late-sown (2nd week of December) and widely spaced (45 × 25 cm) trials at Raichur (52%) while the normal-sown crop (3rd week of November, 30 × 10 cm) had 6.5% disease incidence (Table 2). Veinal chlorosis was noticed in 5 out of 16 locations. However, the incidence was very low (Naidu et al. 1989). Veinal chlorosis was maximum with 3% plants infected at Raichur, while the incidence at the other four locations was <1% (Table 2). The crop was inspected for peanut stripe and mottle symptoms. In some locations plants with stripe and mottle-like symptoms were noticed and brought to the ICRISAT virology unit for further confirmation. The serological tests (ELISA) showed negative reaction for peanut stripe in all the samples, while one sample from Vridhachalam gave a positive reaction for peanut mottle virus only, indicating the absence of peanut stripe disease in these areas.

It was also apparent from the observations that *Scirtothrips* populations were present mostly on leaflets and *Frankliniella* was mostly present in flowers. *Thrips palmi* was present on leaflets as well as flowers in approximately equal proportion.

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Status and Significance of Root-knot Disease of Groundnut in China

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China is the second largest groundnut producer in the world. The area under groundnut has increased from 2 m ha to 3 m ha in the last 10 years. Many abiotic and biotic stresses affect groundnut production in China. The root-knot disease caused by *Meloidogyne* species is considered to be one of the important biotic constraints to groundnut production (Table 1). At present, approximately 400,000 ha of the groundnut-producing area,

Table 1. Distribution of the root-knot nematodes in major groundnut-producing provinces in China.

Province	Total area ('000 ha)	Infested ('000 ha)	Predominant species[1]
Shandong	820	130	*Meloidogyne hapla*
Henan	400	40	*M. hapla*
Guangdong	390	20	*M. arenaria*
Hebei	320	70	*M. hapla*
Guangxi	170	10	*M. arenaria*
Sichnan	180	10	*Meloidogyne* spp
Liaoning	150	30	*M. hapla*
Anhei	140	20	*M. hapla*
Hubei	60	1	*Meloidogyne* spp

1. Based on plant-parasitic nematode surveys of the groundnut-producing regions in China in 1970s.

spanning 10 provinces under different agroecological zones, is considered to be infested with the root-knot nematodes (*M. arenaria* and *M. hapla*). *M. hapla* attacks 80 field crops and 50 weed species in China, and groundnut is one of the most susceptible crops.

Distribution of Root-knot Nematodes

Work on root-knot disease of groundnut in China started in 1958. Surveys conducted by Chinese scientists between 1958 and 1975 revealed that the population of *M. arenaria* in southern China and *M. hapla* in northern China are very widely distributed. *M. hapla*-caused root-knot disease is more severe on sandy soils than on clayey soils. The disease is very important in regions where groundnut is cultivated continuously year after year.

Management of Root-knot Disease of Groundnut

Work on the management of root-knot disease of groundnut in China can be grouped broadly under 5 periods:

1. *1958-64*. During this period, various agronomic practices were evaluated. Rotation of groundnut with grasses and watermelon for 2-3 years increased groundnut pod yields by 15% and significantly reduced root-knot nematode populations in the fields. Deep ploughing and addition of high dosages of organic manures increased the pod yield by 10-15%.
2. *1965-70*. More than 100 chemicals were screened for their efficacy in controlling root-knot disease. Dibromochloropropane (DBCP) was found to be the best in controlling the nematode populations. Application of DBCP at the rate of 24 kg ha^{-1} with irrigation water significantly reduced population densities of *M. hapla* and increased the pod yield by more than 100%.
3. *1971-80*. DBCP was used in all the groundnut-producing provinces. Improved techniques were evolved for application of DBCP in large areas.
4. *1981-85*. The use of DBCP was banned in all the provinces due to health hazards and environmental pollution and the search for another effective nematicide began. More than 50 biocides were screened. Aldicarb (2-3 kg a.i. ha^{-1}), Carbofuran (2-3 kg a.i. ha^{-1}), Phenamiphos (3-6 kg a.i. ha^{-1}), and Mocap (3-4 kg a.i. ha^{-1}) were found to be useful but none of these was as good as DBCP. Application of these biocides in the nematode-infested fields increased the crop yield by 30-80%.
5. *1986-91*. The use of nematicides was restricted because of their high costs and high toxicity. During this period work on host-plant resistance was started. More than 4000 accessions of groundnut were screened for resistance to *M. hapla* at Shandong. Only 2 accessions, N 001 and N 002, were resistant. Eighteen other accessions showed a moderately resistant reaction to the disease.

Deep ploughing to a depth of 50 cm and use of organic manure, rotation of groundnut with grasses, watermelon, or sweet potato for 3 years resulted in a 20% increase in pod yield. Three species of nematode-trapping fungi were identified and work on biological control of *M. hapla* was initiated.

Future Plans

It is proposed to conduct surveys of groundnut-growing regions in all the provinces to identify other important nematode-caused problems. Groundnut germplasm will be screened for resistance to the root-knot nematodes, and management options developed in terms of crop rotation and biocontrol.