Diagnosis and Management of Major Diseases of Groundnut

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Foreword

Groundnut is a premier oilseed crop in our country occupying an area of about 8 million ha during rainy and post rainy seasons together. During the rainy season, drought is a common phenomenon. Besides drought, diseases and pests are the major yield reducers and the dryland farmers are not in a position to control the diseases effectively due to socio-economic reasons and lack of knowledge about the diseases.

For effective management of diseases, their correct diagnosis is the basic requirement. Often the farmers fail to diagnose the causes and go in for remedial measures at their own discrete, which hardly control the disease but increase the burden of the resource poor farmers.

A careful analysis of the groundnut production system reveals that there is a vacuum in terms of handy diagnostic tools at the disposal of the farmers and extension workers for taking up timely management measures to protect their crop and increase the yield levels.

The bulletin on **"Diagnosis and Management of Major Diseases of Groundnut"** with good illustrations is timely and provides necessary information on diseases and their control measures in a user friendly manner to the extension workers and farmers.

The efforts made by the scientists of the NRCG in bringing out this bulletin is appreciated and I hope the information contained in this bulletin would certainly be useful to various groups of clientele.

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Contents

1. Introduction

India is the largest grower and second largest producer of groundnut in the world. The average yields however are low around 1000kg/ha, which are much lower than other major groundnut growing countries. This may be attributed to the rainfed nature of cultivation of this crop coupled with attack by a variety of diseases and insect pests. More than 55 pathogens including viruses have been reported to affect groundnut. Some diseases are widely distributed and cause economic crop losses while others are restricted in distribution and are not considered to be economically important at the present time. The diseases which are of minor importance today may become major in course of time.

Among fungal foliar diseases, leafspots (early and late) and rust are economically important in India which are widely distributed and can cause yield losses in susceptible genotypes to the extent of 70 percent when both of them occur together. Of late, *Alternaria* leafspot and veinal necrosis caused by *Alternaria alternata* (Fries) Keissler is becoming increasingly important in southern states of the Country and Gujarat on rabi/summer crop and in Gujarat on Kharif groundnut crop. Other foliar fungal diseases like *Alternaria* leaf blight, anthracnose, pepper spot and leaf scorch, *Phomopsis* leafspot, *Phyllosticta* leafspot, *Pestalotiopsis* leafspot, leaf blight, *Phoma* leaf disease, *Myrothecium* leaf blight, *Drechslera* leaf blight, *Zonate* leafspot, *Cylindrocladium* leafspot, powdery mildew and *Sclerotium* leafspot are not economically important diseases at present and hence control schedules are not yet developed for these diseases.

Among seed- and soil-borne diseases, collar rot, stem rot and dry root rot have been realized to be the major limitations. These diseases cause severe seedling mortality resulting in 'patchy' crop stand in sandy loam soils and reduce pod yields from 25 to 40 percent. Other seed- and seedling-diseases like aflaroot/yellow mold, *Diplodia* collar rot, *Rhizoctonia* damping off, Pythium diseases, *Cylindrocladium* black rot, Fusarium wilt, pod rot and Rhizopus seed and seedling rot and Rhizoctonia limbrot also have been reported from India.

Some bacterial diseases of groundnut like bacterial wilt (*Ralstonia solanacearum*), bacterial leafspot, and bacterial pod rot have been reported from India.

Several virus diseases of groundnut like peanut mottle, peanut stripe, peanut clump, peanut bud necrosis, cowpea mild mottle, peanut yellow spot, peanut chlorotic streak, groundnut yellow mosaic and peanut stem necrosis disease have been reported from India. Among them, economically important virus diseases are peanut bud necrosis disease, peanut mottle, peanut clump and peanut stem necrosis. Witches' broom caused by mycoplasma like organism has also been reported from India. Control measures for other virus diseases

are not yet established. Peanut bud necrosis disease of groundnut is wide spread with a wide host range.

In India, peanut bud necrosis disease can cause yield losses upto 50 per cent. Peanut (groundnut) mottle virus (PMV) has been reported to occur on rabi/summer groundnut mainly in the states of Andhra Pradesh, Maharashtra and Gujarat. Losses have been reported to vary from 5-30 per cent. The PMV has been reported to be seed borne to the extent of 0.1 to 3.5 per cent. Indian peanut clump virus has been reported from Rajasthan, Punjab, Gujarat, Andhra Pradesh, and Uttar Pradesh states on crops grown in sandy soils. Yield losses up to 60% have been recorded due to this disease, especially in late infected plants.

Recently, a new virus disease, peanut stem necrosis, has been reported from Andhra Pradesh. This disease caused nearly 300 crores rupees worth of crop losses to groundnut in Andhra Pradesh during Kharif 2000. Initially, it was presumed to be caused by Peanut Bud Necrosis Virus (PBNV). But, research done has shown conclusively that the disease was found to be caused by a totally new virus, an isolate of Tobacco Streak Virus (TSV). As a result, the disease was named "Peanut Stem Necrosis Disease (PSND)".

Some diseases caused by nematodes in groundnut have been reported from India. The root knot nematodes have been reported to cause damage in various parts of the country. Root-lesion is also reported in India. Recently, a nematode induced disease locally known as 'Kalahasti Malady' was observed in Chittoor and Nellore districts of Andhra Pradesh. Data on losses caused by nematodes are not available. A list of minor diseases of groundnut occurring in India is also given in this bulletin.

Correct identification of groundnut diseases is the first step in planning a management strategy. Symptoms on plant parts can be used to identify most of the diseases in groundnut. If signs or symptoms of the disease differ considerably from what is considered to be normal, an affected plant sample should be taken for further examination. Special attention should be given to diseases that occur consistently and cause heavy losses, since growers will benefit economically by controlling them. New diseases do occur and minor diseases sometimes become wide spread.

Keeping in view the hard facts that (i) the dryland farmer is resource-poor, (ii) the damage caused by diseases to groundnut is of higher dimension than other major crops, and (iii) resistant commercial varieties to most of the diseases of groundnut are not available, emphasis has been given on cheaper but effective control measures for each of the economically important diseases in this bulletin.

2. Foliar Fungal Diseases

Among foliar fungal diseases, early and late leafspots commonly called as 'Tikka' disease and rust, are economically important.

Early leafspot (*Cercospora arachidicola*)

Hori perfect stage: *Mycosparella arachidis* Deighton

Distribution and economic importance

Normally, early leafspot is more prevalent in northern groundnut growing states. However, recently, it is assuming a serious status in southern and central states of India also. In India, losses in yield due to leafspots have been estimated to be in the range of 15 to 59%. Besides the loss in pod and kernel yield, the value of fodder is also adversely affected.

Symptoms

Lesions are sub-circular in shape and measure 1 to over 10 mm. On the upper surface of the quadrifoliate, the lesions appear dark brown with most sporulation while on the lower surface, they are of a lighter shade of brown. The early leafspot usually has a light to dark brown centre and a yellow halo. Distribution of fruiting structures is random on upper leaflet surface. Lesions are also produced on petioles, stems and pegs. These are oval to elongate in shape and have more distinct margins than the leaflet lesions. When severe, leaflets become chlorotic, lesions coalesce and leaflets are shed. The lesions may even extend to the stem and branches.

Survival

The early leafspot pathogen survives through conidia on affected plant debris in soil or through conidia being carried on the pod shell. The pathogen may also survive from one season to another on volunteer groundnut plants and on 'ground keepers'. The perfect stage of pathogen has not been reported so far from India. However, the role of ascospores, if formed in initiating the outbreak, cannot be ruled out.

Factors responsible for disease development

- Ambient temperatures between 25 and 30°C, prolonged leaf wetness hours, and high relative humidity (>80%) favour infection and disease development.
- Conidia are disseminated by wind and insects leading to secondary infection.

Disease management

- Deep burying of crop residues in the soil, and removal of volunteer groundnut plants are important measures to reduce the primary source of infection.
- Tolerant varieties like ICGS 44, M 335, BG 3, ICGS 76, Somnath, CSMG 84-1 and M 522 can be grown wherever early leafspot is severe.
- Intercropping pearlmillet or sorghum with groundnut (1 : 3) is useful in reducing the intensity of early leafspot.
- Foliar application of aqueous neem leaf extract (2-5%) or 5% neem seed kernel extract at 2 weeks interval 3 times starting from 4 weeks after planting or
- Foliar spray of carbendazim (0.05%) + mancozeb (0.2%) at 2-3 weeks interval, 2 or 3 times starting from the initiation of the disease.

Late leafspot (*Phaeoisariopsis personata (Burk. & Curt) V. Arx.)*

Perfect stage: *Mycosphaerella berkeleyi* W.A. Jenkins

Distribution and economic importance

It is also commonly present wherever groundnut is grown. However, the incidence and severity varies between localities and seasons. In India, late leafspot is more severe in southern and central parts of India. Yield losses due to leafspots range from 15 to 59%, but vary from place to place and between seasons. Besides the loss in pod and kernel yield, the value of fodder is also adversely affected.

Symptoms

Dark brown to black, circular to sub-circular lesions measuring 1-6 mm diameter appear on the lower surface of the quadrifoliate where most sporulation occurs. The lesions are

black in colour and fruiting structures occur in concentric rings on lower leaflet surface giving lesions slightly rough in appearance on the other parts and effects on disease severity are similar to that of early leafspot. In severe cases, oblong lesions occur on the stem and branches.

Survival

The late leafspot pathogen survives through conidia on affected plant debris in soil or through conidia being carried on the pod shell. The pathogen may also survive from one season to another on volunteer groundnut plants and on 'ground keepers'. The perfect stage of pathogen has not been reported so far from India. However, the role of ascospores, if formed in initiating the outbreak cannot be ruled out.

Factors responsible for disease development

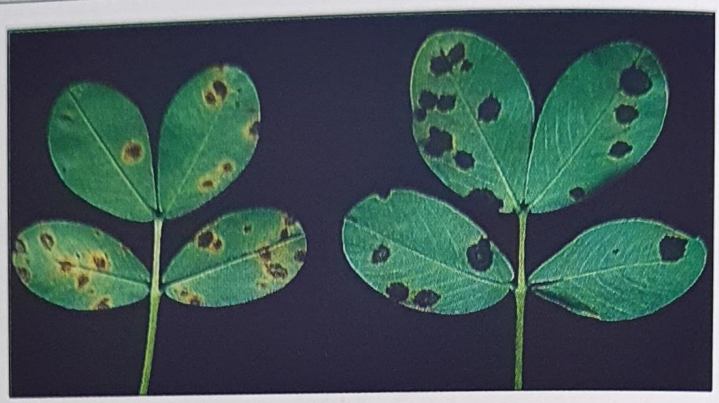
Ambient temperatures between 25 and 30°C. prolonged leaf wetness hours, and high relative humidity (>80%) favour infection and disease development.

Conidia are disseminated by wind and insects leading to secondary infection.

Disease management

- Deep burying of crop residues in the soil, removal of volunteer groundnut plants are important measures in reducing the primary source of infection.
- Use of resistant/tolerant varieties like Girnar 1, RG 141, ICGS 1, ICGV 87160, ICGV 86590, ICGV 86325, TAG 24, K 134, DRG 12, DRG 17, R 8808, Kadiri 4, ALR 1, ALR 2, ALR 3, BSR 1, OG-52-1, CO 3, VRI 5, CO 4, CSMG84-1, CSMG 884, M 335 and BG 3 can be grown wherever late leafspot is severe.
- Intercropping pearlmillet or sorghum with groundnut (1 : 3) is useful in reducing the intensity of late leafspot.
- Foliar application of aqueous neem leaf extract (2–5%) or 5% neem seed kernel extract at 2 weeks' interval 3 times starting from 4 weeks after planting or
- Foliar spray of carbendazim (0.05%) + mancozeb (0.2%) at 2–3 weeks interval, 2 or 3 times starting from the initiation of the disease.

Comparison of early and late leafspots



Characteristics	Early leafspot	Late leafspot
(i) Stage of occurrence on crop	Early	Late
(ii) Shape of spot	Circular to irregular	Usually circular
(iii) Leaf surface where first and most spores produced	Upper	Lower
(iv) Colour of spot on upper leaf surface	Light brown to black tending towards brown	Brown to black tending towards black
(v) Colour of spot on lower Leaf surface*	Brown	Black

*This is the most reliable characteristic for diagnosis.

Rust (*Puccinia arachidis Speg.*)

Distribution and economic importance

The rust of groundnut is prevalent throughout India, however, more severe in the southern states. In India, losses in yield due to rust alone have been reported in the range of 10–52% depending upon the variety. In addition to direct yield losses, rust can lower seed quality by reducing seed size and oil content.

Symptoms

Rust can be readily recognized as orange coloured pustules (uredinia) that appear on the lower leaflet surface and rupture to expose masses of reddish brown urediniospores. Pustules

appear first on the lower surface and in highly susceptible cultivars the original pustules may be surrounded by colonies of secondary pustules. Pustules may also appear on the upper surface of the leaflet. The pustules are usually circular and range from 0.5 to 1.4 mm in diameter. They may be formed on all aerial plant parts apart from flower and pegs. Severely infected leaves turn necrotic and desiccate but are attached to the plant.

Survival

Groundnut rust is known to perpetuate spread and produce severe disease outbreaks by means of urediniospores. In India, groundnut crop or volunteer groundnut plants are available in one or the other parts of the country enabling the survival of uredinial stage round the year. The pathogen may also survive from season to season on self-sown (volunteer) groundnut plants.

Factors responsible for disease development

An optimum temperature of 20^{0}C, prolonged leaf wetness hours and high humidity favour infection and disease development. Spread of the disease within crops is facilitated by wind movement, by rain splash and by insects.

Disease management

- Destroy volunteer (self sown) groundnut plants and /or crop debris to reduce/limit primary source of inoculum.
- Early sowing in the first fortnight of June to avoid disease incidence.
- Intercropping pearlmillet or sorghum with groundnut (1:3) is useful in reducing the intensity of rust.
- Use resistant/tolerant varieties like Girnar 1, ICGV 87160, ICGV 86590, ICGV 86325, DRG 12, TAG 24, ALR 2, BSR 1, OG-52-1, ALR 3, VRI 5, CO 4, ALR 1, CSMG84-1, ICGS-5 and DRG 17.
- Foliar application of aqueous neem leaf extract @ 2-5% is useful and economical for the control of rust or
- Spray 3 to 4 times (depending on intensity of disease) mancozeb (Dithane M 45) or Chlorothalonil @ 0.2 to 0.3%. or
- Two foliar sprays of triodimefon @ 250g/ha on 35 and 50 days of sowing.
- Pods and seeds from rust-affected crops are commonly surface contaminated with urediniospores at harvest. However, the extent of spread of the disease through such source is limited.

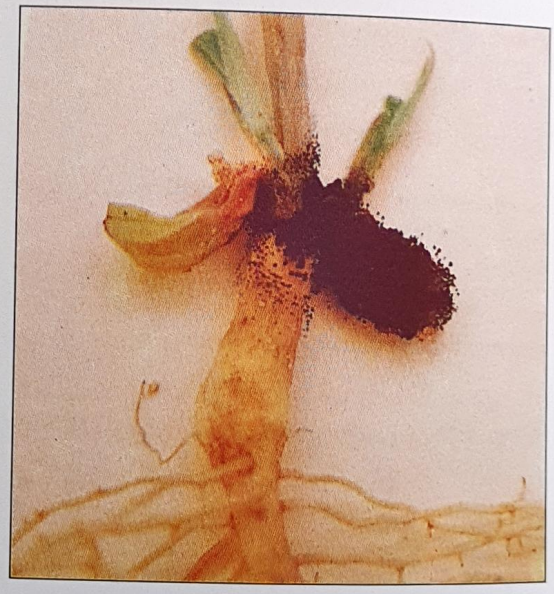
3. Fungal Seed and Seedling Diseases

Pre-emergence seed rot and post-emergence seedling mortality are of common occurrence, which reduce yield. The diseases develop either from fungi already present in the seed or result from direct invasion of seeds and seedlings by soil fungi. Among seedling diseases, collar rot, root rot and stem rot are of economic importance. These diseases cause severe seedling mortality resulting in patchy crop stand mostly in sandy loam soils and reduce the yields from 25-50%.

Collar rot (*Aspergillus niger Van Tieghem*)

Distribution and economic importance

In India, collar rot, also known as crown rot or seedling blight, is prevalent in almost all groundnut-growing states namely in Andhra Pradesh, Tamil Nadu, Uttar Pradesh, Gujarat, Maharashtra, Madhya Pradesh, Punjab, Rajasthan, Karnataka and Orissa especially in sandy loam and medium black soils. The losses in terms of mortality of plants range from 28 to 50%.



Symptoms

The diagnostic symptoms are pre-emergence rotting of seeds, rotting of hypocotyls, but the most common cause of loss is early post emergence seedling blight. Hypocotyl tissue becomes water soaked and light brown. The first symptom in emerged seedling is usually a rapid withering of entire plant or its branches. At this stage, the hypocotyls and tissue of the cotyledonary node are particularly rotted. As the infection spreads, the whole collar region becomes shredded and dark brown. Mature plants may also be attacked. Lesions develop on the stem below the soil and spread upwards along the branches. The dead and dried branches are easily detached from the disintegrated collar region.

Survival

The pathogen survives in the soil. It may be carried in or under the seed coat, but soil borne inoculum mainly serve as primary source of infection.

Factors responsible for disease development

The pathogen can tolerate low soil moisture at 13 to 16%. The fungus develops best at temperature between 31 and 35°C.

Disease management

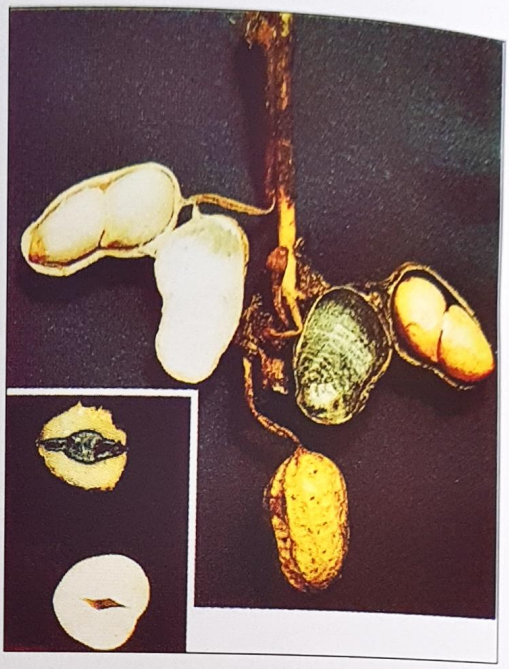
- Avoiding deep sowing (not more than 2 inches).
- Avoiding injury to seedlings and deposition of soil particles on cotyledons during interculture operations.
- Mixed cropping with moth bean (*Phaseolous aconitifolius*) in alternate rows.
- Deep tillage, early sowing, and crop rotation with wheat and gram.
- Soil application of neem cake or castor cake @ 500 kg/ha.
- Use of resistant/tolerant varieties like J 11, JCG 88, and OG-52-1.
- Seed treatment with *Trichoderma harzianum* or *T. viride*@ 4g/kg seed and their soil application as per local recommendation or
- Bacterization of groundnut seeds with strains of fluorescent Pseudomonads or
- Seed treatment with neem seed kernel powder @ 3-5% or
- Seed treatment with carbendazim 1–2 g/kg seed or mancozeb 2–3 g/kg seed or chlorothalonil or captafol @ 2 g/kg seed.

Dry root rot (*Macrophomina phaseolina, (Tassi) Goid Rhizoctonia bataticola*)

Distribution and economic importance

Dry root rot, also known as dry wilt or charcoal rot, is sporadic in occurrence particularly in Rajasthan, Uttar Pradesh, Tamil Nadu, Andhra Pradesh and Maharashtra. This disease causes severe seedling mortality resulting in patchy crop stand and thus reduce the yield.

Symptoms



The disease may appear at any stage of the crop growth. Water soaked necrotic spots appear on the stem just above the ground level. The lesions darken as the infection spreads upward to the aerial parts and down to the roots. If the initial lesion girdles the stem, wilting follows. The infected stem portion is shredded and with the development of sclerotia becomes black and sooty in appearance. Roots, pegs and pods also rot and become covered with sclerotia. Roots are commonly attacked in association with stem rot and wilt. Occassionally when only the roots are attacked, the taproot turns black and later rots and shreds. The kernels turn black with abundant sclerotia on the inner wall of the shell and surface of the testa. The symptoms of the leaf infection are characterized by marginal zonate and irregular spots. Minute spots are also quite common and expand into bigger wavy spots.

Survival

Dry root rot has wide host range. The pathogen is a facultative saprophyte and a soil dweller. Infected soil, plant debris and pods serve as sources of inoculum. It can be isolated from kernel, and shells.

Factors responsible for disease development

The optimum temperature for seedling infection is 29 to 35°C. For pods invasion, the temperature range is between 26°C and 32°C. The dissemination of the fungus is by sclerotia via plant debris, soil infected pods, shell and kernel.

Disease management

- Measures, which encourage good crop growth such as adequate fertilization, irrigation and pest control, help in reducing the incidence of this disease.
- Care should be taken not to damage pods during harvesting and kernels during shelling.
- Closer spacing (30 cm) between rows.
- Seed treatment with *Trichoderma polysporum* or *T. viride* or *T. harzianum* @ 4 g/kg seed or
- Seed treatment with carbendazim @ 2 g/kg seed or captafol or thiram @ 3 g/kg seed.

Stem rot (*Sclerotium rolfsii Sacc.*)

Distribution and economic importance

The stem rot pathogen has a very wide host range. In India, stem rot, also known as *sclerotium* wilt, occurs in all groundnut growing states, particularly very severe in Maharashtra, Gujarat, Madhya Pradesh, Karnataka, Andhra Pradesh, Orissa and Tamil Nadu where it is estimated that over 50,000 ha of groundnut fields are infected by *S. rolfsii.* Pod rot caused by *S. rolfsii* is also economically important in central and southern Maharashtra, Saurashtra region of Gujarat and Raichur area of Karnataka. Of late, this disease is becoming a serious problem in South Saurashtra zone of Gujarat both in medium black and highly calcareous soil. Latur in Maharahstra, Raichur and Dharwad in Karnataka and Hanumangarh in Rajasthan have been identified as hot spots.

In India, 27% or more yield loss has been reported. *S. rolfsii* also causes indirect losses such as reduction in both dry weight and oil content of groundnut kernels.

Symptoms

The first symptom is partial or complete wilting of the stem or branch that is in contact with the infected soil. The leaves turn brown and wilt but remain attached to the plant. As the disease advances a white mycelium web grows at the junction of stem and soil, spreads over the soil and the basal canopy of the plant. The sclerotia of the size and colour of mustard seeds, appear on the infected area as the disease develops and spreads. The entire plant may be killed or only two or three branches may be affected. Infection of pegs can take place independent of the

stem infection or together with it. Lesions on the developing pegs can retard pod development. Infected pods are usually rotted. A root rot caused by *S. rolfsii* is also prevalent in some areas.

Survival

The pathogen has a wide host range. *S. rolfsii* can colonize either living plant tissues or plant debris. Deeply buried sclerotia survive a year or less while those near the soil surface remain viable for many years. Defoliated leaves can also serve as a bridge to facilitate plant to plant spread. The fungus, spreads through infected soil, wind splashed rains and sclerotia.

Factors responsible for disease development

Crop residues particularly influence the sclerotial germination, mycelial growth and infection by *S. rolfsii* in groundnut. Soil moisture to the extent of 40 to 50% of water holding capacity has been found optimum for the development of disease. Generally, when the temperature remains 29 to 32°C during the most of the day and seldom drops below 25°C during nights the disease develops more favourably.

Disease management

- Deep ploughing
- Non-dirting cultivation in combination with minimizing defoliation by leafspot control.
- Deep burial of surface organic matter and crop debris by ploughing it to a depth of 8-10 inches.
- Early sowing and close planting.
- Rotation of groundnut with cotton, wheat, maize, jowar, onion and garlic.
- Use of tolerant varieties like Dh-8, ICGV-86590, OG-52-1.
- Seed treatment with *Trichoderma viride/T. harzianium* @ 4 g/kg seed.
- Soil application of castor cake or neem cake or mustard cake @ 500–1,000 kg/ha and *T. viride / T. harzianium* as per local recommendation.
- Seed treatment with carbendazim or captan @ 2–3 g/kg seed.

4. Virus Diseases

Peanut Bud Necrosis Disease (PBND)

Distribution and economic importance

The peanut bud necrosis disease (PBND) is widely distributed in India. It has been recognized as one of the most important virus diseases of groundnut in Andhra Pradesh, Uttar Pradesh, Madhya Pradesh, Tamil Nadu, Karnataka and Maharashtra on Kharif groundnut crop. It has been reported on post rainy season crop (Rabi/Summer) of groundnut with considerable incidence in Saurashtra region of Gujarat, Nizamabad, Nalgonda, Mahaboobnagar districts of Andhra Pradesh, northern and Vidarbha regions of Maharashtra

and north-eastern parts of Karnataka. The hot spot locations for PBND are Jagtiyal and Hyderabad in Andhra Pradesh, Latur in Maharashtra, Tikamgarh in Madhya Pradesh, Raichur in Karnataka and Mainpuri in Uttar Pradesh. In India, PBND is one of the most damaging virus disease in groundnut and causes 30–90% yield losses depending upon plant growth stage at the time of infection.

Symptoms

The PBND produces a variety of symptoms in groundnut. Initial symptoms appear on young quadrifoliates as mild chlorotic mottle or spots, which develop into necrotic and chlorotic rings. Necrosis of the terminal bud, a characteristic symptom occurs on crop grown in the rainy and post rainy seasons. The secondary symptoms are stunting, auxiliary shoot proliferation and malformation of leaflets. If plants are infected early, they are stunted and

bushy. If plants older than one month are infected, the symptoms may be restricted to a few branches or to the apical parts of the plants. Seeds from early-infected plants are small, shriveled, mottled and discoloured. Late infected plants may produce seed of normal size, but testa on such seeds are often mottled and cracked.

Survival

Both PBNV and the vector (*Thrips palmi*) have wide host range in crop plants, ornamentals and weeds. The virus may survive in these hosts and can provide an inoculum source for vector thrips. In India, tomato, brinjal (egg plant), green gram, black gram, beans and pea are highly susceptible to both virus and vector. Many ornamentals such as zinnia, cosmos and sunflower harbour large numbers of thrips and zinnia and cosmos are also hosts of the virus. Weeds such as *Ageratum conyzoides, Cassia tora, Acanthospermum hispidum, Desmodium triflorum* and *Lagasca mollis* are susceptible to both virus and vector.

Factors responsible for disease development

The thrips are mainly carried by the wind. Temperature around 30°C and a wind speed of 10 km/hr favour migration of thrips. The population of thrips increases rapidly and reaches its peak in late August and September. Major secondary spread of the disease is associated with thrips migrating in August and September. The population of thrips builds up again during January and February and hence rabi crop suffers damage due to the disease. A prolongd dry spell not only increases damage by thrips but also spread of the virus.

Disease management

- Use of tolerant varieties like kadiri 3, ICGS 11, ICGS 44, RG 141, ICGS (FDRS) 10, ICGS 37, RSH 41, TAG 24, K 134, DRG 12, R 8808, Kadiri 4, BSR 1, JCG 88, ALR 3, CO 3, ICGS 5, BAU 13, B 95, ICGV 86325, DRG 17 and CSMG 884 wherever, PBND is a problem.
- Early sowing (at the onset of rains in mid to late June) for central India and late sowing (During July) for North India.
- Closer spacing of 20 or 22.5 × 7.5 or 10 cm.
- Intercropping pearlmillet or sorghum or maize with groundnut (1 : 3) is useful in reducing the incidence of disease.
- Two sprays of water extract of oak leaf (1%) within 40 days after germination or sorghum or coconut leaf extract (1%).
- Need based spray of quinalphos 0.02% within 40 days after germination.

Peanut mottle virus (PMV)

Distribution and economic importance

This disease has been reported to occur on groundnut mainly in the states of Andhra Pradesh, Maharashtra and Gujarat. The disease can cause up to 30% loss in yield.

Symptoms

The symptoms appear on young leaves as irregular dark green islands. Mosaic symptoms are not apparent on older leaves, which show mild mottle symptoms visible in transmitted light. Plants are not severely stunted. Some genotypes show characteristic interveinal depression and upward rolling of leaflet margin. Infected plants produce only a few small pods.

Survival

The virus is seed-borne. The secondary transmission is by aphid species like *Aphis craccivora, Myzus persicae, Aphis gossypii* etc. The PMV occurs on several important legume crops including groundnut, soybean and weeds like *Cassia obtusifolia, C. leptocarpa, C. occidentalis and Desmodium canum.*

Factors responsible for disease development

The primary source of inoculum through seed helps in establishment of the disease in the field. A frequency of as low as 0.1% of seed infection can provide about two infected seedlings per 100 m^2 in a field. The secondary spread through aphids is favoured when the crop suffers prolonged dry spells which are congenial for aphid population build-up.

Disease management

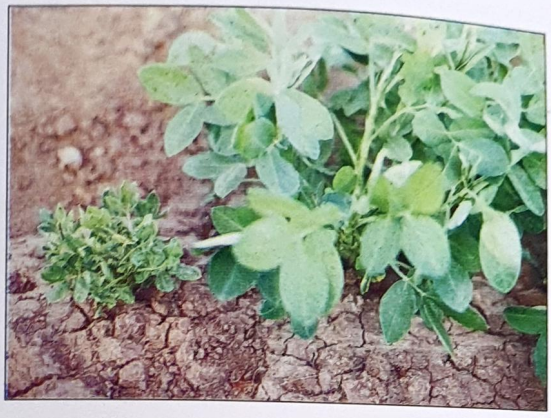
- Avoid primary infection through seed by growing PMV-free seeds.
- Strictly observe quarantine regulations.
- Avoid secondary infection by aphids by control of vectors through chemicals, biological or cultural methods. For biological control of aphids, natural enemies namely Coccinellidae and Syrphidae may be used.
- Sowing trap-crop around groundnut that attracts aphids.

- Growing crop barriers to minimize vector mobility for long distances.
- Minimizing aphid transmission by manipulating sowing dates of groundnut wherever possible.
- Controlling weed hosts.

Peanut clump (PCV)

Distribution and economic importance

Indian peanut clump has been reported from Rajasthan, Punjab, Gujarat, Andhra Pradesh, and Uttar Pradesh on crops grown in sandy soils. Yield losses up to 60% have been recorded in late infected plants.



Symptoms

This disease occurs in patches in the field, which recur and enlarge year after year in the same positions when groundnuts are sown again in the same field. Young leaves show mosaic mottling and chlorotic ring symptoms. Older leaflets are darker green with faint mottling. Early infected plants are conspicuous in the field because they are severely stunted and dark green.

Survival

The virus mainly spreads through soil by *Polymyxa graminis* and possibly by nematodes too. Apart from groundnut, the virus also infects wheat and many other weeds. The virus is also reported to be seed-borne, but to a very negligible extent. In addition, *P. graminis* has also a wide host range and so the virus also perpetuates over seasons.

Disease management

- Seed should be obtained from areas free from PCV, since even a few infected plants can be source for further spread of the disease.
- Weed-free clean cultivation
- Soil solarization
- Crop rotation with pearlmillet
- Soil application of nemagone and temik one week before planting

Peanut stem necrosis disease (PSND)

Distribution and economic importance

During Kharif 2000 PSND occurred in an epidemic form in Anantapur district and to some extent in the adjoining Cuddapah and Kurnool and Chittoor districts of Andhra Pradesh. Since then it is occurring in these districts and also Raichur area of Karnataka. So far, it is not reported on groundnut from any other parts of the country.

Symptoms

Initial symptoms appear as large necrotic lesions on young quadrifoliates. These necrotic lesions coalesce and cover the entire leaflet leading to complete necrosis of young quadrifoliates. These symptoms will be followed by necrosis of the entire stem located below the necrosed quadrifoliates. If young plants are affected (less than one month old) the entire plant is often necrosed. In the case of older plants one or more branches will show necrosis. These plants are stunted and do not show any axillary shoot proliferation. Necrotic spots are observed on majority of pods. Size of the pods is severely reduced and kernels are not marketable. The symptoms, however, have been shown to vary among varieties of groundnut.

Survival

Tobacco Streak Virus infects many plants including the most common weeds in groundnut fields such as Parthenium. It may survive on cowpea, black gram, marigold and sunflower. Both virus and thrips (vector) have wide host range of crop plants, ornamentals and weeds.

Disease management

- As the disease spreads from June to November, farmers should be alerted timely for the management of the disease.
- Avoid monocroping of groundnut wherever possible.
- Thrips (Vectors) and virus have wide host range of crop plants and weeds. Therefore, maintain fields clean by frequent weeding to reduce the disease incidence.

- Maintaining optimum plant population by adopting a seed rate of 100–120 kg/ha reduces further spread of the disease.
- Intercropping of redgram and bajra or redgram and castor with groundnut appear to reduce the disease intensity.
- Alternate cropping of sorghum, bajra, maize, castor, sesamum with groundnut in endemic areas, at least once in three years.
- Judicious and need based application of fertilizers and pesticides.

5. Tools available for integrated disease management

Integrated disease management is an optimum blend of feasible and economically viable options of disease management for different agro-climatic regions depending on the occurrence and importance of the diseases. Various options that are on hand for major diseases are listed below.

Resistant/tolerant variety

Diseases	Resistant/tolerant varieties
Early leafspot, late leafspot, Rust	ALR 1, ALR 2, ALR 3, Girnar1, ICGV 86590, ICGV 87160, ICGV 86325, CSMG 84-1, OG 52-1, RSHY 1, DRG 12, DRG 17, TAG 24, BSR 1, VRI 5, CO 4
Collar rot and aflaroot	J 11, JCG 88 and OG-52-1
Stem rot	OG-52-1, Dh-8, and ICGV 86590
Peanut bud necrosis disease (PBND)	ICGS 11, ICGS 44, ICGS 37, Kadiri 3, ICGV 86325, K 134, DRG 12, R 8808, JCG 88, CSMG 884, Chandra

Cultural practices

- Deep burying of crop residues, destruction of crop debris by burning, removal of volunteer groundnut plants, early planting with wider inter row spacing (40-45cm) for managing early leafspot, late leafspot, and rust.
- Against collar rot, avoid deep sowing (not more than 2 inches) and avoid injury to seedlings and deposition of soil particles on cotyledons during intercultural operations.
- Non-dirtying cultivation in combination with minimizing defoliation due to leafspot, deep burial of surface organic matter and crop debris by ploughing it to a depth of 8–10 inches, early sowing and close planting to manage stem rot pathogen.
- Deep tillage for management of soil-borne pathogens.
- Soil application of castor cake or mustard cake or neem cake @500–1,000 kg/ha against soil-borne pathogens.
- Crop rotation with cotton, wheat, maize, onion, garlic for stem rot.

- Early sowing (first fortnight of June) for peninsular and central India, late sowing (first fortnight of July) for northern India, and close spacing (20 × 10 cm or 30 × 7.5 cm) for the management of PBND.
- Intercropping with pearlmillet, sorghum, pigeonpea and maize for the management of early leafspot, late leafspot and rust and Pearlmillet for management of PBND.
- Mixed cropping with moth bean (*Phaseolus aconitifolius*) in alternate rows for management of collar rot.

Biopesticides and biocontrol agents

- Spray of aqueous neem leaf extract (2–5%) for the management of leafspots and rust.
- Spray of neem seed kernel extract (5%), or crude neem oil (2%) against foliar pathogens.
- Two foliar sprays of water extract of oak leaf @ 1% within 40 days after germination to manage PBND.
- Seed treatment with *Trichoderma viride* or *T. harzianum* against seed and soil-borne pathogens @ 4 g/kg seed.
- Soil application of *Trichoderma viride* or *T. harzianum* @ 25–62.5 kg/ha, preferably in conjunction with organic amendments such as castor cake or FYM against seed and soil borne diseases.

Chemical methods for need based application

Diseases	Spray schedule
Early leafspot, late leafspot, rust	Two sprays of mancozeb 0.2% at 35 and 70 days after germination and one spray of carbendazim 0.025% at 60 days after germination (ICBR 1 : 2.85) or application of carbendazim 0.025% + tridemorph 0.04% five times at fortnightly intervals commencing 35 days after sowing during summer season or spray of carbendazim 0.05% + mancozeb 0.2% at 2–3 weeks interval, 2 or 3 times starting from 4–5 weeks after planting (CBR 1 : 14.8 to 1 : 24.4) or foliar application of chlorothalonil (0.1%).
Collar rot	Seed treatment with carbendazim @ 2 g/kg seed or mancozeb @ 2–3 g/kg seed or chlorothalonil or captafol @ 2 g/kg seed.
Stem rot	Seed treatment with carbendazim 2 g/kg seed or mancozeb 3 g/kg seed, or captun 3 g/kg seed. Soil drenching with 0.2% carbendazim.
PBND	Foliar application of dimethoate or quinalphos @ 0.02%.

6. Minor diseases occurring in India and their symptoms

Foliar fungal diseases

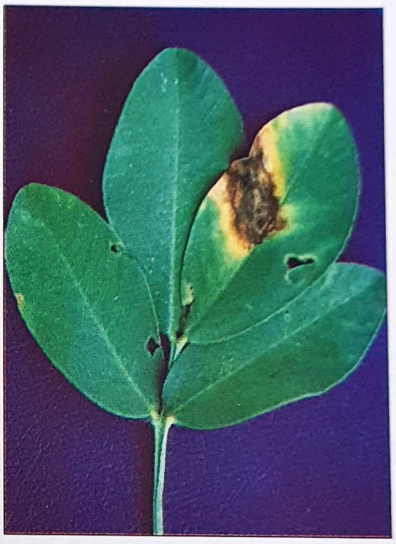
Alternaria diseases (*Alternaria* leafspot and Veinal necrosis *Alternaria* leaf Blight)

Causal organisms

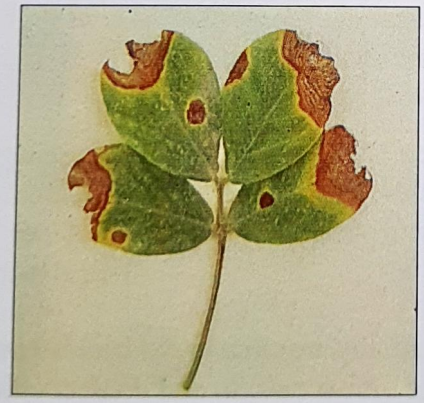
Alternaria alternata

Alternaria tenuissima

Alternaria arachidis



Lesions produced by *A. arachidis* are brown in colour and irregular in shape surrounded by yellowish halos. Symptoms produced by *A. tenuissima* are characterized by blighting of apical portion of leaflets, which turn light to dark brown colour. In the later stages of infection, blighted leaves curl inward and become brittle. Lesions produced by *A. alternata* are small, chlorotic, water soaked, that spread over the surface of the leaf. The lesions become necrotic and brown and



round to irregular in shape. Veins and veinlets adjacent to the lesions become necrotic. Lesions increase in area and their central portions become pale, rapidly dry out and disintegrate. Affected leaves show chlorosis and in severe attacks become prematurely senescent. Lesions can coalesce, give the leaf a ragged and blighted appearance. Profuse sporulation occurs on the adaxial surface of mature lesions.

Anthracnose

Causal organisms

Colletotrichum dematium

Colletotrichum capsici

Small water soaked yellowish spots appear on the lower leaves which later turn into circular brown lesions with yellow margin of 1 to 3 mm in diameter. In some cases lesions enlarge rapidly, become irregular and cover the entire leaflets and extend to the stipules and stems. Abundant acervuli are seen on infected tissues.

Pepper spot and leaf scorch

Causal organism

Leptospphaerulina crassiasca Sachet

This disease is characterized by two distinct symptoms and is confined to leaves. Pepper spots are dark brown to black lesions usually less than 1 mm in diameter, irregular to circular in outline and occasionally depressed. Discrete lesions over the leaflet surface are visible from both sides of the leaflet.

Phomopsis leafspot

Causal organism

Phomopsis sp.

Small spots on the leaflet tips occur which initially are circular but later become irregular in shape and size. Lesions are grey with darker brown margin and distinct chlorotic areas

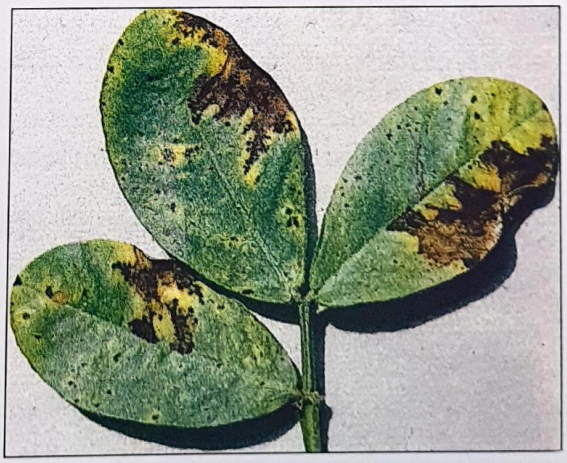
around them. Pycnidia, partially buried in the dead tissue, appear as small dark dots scattered over the lesions. In severe infections the entire infected leaflet becomes chlorotic and ultimately sheds.

Phyllosticta leafspot

Causal organism

Phyllosticta arachidis-hypogaea Vasant Rao

Lesions are irregular, mostly marginal and apical, scattered, dark-brown and epiphyllous.



Pestalotiopsis leafspot

Causal organism

Pestalotiopsis arachidis Sayta

Dark-brown, circular lesions surrounded by yellow halos are developed on leaves. Black spherical acervuli are observed in the centre of the lesions.

Phoma leaf diseases

Causal organisms

Phoma microspora Balasubramaniam and Narayanasamy

Phoma sorghina (Sacc.), Dorenbosch & V. Kest

Symptoms caused by *P. microspora* are characterized by development of scattered light brown lesions mainly on the lower leaves. The lesions enlarge in size to form spots over 5 × 10 mm size. Lesions are light brown in colour with dark brown margins.

In case of *P. sorghina* marginal and scattered spots are developed on leaflet surface, which are circular to irregular in shape, whitish brown with dark brown margins measuring 3 × 3.3 × 7 mm in diameter. Pycnidia are immersed in the lesions, conspicuous on the adaxial surface of the leaflet.

Myrothecium leaf blight

Causal organism

Myrothecium roriduma Tode ex.Fr.

Leaf lesions are round to irregular, 5–10 mm in diameter grey in colour and surrounded by a chlorotic halo. Lesions coalesce and give blighted appearance of leaves. Abundant black fruiting bodies, often arranged in concentric rings, are formed on both leaf surfaces.

Drechslera leaf blight

Causal organism

Drechslera spicifera (Bain) Von Arx.

The disease symptoms start at the tip of the leaflet with the appearance of pale yellow areas, which develop into black brown lesions. The lesions coalese to form V-shaped blighted areas at the tips of the leaflets.

Zonate leafspot

Causal organism

Cristulariella pyramidalis Waterman and Marshall

Necrotic spots ranging from 2 to 13 mm in diameter are developed on leaves. The small lesions have light brown centres, surrounded by brown rings of necrotic tissue. Large lesions exhibit a zonate appearance and pyramidal sporophores are present on both adaxial and abaxial leaf surfaces.

Powdery mildew

Causal organism

Oidium arachidis Chorin

Large spots cover the upper surfaces of leaflets. These spots

are covered with superficial sporulating fungal growth, which gives them a powdery white appearance. The centers of the spots later become brown and necrotic.

Sclerotium leafspot

Causal organism

Sclerotium rolfsii Sacc.

Appear on mature plants as grey necrotic ring spots which may develop shot holes. During long periods of leaf wetness the spots coalesce leading to a severe blight. Sclerotia (about 0.5 to 0.8 mm in diameter) initially white, but later brownish in colour can be seen on both leaflet surfaces.

This pathogen also causes stem, root and pod diseases which are more damaging than the leafspots.

Seed and Seedling Diseases

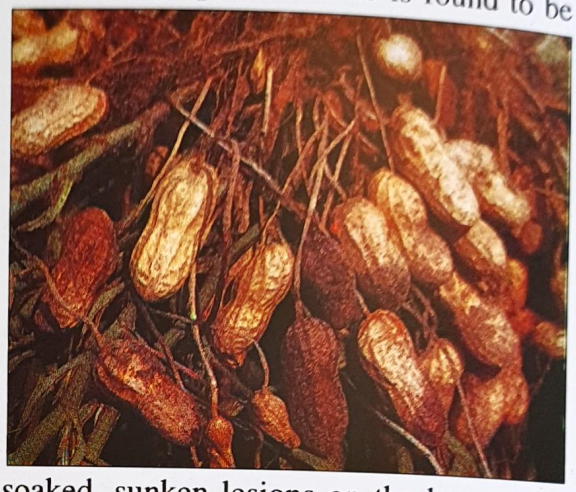
Yellow mold/Aflaroot disease

Causal organism

Aspergillus flavus (Link) Fries

Seed and emerging seedlings attacked by the fungus are rapidly reduced to a shriveled, dried, brown or black mass covered by yellow or greenish spores. Decay is most rapid when infected seeds are planted. In some cases emerging radicle and hypocotyls are infected

which decay rapidly. After seedling emergence cotyledons, already infected with the fungus, show necrotic lesions with reddish brown margins. This necrosis terminates at or near the cotyledonary axis. Under field conditions the diseased plants are stunted and are often chlorotic. The leaflets are reduced in size with pointed tips, widely varied in shape and sometimes with veinal clearing. If infected plants are dug up, the radicle is found to be lacking in secondary root development.



Fusarium rot

Causal organism

Fusarium oxysporum, Fusarium solani

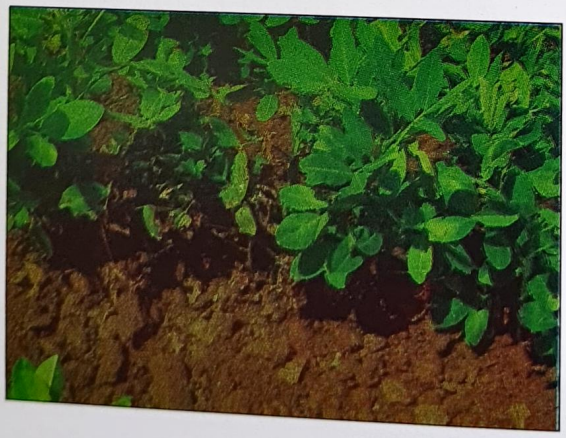
Germinating seeds are attacked by *Fusarium* spp. just before emergence. There is a general tissue disintegration and the surface of the seedling is covered with sporulating mycelium. Damping off symptoms characterized by brown to dark brown water soaked, sunken lesions on the hypocotyls appear which later encircle the stem and extend above the soil level. Roots are also attacked, especially the apical portions. The affected seedlings become yellow and wilted. The leaves turn grayish green and the plants dry up and die. The roots and stem show internal vascular browning and discolouration. These fungi are also commonly associated with pod rot.

Rhizoctonia seedling rot and Rhizoctonia limb rot

Causal organism

Rhizoctonia solani Kuhn

Germinating seeds are invaded by the soil borne inoculum which may result in pre-emergence death. The



fungus is commonly associated with pre- and post-emergence damping off and pod rots in India.

The apical region of the branches are infected first and the necrosis progresses downwards, sometimes killing many branches. When abundant moisture is available the fungus grows as light brown mycelium on infected tissues, decaying leaves and stem. In severe cases, the large irregular light brown to brown sclerotia are formed on the foliage and branches.

Pythium diseases

Causal organisms

Pythium myriotylum Drechsler

P. debaryanum Drec.

P. butleri Subramaniam

Unemerged seedlings show decay of cotyledons and primary roots. A loose mat of white mycelium covers the surface of the rotting tissue. Severely infected seeds are reduced to a dark brown pulpy mass. The infected emerging seedlings are stunted with pale green leaves, which subsequently turn brown, dry up and are shed. The root system is greatly reduced due to rotting of lateral, fibrous and taproots. In advanced stages, the cortical tissues turn brown and disintegrate leaving a non-functional vascular skeleton.

Rhizopus seed and seedling rot

Causal organisms

Rhizopus arrhizus Fischer

Rhizopus oryzae Went & Gerlings

Rhizopus stolonifer (Ehrenberg ex. Fr.) Vuillemin

Seed and pre-emerged seedlings attacked by *Rhizopus* spp. decay rapidly. The infected seed and seedlings are reduced to a dark brown or black spongy mass of rotten tissue covered with a mat of mycelium on which masses of grey-black spores are produced.

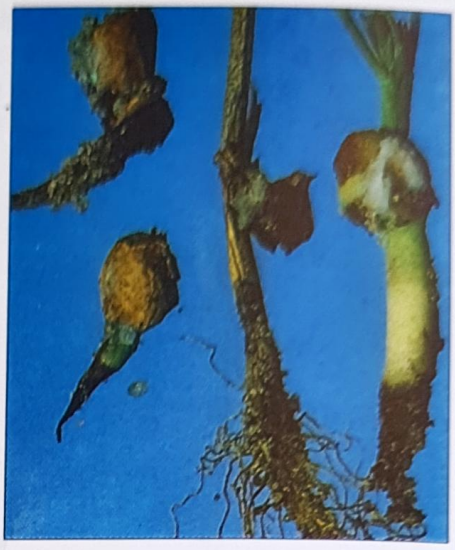
Diplodia Collar Rot

Causal organism

Lasiodiplodia theobromae (Pat.) Griffon & Maubl.

Seedlings or maturing plants are infected at or near the soil surface and the fungus

quickly invades the stem. Wilting of lateral branches or the entire plant is the first field symptom. Infected plants usually die within a few days. The base of the infected plants and the tap root become slate grey to black and easily shred. Black pycnidia develop as pimple-like dots on the necrotic tissues.



Cylindrocladium black rot

Causal organism

Cylindrocladium crotalariae (Loos) Bell & Soken

Diseased plants appear in the field in localized patches which enlarge in subsequent years. Early symptoms are chlorosis and wilting of foliage on the main stem. Lateral branches may not be affected, and occasionally plants may not wilt but appear chlorotic and stunted. Reddish-orange fruiting bodies are formed in dense clusters on infected branches at the soil line. All subterranean plant parts can be affected. Lesions on pegs and pods may remain discrete, or in severe cases the disease may destroy pods and roots.

Diseases Caused by Bacteria

Bacterial Wilt

Causal organism

Pseudomonas solancearum (Ralstonia solanacearum) Smith

Infection of young plants can result in sudden wilting and death, but the leaves remain green. Infection of mature plants results in loss of turgidity, and leaves become light green, chlorotic and curl at the tips. Eventually leaflets become brown but remain attached to the plant. In some instances only a single branch may wilt

and die. The vascular system of the tap root becomes plugged and discolored and this extends into the main stem and lateral branches. Masses of bacteria ooze from the cut ends of infected roots and stems when these are placed in water.

Bacterial leafspot

Causal organism

Unidentified bacterium

Small, light brown, circular to irregular lesions appear on the lower leaves of young plants. During the early stages of disease development lesions are prominent on the upper surfaces of leaflets. The lesions enlarge, become irregular in shape, and the tissues around them become chlorotic. When fully developed, the centre of the lesion is coloured a light brown and the margin is dark brown. In wet weather, the lesions coalesce and the leaves become chlorotic and are shed.

Bacterial podrot

Causal organism

Erwinia caretovora

The symptoms of the disease largely confine to the shell of the groundnut pods and frist appear as minute water soaked to brown spots of about 1 mm size. The spots later enlarge into raised, circular pimples, which become dark brown in colour. As the disease progresses it becomes oval to irregular and the centre of the raised patch soon becomes dark in colour with marked disintegration of the tissues resulting on formation of depressed irregular dark brown patches measuring 10–15 mm . It may even spread deeper into the pods and the shell become fibrous bearing no kernel inside.

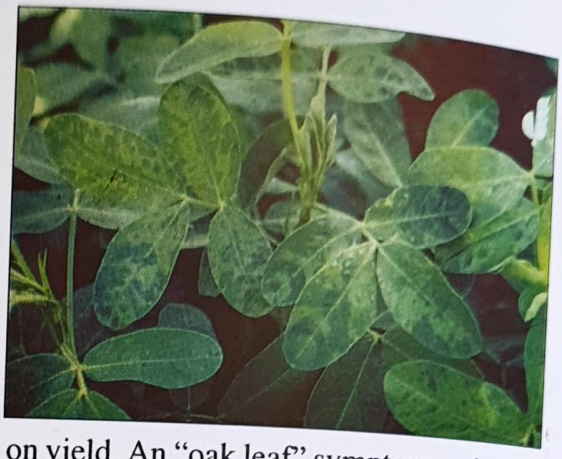
The symptoms of the disease can be observed on the tip of the gynophores and young developing pods. They later blackened and dried restricting further development of the affected pods.

Diseases caused by viruses

Peanut Stripe

Causal organism

Peanut stripe virus (PStV)

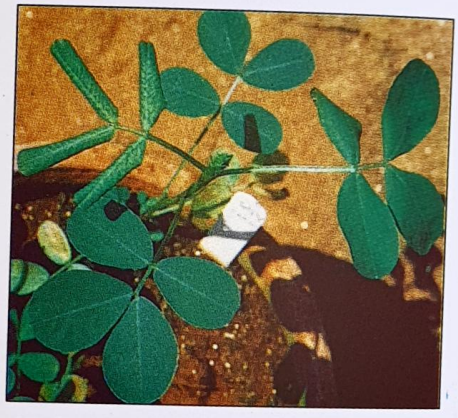


In earlier reports from some countries PStV was misidentified as PMV but, unlike PMV, PStV causes a wide range of leaf symptoms. Symtoms vary, depending upon virus isolate and groundnut cultivar. Necrotic and stripe isolates cause severe yield reductions, whereas mild mottle and blotch isolates have little or no effect on yield. An "oak leaf" symptom on leaves is occasionally seen.

Cowpea Mild Mottle

Causal organism

Cowpea mild mottle virus (CMMV)

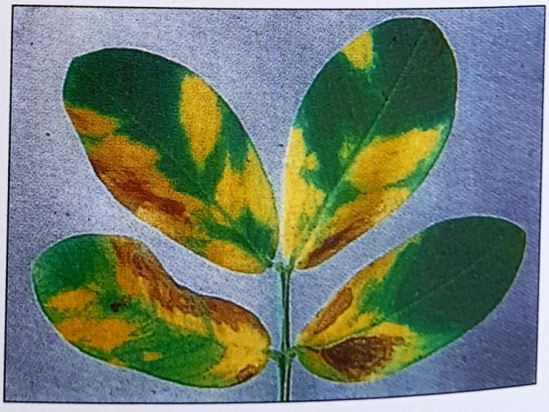


Infected plants are conspicuous by the outward rolling of their leaflet edges and severe stunting. Younger leaflets often show vein banding and older leaflets may become necrotic. The incidence of CMMV in groundnut can be as high as 30% if they are sown adjacent to soybean (*Glycine max*) and cowpea (*Vigna unguiculata*), the two highly susceptible crops.

Peanut Yellow Spot

Causal organism

Peanut yellow spot virus (PYSV)



Chlorotic spots first appear along the midribs of young leaflets where the thrip vectors feed. The spots increase in size and may coalesce and become irregular in shape as the leaves approach maturity. At this stage the colour of the spots is distinctively yellow. Since the infection is localized, symptoms appear only on infected leaflets.

Peanut chlorotic streak and Peanut chlorotic leaf streak (PCLSV)

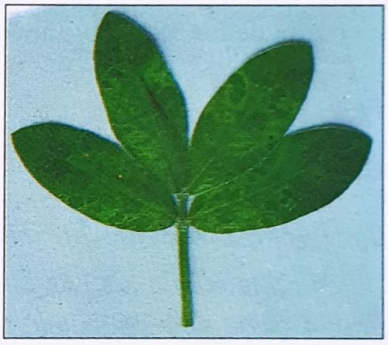
Peanut chlorotic streak (PClSV)

Plants show reduced leaflets, chlorotic streaks, and stunting. Due to infection by PCLCV-CVB strain, plants show severe stunting with chlorotic streaks on the leaves. An isolate of this virus causing chlorotic vein banding (PCLSV-CVB) was reported from Rayalaseema area of Andhra Pradesh.

Groundnut yellow mosaic

Causal organism

Groundnut yellow mosaic virus (GYMV)



A virus transmissible by *Bemisia tabaci* and causing yellow mosaic and leaf distortion of groundnut closely resembling mung bean (*Vigna radiata*) yellow mosaic virus in transmission characteristics, host range and symptoms. This is the first report of a whitefly-transmitted yellow mosaic on groundnut.

Peanut green mosaic

Causal organism

Peanut green Mosaic Virus (PGMV)

PGMV occurs in Chittoor district of Andhra Pradesh in India. Infected plants show chlorotic spots and vein clearing on young quadrifoliates, followed by severe mosaic.

Disease caused by a mycoplasma-like organism

Witches' Broom

Causal organism

Mycoplasma-like Organism (MLO)

The excessive proliferation of leaflets gives infected plants a broom-like appearance. Leaves are small and chlorotic and the plant is stunted. If pegs are formed, they curl upwards against gravity.

Diseases caused by Nematodes

Root-knot Nematodes

Causal organisms

Meloidogyne arenaria

Meloidogyne hapla

Meloidogyne javanica

Groundnut plants infected by root-knot nematodes commonly develop enlarged roots and pegs, which develop into galls of various sizes. Pods also become infected and develop knobs, protuberances, or small warts. Development of the root system is commonly much reduced. Plants infected with root-knot nematodes may show various degrees of stunting and chlorosis.

"Kalahasti Malady"

Causal organism

Tylenchorhynchus brevelineatus

Small brownish yellow lesions appear on the pegs, pod stalks and on young developing pods. The margins of the lesions are slightly elevated because of the proliferation of host cells around the lesion. Pod stalks are much reduced in length and in advanced stages of the disease the entire pod surface becomes discoloured. Discolouration is also seen on roots. Affected plants are stunted and greener than normal foliage.

Root-lesion nematode

Pratylenchus brachyurus

Root-lesion nematodes attack roots, pegs and pods and feed within the parenchymatous tissues. Roots of infected plants are restricted in length and total volume, and tend to be discoloured. The

pod lesions begin as tiny, tan-to-brown colored, pin-point areas on the shell surface and as the nematodes feed and reproduce, the affected area becomes large and darker. Older lesions are characterized by a blotchy appearance and indistinct margins. Severely attacked plants are stunted and chlorotic with reduced root systems. Other microorganisms may colonize the necrotic areas and penetrate the pod causing seed damage.

7. List of recommended fungicides for management of groundnut diseases

Common name	Chemical name	Trade name	Original manufacturer	Name and address of manufacturers/ suppliers in India
Captan	N- (trichloro methylethio) 3a, 4, 7, 7a, tetrahydro-N- (trichloromethanesulphenyl)	Captaf	Sankyo	Rallis India Ltd. Agro Chemical Div., Rallis House 21 D Sukhdeva Marg Mumbai-400 011
Carbendazim	Methyl-1-H-benzimidazol-2-yl carbamate	Bavistin	BASF	BASF (India) Ltd, Tiecicon House, Dr. E.Moses Road, Mumbai-400 011
Mancozeb	Magnese ethylene bisdithiocarbamate	Dithane M45 Indofil M45	-	Indofil Chemicals Co. Nirlon House, Ani Besant Road, Mumbai 400 025
Thiram	75% Tetramethyl thiuram disulfide	Thiram Thiuram	ICI DuPont	The Alkali and Chemical Corporation of India Ltd. P.B. 9093, Chouranghee Road, Kolkata
Tridemorph	N-Tridecyl-2, 6-dimethylemorpholine	Calixin	BASF	BASF (India) Ltd, Tiecicon House, Dr. E.Moses Road, Mumbai-400 011
Triadimefon	1-(4-chlorophenoxy)-3-3-dimethyl-1 (1,2,4-triazol-1-yl) batan-2 one	Bayleton	BASF	BASF (India) Ltd, Tieciscon House, Dr. E.Moses Road, Mumbai-400 011
Chlorothalonil	Tetrachloro isophthalonitrile	Daconil (Kavach)	Syngenta	Syngenta India Ltd., Royal Insurance Building, 14- Second floor, J. Tata Road, Church Gate, Mumbai-400 020

8. Fungicide calculations

The active ingredient (a.i.),which is the principal chemical (toxicant) that acts on pathogen is formulated by various companies to give different concentrations. For example, thiram 75% means the formulation has 75% of tetramethyl thiuram disulfide and 25% of filler material. In its pure form the toxicant may be a solid or a liquid. In commercial solid formulations (dust, wettable powder (WP)), a certain weight of the toxicant is mixed or impregnated with certain weight of inert powders. The concentration of the a.i. is thus expressed as percentage of the weight of a.i. in the total weight of the commercial solid formulation or:

$$\text{Per cent a.i. of dust or WP} = \frac{\text{Weight of a.i.}}{\text{Total weight of dust or WP}} \times 100$$

For wettable powder (WP) use the following formula:

$$\text{WP required (kg)} = \frac{\text{Per cent a.i.} \times \text{specified spray volume (litres)}}{\text{Per cent a.i. in commercial WP}}$$

For emulsifiable concentrates (EC) use the following formula:

$$\text{Litres of EC required} = \frac{\text{Per cent a.i. desired} \times \text{specified spray volume (litres)}}{\text{Per cent a.i. in commercial EC}}$$

When the recommendation is in kilograms of active ingredient percent hactare (kg a.i./ha) use the following formulas:

$$\text{WP/dust required (kg)} = \frac{\text{Recommended rate (kg/ha)} \times \text{area (ha)}}{\text{Per cent a.i. in WP/dust}} \times 100$$

$$\text{WP/dust required (kg)} = \frac{\text{Recommended rate (kg/ha)} \times \text{area (ha)}}{\text{Per cent a.i. in WP/dust}} \times 100$$

Example 1

To control leafspots and rust, 500 litres of 0.2% mancozeb (Dithane M 45) is to be prepared. The wettable powder mancozeb to be used contains 75% mancozeb.

What is the required weight of mancozeb?

Data given

(a) Concentration of commercial mancozeb 75% a.i. WP

(b) Specified spray volume = 500 litres/ha

(c) Reccommended concentration = 0.2% a.i.

Formula

$$\text{WP required (kg)} = \frac{\text{Per cent a.i.} \times \text{specified spray volume (litres)}}{\text{Per cent a.i. in commercial WP}}$$

Calculation

$$\frac{0.2 \times 500}{75} = 1.33 \text{ kg of mancozeb (Dithane M45) 75 WP}$$

Example 2

To control rust, 500 litres of 0.05% Tridemorph (Calixin) is to be prepared for 1 ha. The emulsifiable concentrate (EC) Tridemorph to be used contains 80% active ingredient.

What is the volume of commercial Tridemorph 80% EC required?

Data given

(a) Concentration of commercial Tridemorph 80% EC

(b) Specified spray volume = 500 litres

(c) Recommended concentration = 0.05% a.i.

$$\text{Litres of EC required} = \frac{\text{Per cent a.i. desired} \times \text{specified spray volume (litres)}}{\text{Per cent a.i. in commercial EC}}$$

Calculation

$$\frac{0.05 \times 500}{80} = 0.31 \text{ litres of 80\% Tridemorph EC}$$