Compendium of Peanut Diseases

SECOND EDITION

Edited by

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√ JA 1705

Myrothecium Leaf Blight

A leaf blight of peanut caused by *Myrothecium roridum* has been observed in India and Thailand. *M. gramineum* has also been reported as a leaf blight pathogen in India. Both pathogens infect a wide range of host plants.

Symptoms

The two pathogens produce similar symptoms on infected peanut leaves. Lesions are round to irregular, 5–10 mm in diameter, with tan centers and brown margins surrounded by chlorotic halos. The centers of these lesions become thin, papery, and light tan. Lesions coalesce to give affected leaves a blighted appearance. Abundant olive green to black fruiting bodies, often arranged in circular rings, are formed on necrotic areas of both leaf surfaces (Plate 29).

Causal Organisms

The conidia of *M. roridum* Tode:Fr. are hyaline, one celled, elongated, and 4.7–11.7 × 1.2–3.5 µm. Conidia of *M. gramineum* Lib. are 5.5–14.0 × 3.0–5.0 µm with stiff, acute setae mixed with smaller, torsive ones.

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Mahrshi, R. P. 1983. *Myrothecium gramineum*—A new report on groundnut from Rajasthan. Indian Phytopathol. 36:728.

(Prepared by P. Subrahmanyam)

Neocosmospora Foot Rot

Foot rot has been observed in peanuts in Taiwan and South Africa. The causal organism, *Neocosmospora vasinfecta* E. F. Sm., has been observed colonizing aboveground plant parts and is also pathogenic to pod hulls and seed. Pods exhibit discolored internal tissues and later decompose. Diseased plants are stunted with yellow lower leaves and frequently defoliate and senesce prematurely. There are no control measures available.

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(Prepared by D. M. Porter)

√ JA 1708

Olpidium Root Discoloration

Root discoloration of peanut caused by *Olpidium brassicae* has been reported in the Indian states of Andhra Pradesh, Gujarat, and Punjab and in Texas in the United States.

Symptoms

Lightly infected roots remain apparently healthy, but when infection is advanced, the root cortex becomes brown to black. The pathogen is restricted to the peripheral layers of the cortex of infected roots.

Causal Organism

Plasmodia of *O. brassicae* (Woronin) P. A. Dang. are thin walled, cylindrical to rounded, and 10–22 × 15–45 µm and have densely granulated protoplasm. Zoosporangia are variable

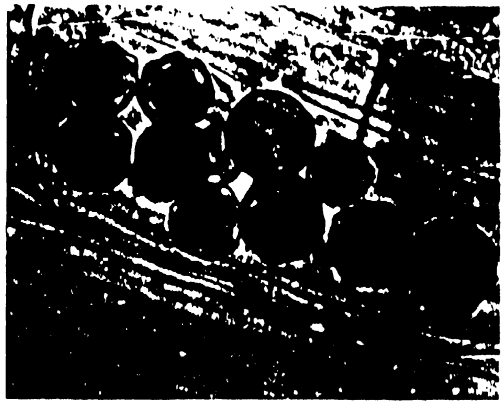

Fig. 34. Endospores of *Olpidium brassicae* with typical stellate wall surfaces.

in size (8–32 µm in diameter) with a single exit tube. Resting spores are spherical (10–27 µm in diameter) and consist of thick, stellate exospores and thin, smooth endospores (Fig. 34). Zoospores are spherical and have a single posterior, whiplash flagellum.

O. brassicae is widely distributed, particularly in temperate regions. It is parasitic on roots of several phanerogams and is a vector of several soilborne plant viruses.

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Subrahmanyam, P., and McDonald, D. 1980. Occurrence of *Olpidium brassicae* on groundnut. Trans. Br. Mycol. Soc. 75:506-509.

(Prepared by P. Subrahmanyam)

Peanut Pod Rot Complex

Peanut pod rot (pod breakdown) is a sporadic but common disease of peanut that causes serious losses throughout all peanut-growing regions of the world. In 1954, the condition was described in Georgia as black pod, and it has been prevalent in Israel since 1959. In 1964, a preharvest pod (fruit) rot of peanut in Virginia was described and referred to as pod breakdown. Others have since referred to what appears to be the same malady as the peanut pod rot complex. Losses are variable and appear to be related to cultivar, the pathogen involved, and nutrition.

Symptoms

Symptoms of the pod rot disease complex vary depending on the location, season, and pathogens involved. Deterioration or rot of fully developed pods is the first sign of disease. Pods develop either a tan to brown, dry decay or a greasy, black, wet decay, depending on the pathogens and environmental conditions (Plate 30). Many pods, both sound and rotted, may remain in the soil after digging, the result of weakened or decayed pegs.

There are no aboveground symptoms of pod rot, except that severely affected plants may be darker green and exhibit prolonged flowering. The root system generally is not infected, and the reduced demand for carbohydrate from the loss of the fruit usually increases the vigor of the foliage. Plants with the greatest degree of pod rot at or near harvest will appear to be the most vigorous and provide no indication of serious disease losses below the soil surface.

JA 1706

Diseases Caused by Bacteria

Bacterial Leaf Spot

Bacterial leaf spot of peanut, caused by an unidentified species of *Pseudomonas*, has been observed in India, Vietnam, and Zimbabwe.

Symptoms

Lesions, which are small, circular to irregular, and light brown, frequently occur on the lower leaves of young plants. At early stages of disease development, the lesions are water soaked and prominent on upper surfaces of leaflets. On the lower surfaces of the leaflets, lesions become visible only after the spots on the upper surfaces are well developed. The lesions enlarge, become irregular, and may develop chlorotic halos. When lesions are fully developed, their centers are light brown with dark brown margins (Plate 78). Under favorable conditions for disease development, the lesions coalesce, and the leaflets become chlorotic and shed prematurely.

Bacterial colonies grown on D4 medium are pale white, circular, raised, and 1–2 mm in diameter. The bacterium (0.5–0.8 × 1.0–1.3 μm) is gram negative, nonfluorescent on King's medium, and rod shaped and has one or two polar flagella.

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(Prepared by P. Subrahmanyam)

Bacterial Wilt

Bacterial wilt of peanut, caused by *Pseudomonas solanacearum*, was first reported in Indonesia in 1905 and since then has been reported in many regions throughout the world. The first report of the disease in the United States was in 1915 from Granville County, North Carolina, which had previously experienced a high incidence of bacterial wilt of tobacco. Bacterial wilt of peanut was responsible for heavy losses in Georgia in 1913 but is now of minor importance in the United States. By contrast, the disease is a major constraint to peanut production in several Asian and African countries, notably China, Indonesia, Malaysia, Uganda, and Vietnam.

In Indonesia, bacterial wilt of peanut is most severe in western Java, southern Sulawesi, and southern Sumatra and is also important in central and eastern Java, Bali, and North Sulawesi. In China, the disease is most severe in 16 southern and central provinces, where it is estimated that more than 200,000 ha of peanut fields are infested with the wilt pathogen. The annual incidence of the disease is estimated to be 4–8% on resistant cultivars and 10–30% on susceptible ones in some regions, and the annual loss in pod yield caused by the disease is estimated to be approximately 36,000 t. The disease is widespread in the major peanut-growing areas of both northern and southern Vietnam and is most severe in dryland cropping systems, especially on sandy upland or riverbank soils. Peanut is probably less susceptible to bacterial wilt than solanaceous hosts such as tomato, potato, tobacco, and eggplant, except where peanut is intensely cropped under environmental conditions conducive to the disease and highly virulent strains of *P. solanacearum* occur. Bacterial wilt is regarded as a potential threat to peanut production in several warm, humid areas of the world as production expands into new areas or cultural practices change.

Symptoms

Infection of young plants can result in the sudden wilting of stems and foliage, although leaves on dead plants remain green (Plate 79). Wilt symptoms can be observed 2–3 weeks after sowing. The first sign of the disease is a slight drooping or curling of one or more leaves. In mature plants or in cultivars that are not highly susceptible, a gradual decline causes the foliage to turn yellow. Wilt and death of single branches (Plate 80) or of the entire plant (Plate 81) may follow. Alternatively, the plant may show signs of recovery. The root systems of infected plants display numerous discolored and dead roots. Dying branches often curl to form a "shepherd's crook." Diagnostic characteristics for this disease are a dark discoloration in the xylem and pith (Plate 82) and a milky white ooze composed of masses of bacteria that exudes from cut ends of stems placed in water.

Causal Organism

P. solanacearum (Smith) Smith (syns. *Burkholderia solanacearum* (Yabuuchi et al.) and *Ralstonia solanacearum* (Yabuuchi et al.)) is an aerobic, gram-negative, rod-shaped bacterium that does not form spores and accumulates poly-β-hydroxybutyrate as a carbon reserve. Although the bacterium does not produce fluorescent pigments, it can produce a brown, diffusible pigment on agar media containing tyrosine. The organism does not grow at 41°C, and it cannot utilize arginine and betaine as sole carbon sources. The bacterium is unable to hydrolyze starch, and gelatin is liquefied weakly or not at all. There is variation in nitrate metabolism. Asian isolates from peanut produce gas from nitrate, whereas those from the Americas reduce nitrate to nitrite but without gas production. The optimum temperature for growth is 30–35°C.

P. solanacearum is heterogeneous in phenotypic properties, such as ability to utilize specific carbon sources, and has been classified into five biovars on the basis of differences in oxidation of particular hexose alcohols and disaccharides. Biovars 1, 3, and 4 have been reported as pathogens of peanut. In the United States, the disease is caused by biovar 1, whereas in those Asian and African countries for which there is published information, it is caused by biovar 3 or 4. On the basis of hosts of origin and host range, isolates of *P. solanacearum* have been tentatively divided into five races. The isolates from peanut are identified as race 1.

The classification of strains of *P. solanacearum* has been greatly advanced by DNA analysis. Restriction fragment length polymorphism (RFLP) analysis has been used to differentiate *P. solanacearum* into RFLP groups by using nine probes to regions of the chromosomal DNA associated with virulence and the hypersensitive response. Similarity coefficients for all

Part IV. Other Organisms

Parasitic Flowering Plants

Alectra vogelii

Alectra vogelii Benth. (Scrophulariaceae) is a root parasite of peanut and several other leguminous crop plants. It has been reported in various countries in Africa (Angola, Burkina Faso, Malawi, Mozambique, Nigeria, Swaziland, Zambia, and Zimbabwe). A high disease incidence (about 90%) has been reported in Burkina Faso and Malawi. *A. picta* Hemsl. parasitizes peanut in glasshouse experiments.

A mature plant of *A. vogelii* reaches a height of about 0.5 m with stems branching out at the base (Plate 188). Flowers are a prominent lemon yellow with horseshoe-shaped stigmata. Roots are orange and poorly developed. The connection between the parasite and the peanut roots can be seen by carefully removing the soil in the root zone (Plate 189).

Parasitized peanut plants become stunted, and yields are reduced. The potential pod yield loss has been estimated at about 40% in Nigeria.

Striga spp.

More than 60 species of *Striga* (Scrophulariaceae) have been reported as parasites of several cereal and leguminous crop plants. *S. hermontheca* Benth. has been reported on peanut in West Africa and *S. gesnarioides* (Willd.) Vatke (witchweeds) on peanut in Mozambique and on *Arachis repens* in Nigeria.

S. hermontheca is a cross-pollinated species with wide variation in plant type and floral morphology. It is an annual, erect herb reaching a height of about 0.5 m (Plate 190). Leaves are green and 20–60 mm long. Flowers are sessile, irregular, and bright pink. The calyx is distinctly five ribbed, and the corolla tube, 11–17 mm long, bends characteristically at an angle immediately over the tip of the calyx. Bracteoles are 2–3 mm wide. The fruits (capsules) contain vast numbers of minute seed.

S. gesnarioides is an annual, erect herb reaching a height of about 0.15 m (Plate 191). Leaves are scalelike, rarely exceed-

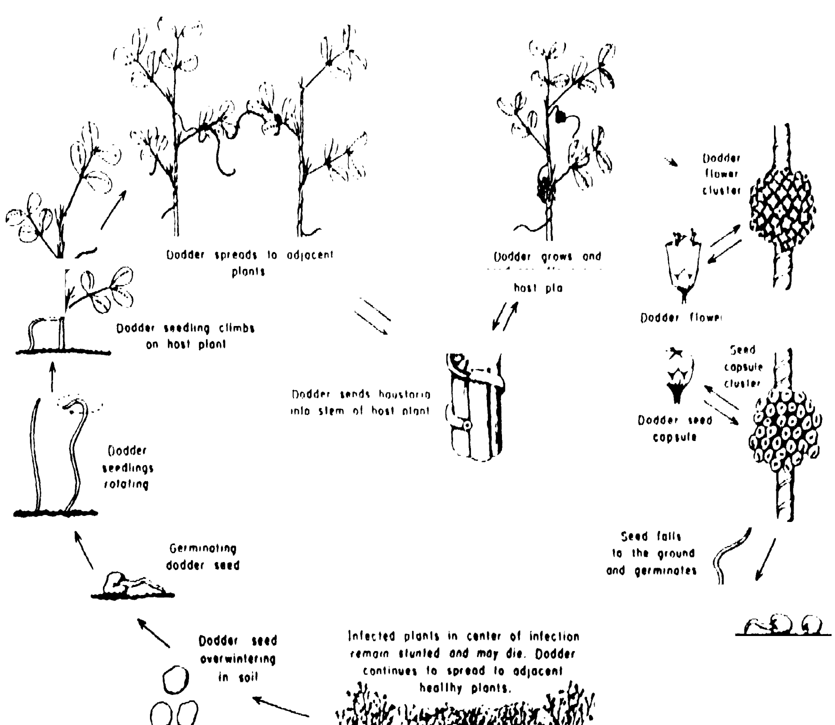

Fig. 77. Life cycle of dodder. (Modified and reprinted, by permission, from G. N. Agrios, 1978, Plant Pathology, 2nd ed., Academic Press, New York. Prepared by Nancy Browning)

ing 5 mm in length. Compact branches arise from ground level. The plant forms a large haustorium (feeding structure) with the host root, unlike *S. hermontheca*. Flowers are irregular and vary greatly in size and color but are usually creamy white, bluish, or pink.

Cuscuta campestris

Cuscuta campestris Yunck. (Convolvulaceae) (dodder) is a stem parasite that attacks a wide range of flowering plants. It is a parasite but not an important pest of peanut in the United States. *C. campestris* lacks true roots and leaves and produces a tangle of wiry branches (Plate 192) that coil around the branches of host plants and produce haustoria. The branches are orange to golden yellow and devoid of chlorophyll. Minute, bell-shaped flowers are produced in small clusters. The life cycle of *C. campestris* is outlined in Figure 77.

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(Prepared by P. Subrahmanyam)

Beneficial Organisms

Mycorrhizae

The peanut root, like roots of most other herbaceous plants, is commonly colonized by vesicular-arbuscular endomycorrhizal fungi (Figs. 78 and 79). Species of the genera *Glomus*, *Gigaspora*, *Scutellospora*, *Sclerocystis*, and *Entrophospora* have been reported to be naturally associated with peanuts. The association is characterized by the formation of arbuscules (haustoriumlike structures) in the roots and of chlamydospores and azygospores (Fig. 80; Plates 193 and 194) in the roots and soil. Sporocarps may also be formed in the soil.

Most research has focused on the effects of these fungi on growth of inoculated plants in the greenhouse and in sterilized soils. In general, mycorrhizal fungi have a positive effect on peanut growth. Individual species differ significantly in their effectiveness in promoting growth. Growth response may be enhanced by inoculation with mixtures of glomalean fungi and/or *Bradyrhizobium*. Vegetative growth has been enhanced by more than 300% in peanuts inoculated with various species. Some reports indicate increases in seed yield. Other reports indicate no positive response. Experiments have been conducted on the effects of metals, phosphorus, water, pesticides, and other soil microorganisms on the activity of mycorrhizal fungi associated with peanuts.

Progress in research pertaining to endomycorrhizal fungi and their effects on peanuts (and all other plants) has been hampered by the fact that the taxonomy of these glomalean fungi is little understood. Identification of species is difficult. It involves interpretation of spore color, spore size, structure and chemical reactions of cell wall layers, presence or absence of sporocarps, and morphological characteristics of the sporocarps. None of the species can be grown and maintained in pure culture in the laboratory. Cultures must therefore be grown in association with living host roots in the greenhouse and separated from the soil or other growth medium for use as

Fig. 78. Vesicular-arbuscular mycorrhizal fungi in peanut roots. (Courtesy M. Yeh)

Fig. 79. Hyphae of a mycorrhizal fungus in a peanut root (note penetration site). (Courtesy D. M. Porter)

such as flutolanil or fluazinam may be registered also. These treatments will also reduce losses to *Rhizoctonia*-induced pod rots but may not be active against other pod-rotting organisms such as *Pythium myriotylum* and *Fusarium solani*. Foliar sprays of flutolanil have been shown to reduce the incidence of *R. solani* in peanut pods left in the soil. Adequate calcium nutrition is known to be essential for pod rot management. Combination chemical treatments containing carboxin, PCNB, and captan provide some control of *R. solani* on seed and seedlings, although stand reductions can still be significant in cold, wet soils. Resistance to limb rot has not been available in large-seeded peanut cultivars. Some resistance has been reported in spanish-type peanuts. The recently released runner cultivar, Georgia Browne, has good partial resistance to limb rot.

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(Prepared by T. B. Brenneman)

Rust √ JA 1721

Rust is an economically important disease in most peanut-producing countries of the world and causes substantial yield losses, particularly if the crop is also attacked by the leaf spot pathogens *Cercospora arachidicola* and *Cercosporidium personatum*. During recent years, combined attacks by rust and leaf spot have caused severe crop losses in many countries of Asia and Africa and have all but eliminated commercial peanut production in the Caribbean region and Central America. In the People's Republic of China, rust caused a 49% reduction in pod yield and lowered the 100-kernel weight by 19%. Artificially induced rust epidemics caused up to 79% reduction in pod yield in India. The disease is not a major limiting factor in peanut production in the United States, with the exception of southern Texas, where rust causes severe economic losses during some years. Losses measured at two locations in Texas were 77 and 86% from foliar diseases and 50 and 70% from rust alone. Establishment of the disease early in the growing season causes reduced pod fill and necessitates early harvesting. In addition, hay yields are drastically reduced.

Symptoms

Rust can be easily recognized when the orange pustules (uredinia) appear on the lower surfaces of peanut leaves and then rupture to expose masses of reddish brown urediniospores (Plates 48 and 49). In highly susceptible cultivars, the original pustules may later be surrounded by colonies of secondary pustules. Pustules may later be formed on the upper surfaces of the leaflets opposite those on the lower surfaces. The pustules, which develop on all aerial plant parts except flowers, are

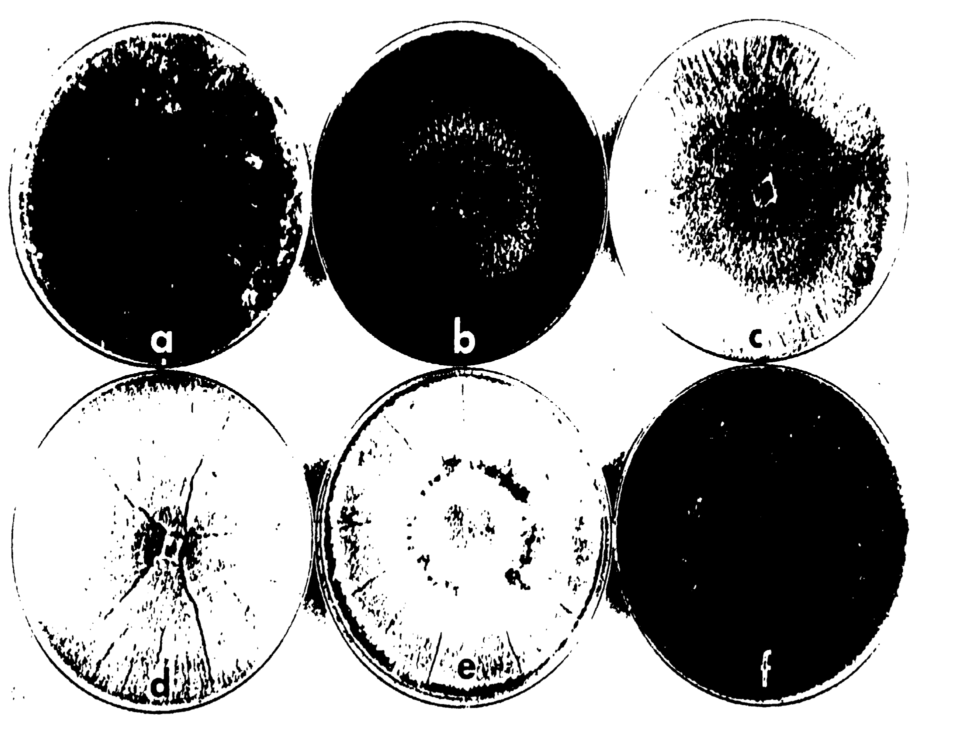

Fig. 42. a–c, Multinucleate anastomosis groups of *Rhizoctonia solani* and d–f, binucleate *Ceratobasidium* anastomosis groups of *Rhizoctonia*-like fungi from peanut. (Courtesy D. Bell)

usually circular and 0.5–1.4 mm in diameter. Pustules may also form on shells of developing pods. Unlike the rapid defoliation associated with leaf spots, leaves infected with rust become necrotic but remain attached to the plant. Heavily infected plants often appear pale green.

Causal Organism

Puccinia arachidis Speg. is the causal organism of peanut rust. ,The uredinial stage is the predominant and most commonly observed. The uredinia are pustular, scattered or irregularly grouped, and round, ellipsoid, or oblong. They are subepidermal in origin; covered by a thin, membranous, netlike peridium; and blisterlike when immature, becoming crumpent, powdery, and dark cinnamon brown when mature. The ruptured epidermis is conspicuous. Urediniospores (Fig. 43) are broadly ellipsoid or obovoid (23–29 × 16–22 µm), have brown walls 1–2.2 µm thick, and are finely echinulate, with echinulae 2–3 µm apart (Fig. 44). Urediniospores usually have two germ pores, which are nearly equatorial, often forming in flattened areas.

Telia, chiefly occurring on the lower sides of peanut leaves, are scattered, prominent, naked, pulvinate, and chestnut brown or cinnamon brown, becoming grayish from the germination of spores. A ruptured epidermis is prominent. Teliospores (Fig. 45) are oblong, obovate, ellipsoid, or ovate with a rounded to acute and thickened apex. They are constricted in the middle, tapering gradually at the base or tapered and rounded at both ends; smooth walled; predominantly two celled but sometimes have one, three, or four cells, 38–42 × 14–16 µm; light or golden yellow or chestnut brown; 0.7–0.8 µm thick at the sides; and 2.5–4.0 µm thick at the top. The apical thickening is almost hyaline. The pedicel is thin walled, hyaline, usually collapsing laterally, and up to 35–65 µm long but is usually detached at the spore base. Teliospores germinate at maturity without a dormancy requirement.

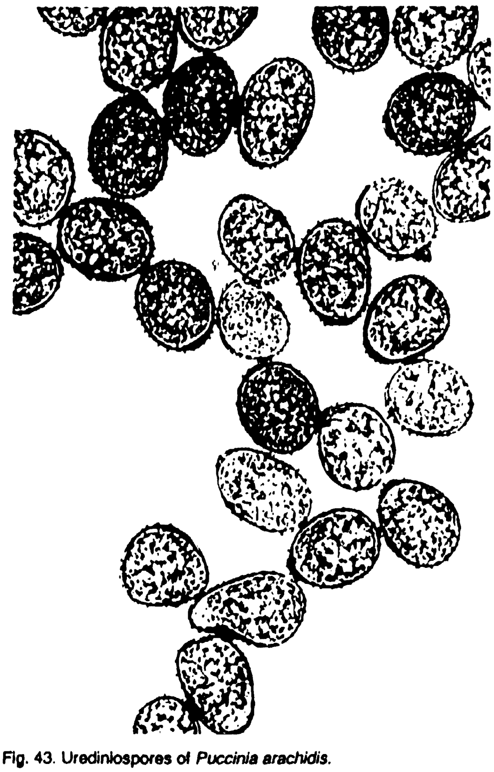

Fig. 43. Urediniospores of *Puccinia arachidis*.

Spermagonia, aecia, metabasidia, and basidiospores have not been reported for *P. arachidis*.

Because there is no knowledge of spermagonia, aecia, and hosts that basidiospores will infect, the life cycle of peanut rust is unknown and the taxonomic position of the fungus is obscure.

Disease Cycle and Epidemiology

Urediniospores are the main, if not the only, means of dissemination of this pathogen. There are a few authentic records of the occurrence of teliospores in South America but none from other countries. The pathogen is highly host specific. There are no records of any collateral hosts of peanut rust outside the genus *Arachis*. Urediniospores are short lived in infected crop debris in the tropics, and the fungus is unlikely to survive from season to season under postharvest conditions that include a fallow period of more than 1 month between successive peanut crops. The pathogen may survive from season to season on volunteer peanut plants. Long-distance dissemination of the pathogen may be by airborne urediniospores, movement of infected crop debris, or movement of pods or seed, the surfaces of which are contaminated with viable urediniospores. There is no reliable evidence of peanut rust being internally seedborne, and there is no authenticated report of rust being spread by germ plasm exchange. Spread of the organism within fields is facilitated by wind, rain splash, and insects. Urediniospores can remain viable for several months when stored at a low temperature (−16°C), but at a high temperature (40°C), they lose viability within 5 days. The thermal death point of urediniospores is 50°C for 10 min. The optimum conditions for germination of urediniospores include temperatures of 20–25°C and low light. Temperatures of 20–30°C and free water on the leaf surfaces favor infection and subsequent disease spread. Plants of all ages are susceptible. The incubation period varies from 7 to 20 days, depending on environmental conditions and host genotype. Intermittent rains with mean relative humidity above 87% and temperatures between 23 and 24°C for several days favor disease initiation. Continuous dry periods with temperatures greater than 26°C and relative humidity below 75% delay rust infection and reduce disease severity.

Control

Wherever possible, field management should include a fallow period of at least 1 month between successive peanut

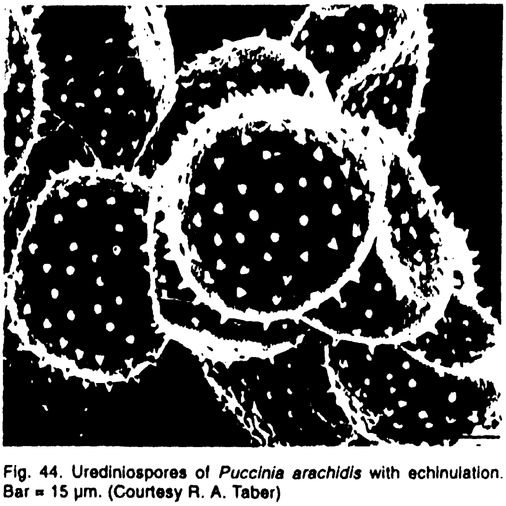

Fig. 44. Urediniospores of *Puccinia arachidis* with echinulation. Bar = 15 µm. (Courtesy R. A. Taber)

crops. Eradication of volunteer peanut plants during this period is important in reducing the primary source of inoculum. If cropping systems permit, time of sowing should be adjusted to avoid infection from outside sources and to avoid environmental conditions conducive to the onset of an epidemic. Existing plant-quarantine procedures should suffice to prevent spread of the pathogen on pods or seed externally contaminated with rust spores to areas where the disease is absent.

Several fungicides and mixtures of fungicides have been tested for control of rust or, more often, for control of rust and leaf spot together. The dust formulations (copper, sulfur, and copper plus sulfur) that were commonly used for control of leaf spot in the United States up to the 1960s also controlled rust, but sprays of Bordeaux mixture and dithiocarbamates were even more effective. The structurally related fungicides benomyl and carbendazim are effective against leaf spot but ineffective against rust. Tridemorph is effective against rust but not against leaf spot. Chlorothalonil and tebuconazole are effective against both rust and leaf spot. It is obvious that any fungicide treatment applied for control of rust must also be effective against leaf spot, because the diseases frequently occur together.

Prior to 1977, there were only a few reports of research on genetic resistance to peanut rust, but the rapid spread of rust during the early 1970s and the increasing cost of disease management with fungicides have resulted in increased research on genetic resistance to peanut rust. At the ICRISAT (International Crops Research Institute for the Semi-Arid Tropics) Asia Center in India, the world collection of more than 13,000 germ plasm accessions was screened for resistance to rust during the period from 1977 to 1992, and more than 120 rust-resistant germ plasm lines have been identified. Most of the currently available rust-resistant genotypes originated in Peru, which is believed to be one of the secondary "gene centers" of cultivated peanut.

Most of the rust-resistant germ plasm lines are primitive land races and have undesirable pod and seed characters. In recent years, several high-yielding, agronomically superior lines, with high levels of resistance to rust and moderate levels of resistance to late leaf spot, have been developed and released for cultivation in India (e.g., ICGVs 86590, 87157, 87160, Girnar 1, and ALR 1). ICGV 87160 has also been released in Myanmar (Burma). High levels of resistance and immunity to peanut rust have been found in wild *Arachis* spp. Cytogenetic research aimed at incorporating the rust resistance from wild *Arachis* spp. into the cultivated peanut is in progress in various countries. At the ICRISAT Asia Center, several stable, tetraploid or near-tetraploid lines derived from crosses between the cultivated peanut and wild species have been developed.

The rust resistance available in the cultivated peanut is the "slow-rusting" type, i.e., resistant genotypes have an increased incubation period, decreased infection frequency, and reduced pustule size, spore production, and spore viability. On the basis of field scores, rust resistance in cultivated peanut is reported to be governed by two or three duplicate recessive genes. On the contrary, in diploid *Arachis* spp., rust resistance appears to be partially dominant. In crosses involving both cultivated and interspecific derivatives, rust resistance was found to be controlled by both additive and nonadditive gene action. Rust resistance in most genotypes is stable over a wide range of geographical locations except in a few locations, indicating possible variation in the pathogen.

Several mycoparasites of the peanut rust pathogen have been reported, and mycophagous insects may feed on urediniospores of peanut rust. However, no serious attempts have been made to use any of these organisms in biological control of peanut rust at the field level.

Fig. 45. Teliospores of *Puccinia arachidis*. (Courtesy J. F. Hennen)

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Scab

Peanut scab was first observed in São Paulo, Brazil, in 1937 with subsequent reports in Brazil during 1941 and 1961 and in the Argentinian provinces of Corrientes (1966) and Córdoba (1975). Córdoba produces 99% of the peanut crop in Argentina. Scab has also been reported in the Chiba prefecture of Japan and in Swaziland. The mode of distribution of the scab pathogen to Africa, Asia, and South America has not been determined.

Symptoms

Symptoms first appear on leaves and petioles near the top of the plant. Numerous small, chlorotic spots, usually less than 1 mm in diameter, often form on the adaxial and abaxial leaf surfaces and are either uniformly distributed or clustered near the midvein. Spots on the adaxial leaf surface are light tan with raised margins and sunken centers, while spots on the abaxial surface are darker and not raised. Spots have a maximum diameter of 2 mm and coalesce near the midvein. Plant tissue becomes necrotic and torn, and leaf margins curl upward, resulting in additional tearing of tissue.