Preventing the Diseases of Peanuts

Coyt Wilson

Prevention, rather than cure, is the rule with the diseases of peanuts.

Some beneficial preventive measures are the application of fungicides to seed to prevent seed rot, the use of fungicidal dusts or sprays on growing plants to prevent leaf spot, and the treatment of soil with chemicals before planting to control nematodes and soil insects.

Prevention involves more than the use of chemicals, however. Management practices that promote vigorous growth enable the plants to escape infection or to survive after infection. Outstanding are rotations that include one or two crops of corn, oats, or similar crops before each peanut crop; adequate mineral fertilization; planting on light-textured, well-drained soils; and reduction of mechanical damage by cultivating implements.

SEED ROT is the most serious of the diseases that affect stands of peanuts. It is caused by mildly pathogenic or saprophytic organisms that live in the soil—mainly species of *Fusarium*, *Rhizopus*, *Mucor*, *Diplodia*, *Penicillium*, and *Aspergillus*. Their entrance is facilitated by broken seed coats and by other mechanical injuries produced by the sheller. Seed rot is most destructive under conditions that retard germination—cool, damp weather, abnormally deep planting, and waterlogged soils. Most seed rot occurs within the first week after planting.

Beginning about 1940, when farm labor became scarce, a trend was started toward the use of machine-shelled seed. Poor stands often resulted. Work started by Luther Shaw in North Carolina in 1939—and later confirmed by research in Virginia, South Carolina, Georgia, Florida, and Alabama—showed that machine-shelled seeds treated with a seed protectant before planting produced stands comparable to those obtained by using hand-shelled and treated seed.

Although seed usually are treated at the time they are shelled because of convenience, the treatment may be applied with equal effectiveness just before planting.

Several good seed protectants are available commercially. Eight materials were tested in Alabama in 6 years. Best results were had with Ceresan M (7.7 percent ethyl mercury *p*-toluene sulfonanilide). Phygon (90 percent 2, 3-dichloro-1,4-naphthoquinone), Arasan (50 percent tetramethyl thiuramdisulfide), and Spergon (98 percent tetrachloro-*p*-benzoquinone) were somewhat less effective. Reasonably good results were obtained with Yellow Cuprocide (yellow cuprous oxide containing 47 percent metallic copper) and Dow 9–B (50 percent zinc trichlorophenate). Seedox (50 percent 2,4,5-trichlorophenyl acetate) and Merc-O-Dust (a compound of indefinite composition containing mercury and formaldehyde) were ineffective. Similar results have been obtained in other States.

Although the mercurial treatments such as Ceresan M are most effective, they are more dangerous to use. Overdosage results in poor germination. The radicle of the germinating seed does not elongate but becomes thickened and stubby. If a seedling is produced, it is stunted and never makes normal growth. Therefore—and because of the danger to warm-blooded animals that might eat treated seed—most States recommend one of the organic materials such as Arasan or Spergon in preference to the mercurial treatments.

The organic seed treatments have a tendency to be somewhat erratic in performance. In tests lasting 6 years at Auburn, Ala., Ceresan M was the most consistent of four treatments. Spergon was the best of the four in 1949 but the poorest in 1947. Dow 9–B was practically as good as Arasan or Ceresan M in 1946 but was considerably poorer than either in 1948. Arasan gave less protection than Ceresan M in 1944, 1946, 1948, and 1949.

Seed protectants are applied as dust treatments at the rate of 2 or 3 ounces to 100 pounds of seed. Slurry treatments—liquid suspensions of the fungicide—have not been popular on peanuts, probably because of the tendency of the seed coats to peel after the slurry treatments are applied. The tendency appears to be more common with Spanish-type seed than with seed of runner peanuts.

Seedling blights may be destructive in some localities, but generally they do little damage in established stands. Damping-off is not a serious disease of peanuts.

One of the most common types of seedling blight in peanuts is caused by *Sclerotium bataticola*. This organism causes a disease known as charcoal rot in a number of other species of plants during periods of high temperatures. Infections result in the formation of lesions on the succulent stems. The initial infections usually are near the soil line, but the lesions may extend downward some distance into the soil. If plant growth is retarded by dry weather and if the temperature is high—above 75° F.—the lesion is likely to girdle the stem and kill the plant. The stem assumes a dull brown color and becomes quite dry. Sometimes the progress of the disease is stopped and the seedling is stunted rather than killed. Then the plant is made more susceptible to other diseases later in the season. Charcoal rot in peanuts can be recognized by the many small, irregular, black sclerotia that develop in the affected tissues and give them a dark gray or black color on the inside.

Another form of seedling blight is dry rot, caused by *Rhizoctonia solani*. It is like charcoal rot in the early stages. Lesions develop on the stem near the soil line. The plant may be girdled and killed; if the infection does not spread, the plant may partly recover. The lesions are not likely to extend as far below the surface as those caused by *Sclerotium bataticola*.

There are no specific control measures for seedling blights. Losses may be reduced by planting treated seed of good quality on a well-prepared seedbed.

Of the diseases of growing plants, leaf spot generally is the most destructive disease during the growing season. It is recognized by the brown or black and somewhat circular spots on the leaves. As the disease progresses, the spots enlarge until the entire leaf is affected. Defoliation follows. The detrimental effects of leaf spot are threefold: The yield of nuts is reduced; the quality of the peanut hay is lowered; and the fallen leaves provide organic matter on which inoculum of other fungi, such as *Sclerotium rolfsii*, is produced.

Two species of fungi cause leaf spot. Each produces characteristic symptoms.

Early leaf spot, caused by *Cercospora arachidicola*, produces spots that are light tan at first. With age the spots become reddish brown to black on the lower surface and light brown on the upper surface of the leaf. A yellow halo surrounds each spot. Late leaf spot, caused by *C. personata*, produces dark-brown or black spots on both surfaces of the leaf. The spots usually are somewhat smaller than those of early leaf spot and there is no distinct halo. The fungi can be distinguished by microscopic examination of the conidia.

The conidia of *Cercospora arachidicola* are colorless to pale olive green and often curved. According to measurements made by W. A. Jenkins in 1938, they are 37–108 by 2.7–5.4 microns and contain 3 to 12 septations. The conidia of *C. personata* are much shorter and considerably thicker; they measure 18–60 by 5–11 microns, with 1 to 8 septations. They are generally cylindrical and seldom curved. Both leaf spots attack the leaves, petioles, pegs, and pods of Spanish, bunch, and runner peanuts. No host plants other than *Arachis hypogaea* are known for them.

Primary infections of leaf spot are caused by ascospores formed in the spring on overwintered peanut leaves. Secondary infections result from conidia. Although the fungus has been reported to be seed-borne, this method of overwintering is of minor importance. The principal means of dissemination is by wind-borne inoculum. The ascospores or conidia germinate within a few hours and penetrate the leaf directly through the epidermal cells or through stomata. In both species, the mycelium is intercellular at first. Branched haustoria are soon formed by the mycelium of *Cercospora personata* and the host cells are not killed outright. *C. arachidicola* does not form haustoria; the host cells are killed in advance and the invading germ tubes enter dead cells. Infections on leaves are visible within 8 to 23 days after inoculation.

Leaf spot is controlled by fungicides applied as dusts or sprays to the foliage. Most commonly used are dusting sulfur or dusting sulfur containing approximately 3.5 percent metallic copper. Specific recommendations vary slightly in different States; three to five applications beginning about 90 days after planting often are recommended. Usually applications are repeated every 10 to 14 days; 15 to 25 pounds of dust per acre are applied each time.

Bordeaux spray—6 pounds of copper sulfate and 2 pounds of hydrated lime in 100 gallons of water—is effective, but offers no particular advantages over fungicidal dusts. The dithiocarbamate fungicides have not come into general use on peanuts, probably because of their higher cost. Increases in yield resulting from dusting depend upon the fertility of the soil on which the crop is grown, the prevalence and severity of leaf spot, and the type of peanuts being grown. Highest returns have been obtained on runner peanuts growing on fertile sandy loam soils in the Southeast. Increases of 1,000 pounds an acre have been reported by the Alabama Agricultural Experiment Station. The increases generally amount to 500 pounds an acre or less.

SOUTHERN BLIGHT, caused by *Sclerotium rolfsii*, is more destructive on Spanish and bunch types of peanuts than on runners. It may appear on the plants at any time during the growing season but is more likely to cause damage in late summer and early fall as the plants approach maturity. The fungus, soil-borne, attacks the plants near the soil line. It causes wilting and eventual death of the part of the plant above the infection. It may attack the central stem and affect the entire plant, or the infection may be limited to one or more branches. Diseased plants wilt; the leaves gradually turn brown or black and eventually fall off. The fungus destroys the succulent tissues in the stem; the vascular bundles that are left give a shredded appearance to the diseased area. When the humidity is high, light-tan to reddish-brown sclerotia are formed in abundance on the infected tissues and the surrounding ground. The sclerotia are usually spherical and about the size of mustard seed but may be larger and irregular in shape. In dry weather the sclerotia are not so conspicuous.

Sclerotium rolfsii attacks hundreds of species of plants. In the absence of suitable hosts it lives quite well as a saprophyte in the soil. Crop rotation is therefore of limited value for control. Most grasses are highly resistant, but among them usually are enough volunteer plants that are susceptible to enable the fungus to survive in the soil. Southern blight appears to be more destructive on peanuts following peanuts or cotton, however, than on peanuts following corn.

Occasional reports of strains of peanuts resistant to *S. rolfsii* have been made, but it has not been possible to incorporate the resistance into the commercial varieties that are available.

Collar rot of runner peanuts is a disease complex that sometimes resembles southern blight. The disease has been reported only from Georgia, Florida, and Alabama. The cause has not been definitely established. The fungi that can be isolated from diseased plants are either saprophytic or weakly pathogenic, and efforts to produce the disease by inoculating healthy peanut plants with these fungi usually are unsuccessful. *Diplodia theobromae* apparently is always associated with the disease. Other fungi that usually are present include various species of *Fusarium*, *Penicillium*, *Trichoderma*, and *Rhizopus nigricans*. *Sclerotium rolfsii* and *S. bataticola* sometimes are isolated.

COLLAR ROT may result when plants that have been wounded are invaded by any of those fungi. L. W. Boyle in Georgia has demonstrated that young seedlings of peanuts are subject to sunscald. The injured areas on the stem or branches become lesions or cankers through which the fungi gain entrance. If the lesion is small, the plant may continue to grow for several weeks before the disease becomes severe enough to cause death.

Other types of injury also may predispose the plants to attack—injury by cultivating implements, windblown sand, and chewing insects. It is possible that infections also develop in lesions produced by the charcoal rot and rhizoctonia dry rot organisms.

Collar rot may appear at any time during the growing season. It usually is most noticeable during July, August, and early September. It may involve the entire plant or only a single branch. The affected part wilts suddenly; the leaves become pale green and turn dark brown or black rather quickly. Death is usually complete within 2 or 3 days after wilting becomes evident. If the entire plant is diseased, the wind usually blows the leaves and stems away, leaving the ground completely bare. The taproot is usually shredded at or near the soil line.

There is no control for collar rot.

NEMATODES have become increasingly important on peanuts. Several species attack peanuts, among them the root knot nematodes (*Meloidogyne arenaria* and *M. hapla*), meadow nematode (*Pratylenchus leiocephalus*), and the sting nematode (*Belonolaimus gracilis*).

The root knot nematode attacks both roots and fruits and causes the formation of galls. The feeding roots are deformed. The knots on the roots usually are similar in size and shape to the nodules formed by nitrogen-fixing bacteria. On the fruits and peduncles the galls are corky and variable in shape. Symptoms on the above-ground part of the plant are not characteristic. Plants are stunted; leaves are likely to show chronic symptoms of wilting; and the color is light green. In advanced stages leaves are necrotic along the margins, and considerable leaf shedding results. Heavy infestations may reduce yields to 500 pounds or less to the acre.

The symptoms of meadow nematode injury consist of lesions on peanut shells and lateral feeding roots. The damage it does to plant tissues provides avenues of entrance for soil fungi that cause peg rot.

The most characteristic symptom of the sting nematode is an unusually long taproot with relatively few lateral roots. Those that are present are short, stubby, and deformed. This nematode causes damage by puncturing the roots with a needlelike "sting" and withdrawing the juices. The nematode does not enter the roots but feeds externally. The area punctured by the sting is attacked by soil fungi. Small dead spots develop; the result is root pruning, which accounts for the elongated taproot and the deformed lateral roots.

If the nematode infestation is light, control can usually be accomplished by rotation. Such crops as corn, oats, and grain sorghum are resistant to the root knot nematode but not to the sting nematode. Control by rotation is not successful if infestations are heavy.

If infestations are heavy, nematodes can be controlled by fumigating the soil before planting. A fumigant, such as Dowfume W–40, should be applied to the drill at the rate of 7 gallons to the acre about 3 weeks before planting. After fumigation the soil should be left undisturbed until planting time. Care should be taken to plant the seed directly above the area in which the fumigant was applied. The plows used for opening the furrows should be as small as possible to prevent mixing of fumigated and unfumigated soil.

The root knot nematode, *Meloidogyne arenaria*, attacks several plants other than peanuts, including sweetpotato, Ramie, coffeeweed, tomato, okra, onion, peach, and several weeds.

PEG ROT, strictly speaking, is not a disease of the growing peanut plant. The term includes all losses that result from rotting, sprouting, and other types of damage to the developing nuts or to loss of nuts in the soil at harvest by breaking of the gynophores.

The peanut flower is formed in the axil of the leaf on the stem. After pollination, the petals wither, and the peg (or gynophore) elongates and grows into the soil, where the fertilized ovary at the tip of the peg enlarges to form the pod or peanut fruit. The peanut fruit thus develops in an environment populated with soil micro-organisms and is subject to attack by them during all of its development.

Soil insects such as wireworms and the larvae of the southern corn rootworm do considerable damage to the developing pods and facilitate infections by fungi. Many soil fungi attack the slender gynophore near the soil line as the fruit approaches maturity and many gain entrance to the tissues. Their action weakens the gynophore so that when the plant is pulled or lifted from the soil the gynophore breaks, leaving the pod in the soil. Early defoliation of plants by leaf spot, leaf-eating worms, or other causes also causes the gynophores to be more brittle and to break more easily.

Injuries to the "shell" of the developing fruit by soil insects permit soil-borne fungi to gain entrance. Discoloration or decay of the seed follows. If harvest is delayed beyond maturity of Spanish or bunch peanuts, the seeds begin to germinate.

Miscellaneous fungi, including *Sclerotium rolfsii* and *S. bataticola* and species of *Rhizoctonia*, *Diplodia*, *Rhizopus*, *Aspergillus*, and *Penicillium*, may be isolated from developing pegs and mature fruits. Apparently any one of them may cause one form of peg rot under proper conditions.

The control of peg rot is a problem of crop management. The plants should be kept growing as vigorously as possible until harvesttime. Defoliation should be prevented by controlling leaf spot and leaf-eating worms. The crop should be harvested as soon as mature. With runner peanuts, that is quite a problem because the fruits are formed and mature in cycles. Thus it is necessary to decide when peak production has been reached, to sacrifice some of the earliest formed fruits, and to harvest before the later fruits are fully mature. The crop should be harvested with machinery adapted for the purpose so as to minimize unnecessary breaking of the pegs.

SEVERAL OTHER diseases of growing peanuts occur occasionally in the United States.

Peanut rust, *Puccinia arachidis*, has been found occasionally in Florida, Alabama, and Texas. A leaf spot caused by an unidentified species of *Phyllosticta* appears on young peanut leaves early in the spring, but infections do not spread to older leaves. Botrytis late blight of peanuts has been observed on overmature peanuts during cool, damp days of early fall in Georgia. It is sometimes destructive on peanuts grown in greenhouses in winter. Fusarium wilt of peanuts has been reported from Southeastern States many times, but apparently it has not caused heavy damage. Virus diseases and bacterial wilt—destructive in the East Indies and in Africa—are not serious in the United States.

As THE PEANUT DEVELOPS in the soil, a variety of fungi become established in the shell, the peg, and occasionally the seed. When peanuts are harvested, they usually are placed in stacks or small piles or windrows and allowed to cure. During the curing process the fungi continue their activity and frequently become established in the tissues of the seed or on the interfaces of the cotyledons. Activity of the fungi during curing, together with the activity of the enzymes within the peanut seed, results in various types of seed deterioration. In commercial circles all these troubles are grouped together under one heading—damage.

Concealed damage is first evident as a slight yellow discoloration on the interfaces of the cotyledons. A mat of fungal mycelium develops between the cotyledons as the disease progresses. The tissues become rancid and discolored. There is no evidence of the disease on the outside until its late stages. If conditions remain favorable, the entire seed becomes shriveled and blackened, assumes an oily appearance, and is unfit for human consumption. The percentage of free fatty acids in the oil increases markedly. The disease is more common in runner peanuts than in Spanish or bunch peanuts, and has been more prevalent in the southeastern peanut belt than in the Virginia-North Carolina area and the Texas-Oklahoma area.

Seeds with concealed damage may contain a variety of fungi, primarily *Diplodia theobromae*. Others are species of *Fusarium*, *Aspergillus*, *Penicillium*, *Rhizopus*, and *Rhizoctonia*. Occasionally, *Sclerotium rolfsii* and *S. bataticola* are found. The disease has been produced by inoculation only with *Diplodia theobromae* and *Sclerotium bataticola*. Although initial infections usually occur before digging, concealed damage makes its most rapid development during the curing process. The moisture content of the seed is the principal conditioning factor, as temperatures during the curing period are usually near the optimum for fungal development. Concealed damage develops most rapidly in partly cured peanuts that contain 15 to 35 percent moisture. The disease does not develop appreciably in seeds containing less than 10 percent moisture. Neither soil type nor fertilizer practice has any measurable effect on development of the disease.

Concealed damage can be controlled by rapid curing of peanuts as soon as they are harvested and the use of resistant varieties.

Freshly dug runner peanuts usually contain 40 to 55 percent moisture. If peanuts are allowed to wilt before being placed in symmetrical, well-capped stacks with provisions for air circulation at the base, curing usually is rapid enough to prevent development of concealed damage. If peanuts are stacked before wilting or if they are allowed to become brittle before stacking, curing is retarded and the disease is more pronounced. Peanuts that are cured in windrows instead of stacks usually contain very little concealed damage, but this method of curing is more hazardous because of shattering in unfavorable weather.

The Dixie Runner variety has a great deal of resistance to concealed damage, and that resistance has been incorporated into a number of other strains of peanuts. By using resistant varieties and by exercising reasonable care at harvest, most growers can keep losses from concealed damage to a minimum.

Blue damage is a discoloration that often occurs on the seed coat of Spanish peanuts cured during periods of warm, damp weather. The small spots usually have a "bull's-eye" appearance, with colors ranging from blue through black. Larger spots may be irregular in outline with no evident center. The discoloration does not produce detectable changes in chemical constituents, taste, or germination of seed. Quite often the discoloration does not extend into the cotyledons, but sometimes the cotyledons may be conspicuously discolored.

Experiments at the Georgia Agricultural Experiment Station showed that the discoloration results from an interaction between pigments in the seed coat and oxalic acid produced by *Sclerotium rolfsii*. Under favorable conditions *S. rolfsii* grows saprophytically on the peanut shells during the curing process. The fungus secretes oxalic acid, which diffuses into the tissues in advance of the hyphae. When curing conditions are unfavorable for growth of *S. rolfsii*, no discoloration occurs.

OTHER STORAGE disorders, including seed rot, rancidity, and reduced germination, may be the result of improper curing or of improper storage. Peanuts should contain less than 10 percent moisture at the time they are stored. Some deterioration occurs at moisture contents between 6 and 10 percent, but the rate is fairly slow. The relative humidity of the storage environment should be 65 percent or less. Under those conditions, well-cured peanuts will keep well in storage for several months.

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Ways To Combat Disorders of Tomatoes

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Every tomato grower is faced with the hazard of loss from disease. Infections by fungi, bacteria, or viruses are responsible for much of the loss, but extremes of temperature and moisture or excess or deficiency of mineral elements in the soil at times may damage the crop.

The symptoms thus caused can be classified as wilts, leaf spots, fruit spots or rots, and abnormalities of growth of the foliage or fruits.

Fusarium wilt, caused by the fungus *Fusarium oxysporum* f. *lycopersici*, is serious on tomatoes. Its first symptom is a yellowing of the oldest leaves, usually on a single stem. Beginning at the base, the yellowed leaves wilt and die until all the leaves are killed. Often a single shoot dies before others are severely injured, but eventually the entire plant is affected. There is no soft decay of the stem, but if one cuts it lengthwise near the ground, he can see in the woody portion next to the outer "bark," or cortex, a brown discoloration of the water-conducting tissues—fibrovascular bundles—which is characteristic of the disease.

The fungus that causes fusarium wilt can persist in the soil for many years. Infection occurs through the roots. From them the fungus passes into the water-conducting vessels of the stem. Apparently it produces a toxic substance that causes the wilting of the foliage and eventual death of the plant. The fungus is most active at