The bacterium enters the plant through the stomata and through wounds. Any practice, therefore, that injures the plants, especially when they are wet, serves to increase infection. Hail injury frequently paves the way for rapid and severe infection.

The most effective control of bacterial blight is the use of disease-free seed. A 4- or 5-year rotation, recommended for the control of other pea diseases, would certainly eliminate diseased vines as a primary source of infection.

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Blights and Other Ills of Celery

A. G. Newhall

Celery is grown extensively as a truck crop on the muck lands and irrigated mineral soils of many States from Florida to Massachusetts, the Great Lakes States, and some of the Mountain and West Coast States. It is grown also as a market garden crop near many large population centers. It has an annual value of more than 50 million dollars.

In some districts celery has been grown intensively for nearly a century. The importation of much of our seed from Europe before 1920 and the free exchange of seeds and plants within the States at all times have meant that there are few if any celery diseases that we have not acquired. Appropriate control measures have been developed for many of them by Federal and State agencies and seed growers.

The most widely distributed and costly diseases of celery are the early and late blights, caused by the fungi Cercospora api and Septoria api var. graveolentis, and the rather minor bacterial leaf spot, caused by Pseudomonas api.

Cercospora may be seed-borne, hence early blight occurs almost everywhere that celery can be grown. Because it requires hot weather for its most rapid development, the fungus is most troublesome on the early summer crops in the Northeastern and Great Lakes States. In Florida
it may occur in the seedbeds in October and do some damage all winter, but the greatest losses occur on the late winter crop, which matures during the warm weather of March to May. It is checked by periods of cool weather below 40° F. Losses are due to stunting of growth, the necessity for heavy stripping of diseased stalks at harvest, and poorer keeping and market quality.

The fungus overwinters readily on debris from a previous crop. Early blight first appears on seedlings in the plant bed or on transplants in the field as small, pale-green or yellow spots a week after inoculation with the spores of *Cercospora*. The spots enlarge and often envelop much of the leaf. They turn brown to slate gray as the fungus fructifies on the lower surfaces of the leaves by pushing spore-bearing conidiophores through the stomatal openings. Spores are produced on the upper leaf surface also or on plant debris left on the ground. The spores, when abundant, give a delicate gray or pale-lavender sheen to the affected areas. Sunken, tan-colored, elongated spots may occur on the stalks just before harvest that require heavy trimming and loss of edible product.

L. J. Klotz, at the Michigan Agricultural Experiment Station, found the best temperature for growth and germination of spores of *Cercospora* to be about 70° F. Spores survived desiccation on dried leaves more than 170 days. They are well adapted to dissemination by air and can infect floral parts and grow into the seed coat. When the seed germinates, the fungus can attack the young cotyledons and from them pass to other leaflets. The life cycle takes 10 or 15 days. J. D. Wilson and I, working at the Ohio Agricultural Experiment Station, showed that the longer plants are left in the crowded seedbeds, the worse blight is apt to be later in the field.

An important leaf spot of carrot also is caused by a *Cercospora*, but it is nonpathogenic to celery as is the celery pathogen to carrot.

**Late blight**, caused by the fungus *Septoria apii* var. *graveolentis*, can cause even more destruction than early blight in cool, wet seasons and on the later crop in the Northern States. It can attack any part of the plant above ground. As outer leaves and stalks turn dark and wither, the entire field may look scorched.

The fungus is seed-borne. It also overwinters on debris from a previous crop. It may get started in the seedbed where it forms small, circular, water-soaked spots on the leaves about one-sixteenth inch in diameter. In 10 or 20 days, the spots turn nearly black and become filled with many minute black dots, the fruiting bodies (pycnidia) of the fungus. Spores are formed in these closed, black, pear-shaped cups partly embedded in the plant. They are exuded during wet weather as gelatinous, snakelike tendrils, and require spattering raindrops rather than air currents for quick spread.

When celery is wet with dew, the clothes of workers can spread the fungus down the row. K. H. Lin, at the New York State College of Agriculture, found that the number of spores in a single pycnidium—a structure no larger than the dot over this i—varied between 1,448 and 5,493, with a mean for nine pycnidia of 3,675. Dr. Wilson and I found more than 2,000 spots on untreated plants, with an average of 56 pycnidia per spot; potentially, therefore, half a billion spores can be produced on one plant. Germinating *Septoria* spores can penetrate directly through the epidermis as well as through stomata and as readily on the upper surface of leaves as on the lower surface, although there are only about one-third as many stomata on the upper surface.

**The bacterial leaf spot** is caused by a soil-inhabiting bacterium, *Pseudomonas apii*. In the Lake States and
New Jersey it sometimes gives trouble on outer leaves in hot, humid weather. It makes small, circular, rusty-reddish-brown spots up to one-eighth inch in diameter; sometimes they have pale-yellow borders. The spots remain smaller than early blight spots and are a darker brown. They differ from septoria late blight in lacking the black pycnidia within.

The disease is not seed-borne but it often gets its start in the seedbed. It is most troublesome on the crop maturing in August and September. It was the first bacterial plant disease to be controlled by dusting with a fungicide, in 1922.

CONTROL MEASURES for all three celery leaf spots are practically the same. In the absence of resistant varieties, growers have relied heavily upon the use of copper fungicides in the field ever since the work of B. D. Halsted in New Jersey in 1891. No fungicide has exceeded bordeaux mixture in effectiveness, but the residues it leaves and the inconvenience of preparing it (compared with the low-soluble coppers, such as basic copper sulfate, copper oxide, and copper oxichloride, and the organic fungicides) have led more and more growers to abandon bordeaux.

The use of disease-free seed and a 2- or 3-year rotation, to eliminate the two important sources of primary inoculum, have helped many growers. Because the Septoria fungus embedded in the seed coat usually dies within 2 years and the seed retains its vitality 3 to 6 years, many growers buy their seed in advance or ask for 2-year-old seed when it is available.

In Bermuda the blight problem was greatly reduced by microscopic examination of samples of all imported seed and rejection at port of entry of all seed lots showing pycnidia. A free examination service offered at Cornell University to New York farmers similarly aided growers.

Fresh seed can be treated in various ways to kill the pathogens that cause early and late blights: A dip in hot water for 30 minutes at 118° to 120° F.; a dip in formaldehyde solution (1 to 300) for 3 hours at room temperature, followed by a rinse; a preliminary soak in tepid water for 30 minutes, followed by a dip in mercury bi-chloride solution (1 to 1,000) for 5 minutes and by a 15-minute rinse. The hot-water treatment is the best.

Dusting or spraying seedbeds with a copper fungicide two to four times (first practiced by growers in New York and Ohio) is an economical and effective way of reducing and delaying the onset of all three blights. It has been widely used.

If treatment of seed and seedbeds does not eliminate the blights, lack of rotation might be to blame. Growers who cannot rotate crops can hold the diseases in check by spraying or dusting in the field.

Local practices respecting materials and methods of field spraying and dusting vary a great deal. They depend upon variations in climate, on chances of losses at different times of the year, on growers’ preferences, and on the extent of local experimental testing of the newer fungicides.

Bacterial blight can be controlled with a dust of 20 parts copper and 80 parts lime. That was a standard treatment among muck growers in New York between 1924 and 1935. But its high lime content and the need to apply it when plants are wet has led to its gradual abandonment in favor of the low-soluble coppers. The modern trend is toward materials that do not clog nozzles very much and leave no unsightly residues. This change was made possible by general adoption of the seed and seedbed practices I mentioned, which give better control of blights in the seedbed and hence a reduced amount of blight in the field. The low-soluble coppers have given fair satisfaction where disease potential was not too high, although the rate at which they wash and weather off has made it wise to shorten the interval between applica-
BLIGHTS AND OTHER ILLS OF CELERY

...tions to 5 or 6 days on many farms, even to 3 or 4 days in southern Florida.

Heavy fertilization, the use of mulches between rows, side dressing with nitrogen, and adequate irrigation to keep celery growing rapidly are enough in some cool seasons up north to give growers a satisfactory crop despite early blight. But these practices are not so reliable in a hot, dry summer, on the early crop maturing in August, or on the late crop in Florida, which matures in April when temperatures are rising.

Nabam has been widely used in the Everglades in Florida. Ferbam, ziram, and the coppers have proved more suitable to the upland soils of the Sanford area.

In California the most satisfactory and inexpensive program against late blight includes spraying with 3–3–50 bordeaux mixture (3 pounds copper sulfate, 3 pounds lime, 50 gallons of water); in some localities zineb and the fixed coppers are preferred even though they adhere less well to the plant.

New York growers are giving up copper lime dust for the low-soluble coppers. A few use Dithane in liquid form. In most years control is satisfactory, but in some seasons many have been urged to go back to bordeaux mixture or to an alternate schedule of bordeaux and ziram, zineb, or captan.

In Massachusetts growers prefer a low-soluble copper to bordeaux, but the organics, zineb and ziram, if applied more often, are finding favor from the standpoint of safety and effectiveness. Zineb is generally considered more effective than ziram against Septoria.

Growers in Colorado have started using zineb sprays. Ziram and tribasic copper sprays have been favored in Oregon.

Extensive tests of fungicides in Michigan culminated in the development of a yellow cuprocide-sulfur-talc dust, 7–30–63, which is easier to use than liquid bordeaux, possesses less lime than 20–80 copper-lime dust, is more lasting than other low-soluble copper dusts, and has better flowing and keeping qualities.

Still better control of early blight was obtained in 1951 with a Dithane Z–78-sulfur-talc dust (7–30–63). Sulfur by itself is of little value in the control of celery blights, but its presence is said to enhance the performance of both copper and nabam. J. D. Wilson in Ohio found Methasan and Manzate to be among the better replacements for bordeaux mixture.

Breeding for resistance to celery blight has been made possible by the use of blight-resistant foreign plants brought in by the Eastern States Farmers' Exchange and the Department of Agriculture. The first was a hollow-stalked Danish celery, which was crossed in 1937 with Golden Self Blanching and given to plant breeders at Cornell University, who crossed it to their new yellows-resistant variety, Cornell 19, in 1940. Progenies were later crossed with Cornell 6 to improve quality. Further testing and selecting in New York and Florida resulted in the release in 1951 of Emerson Pascal, the first celery variety fairly resistant to early and late blights and highly resistant to fusarium yellows.

In 1940 and 1941, G. R. Townsend, then a pathologist at the Florida Everglades Experiment Station, discovered Cercospora resistance in a number of plants grown from seed that was brought from Turkey by the Department of Agriculture. The plants resembled celeriac. Because he was unable to induce them to set seed, he shipped seven plants to Cornell, where R. A. Emerson, after two more years, finally induced two of them to flower. Emerson made reciprocal crosses between Cornell 19 and P. E. I. (for Plant Exploration and Introduction, Department of Agriculture) 115557. Workers began a program whereby progenies highly resistant to both blights were being selected from that cross in Florida during the winters and...
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in New York during the summers. As celery is a biennial, progress has been slow, but facts of value to vegetable breeders have emerged: Blight resistance is due to more than one gene. Hollow stalk and green color are each dominant in the F1 generation and are governed by a single factor, and hence are easily eliminated. Susceptibility to black heart and to magnesium deficiency in the soil are both hereditary factors that can be eliminated by breeding.

The yellows disease was next in importance to the leaf spots in most of the Northern States until resistant varieties were discovered and developed in Michigan, New York, and California. Ray Nelson, G. H. Coons, and L. C. Cochran, at Michigan Agricultural Experiment Station, found there are three distinct diseases in the sense that three separate strains of _Fusarium_ may be involved. Stunting of the plant, vascular discoloration, and crown and root rotting are common to all three, but leaf symptoms clearly distinguish two of them. Hot, dry weather is necessary to bring on a full expression of yellows. When the weather turns cool and wet, even infected plants may recover partly.

The first symptom, a lagging in the growth rate, is sometimes seen even in the seedbed. In the field, plants lose their glossy appearance and there is a yellowing of the outer leaves between the veins. _Fusarium apii_ form 1 is responsible for those symptoms. When temperatures are high, the entire plant, if not more than half-grown, may turn yellow in a few days. Often leaves of an infected plant when about to turn yellow become brittle. When they are crushed in the hands, they crackle like dead twigs. That is particularly true of green varieties, which usually never turn yellow; that and stunting may be the only visible indication above ground of the disease in such varieties. Petioles of affected plants often develop a bitter taste.

In the second type of yellows the earliest symptoms are a downward curling of the young heart leaves. Then the veins lose color. In this type _Fusarium apii_ var. _pallidum_ or form 2 is at work, and the areas between the veins are the last to turn yellow. Stunting, root rotting, and browning of the vascular elements in the roots accompany above-ground symptoms in both instances.

The California variation of the yellows complex lacks symptoms of leaf yellowing, curling, and brittleness even in warm weather. It is primarily a stunting, with secondary root rotting and primary vascular discoloration. The identity of the _Fusarium_ that is responsible seems not to have been established. But it differs from the other two, which are more common causes of yellows in the Northeast.

In warm soil (77° to 85° F.), the symptoms below ground include brown discoloration and death of small secondary roots, vascular discoloration and dry rotting of the taproot and crown, and even splitting of the latter. Many plants die.

The fungi responsible for fusarium yellows have been isolated from vascular tissue of all parts of affected plants from lower roots to upper leaf stalks. _Fusarium apii_ form 1 develops a pink to purple color on steamed rice, while _F. apii_ var. _pallidum_ or form 2 remains colorless. Some writers put both together under the name _F. oxysporum_ form _apii_, but not this one. The fungi live in the soil for many years even in the absence of celery.

Green varieties generally are much less susceptible. Many of them can be grown on infested land without fear of much loss. There is also a difference in susceptibility of different strains of the same variety as well as a difference in apparent behavior of one variety in different seasons. The most extensive testing of varieties has been done in Michigan by Ray Nelson and L. C. Cochran and in Ohio by J. D. Wilson.

The following lists of varieties resistant and susceptible to yellows are based partly on their findings:
Yellow Varieties


*Very susceptible:* Golden Self Blanching, Wonderful (some strains), Early Fortune (some strains), Meisch's Special, Hoover's Special, Gunson's Special, Golden Phenomenal, Golden 14, Golden Detroit, and Golden Plume (some strains).

Green Varieties


*Moderately susceptible:* Winter King, Utah, Fordhook, Columbia, Epicure, Pascal, Emperor, Newark Market, Crystal Jumbo, and Winter Queen.

*Very susceptible:* White Plume, Houser, and Paragon.

Some varieties are classified as resistant at one time or by one worker and susceptible at another time or by another worker. T. C. Ryker, who grew plants in infested soils held at different temperatures at the University of Wisconsin, pointed out a possible reason for this discrepancy. He found some varieties or strains of a variety are resistant in soils up to a temperature of 79° F., above which they are susceptible. Early planting in the Northern States therefore enables a fairly susceptible variety to make good growth before soil temperatures become high enough to induce fungus infection. In wet, cool seasons infection may be delayed until the crop is made.

**Control of celery yellows** has been accomplished in Michigan by the selection of individual plants that grew well in fields, where nearly everything else died of the disease, and propagating directly from them. That was done between 1919 and 1926 with selections from a field of Dwarf Golden Self Blanching. The variety released was named Michigan Golden. A similar process of field selection and multiplication from a field of Tall Golden Self Blanching resulted in the Michigan Golden Tall strain between 1930 and 1933. Both were yellow varieties, but in 1951 a green variety, Michigan State Green Gold, was released. It was the result of hybridizing the Downing Strain of Fordhook with the tall strain of Michigan Golden. It has a light-green stalk and is widely grown in Michigan and elsewhere.

At Cornell University in 1933 Swarn Singh crossed Utah, a moderately resistant green variety, and Golden Self Blanching, a popular susceptible yellow one. His work culminated in the development of two new varieties, Cornell 19 and Cornell 6, both self-blanching and highly resistant to the eastern strains of yellows. By crossing the blight-resistant strain described under early blight with each of these in succession, New York workers developed Emerson Pascal, a variety resistant to both diseases. It was put on the market in 1951.

**Phoma root rot** has occurred at times in the Northeast. The fungus that causes it, *Phoma apiicola*, can attack other members of the Umbelliferae, such as carrot, parsnip, parsley, and caraway, but not hemlock or dill. It can live over in the soil on plant debris and occasionally on the seed.

Its first appearance often is in the seedbed, where it causes stunting, yellowing of outer leaves, brown
rotting of roots, and sometimes death of young plants. The fungus fruits on the roots and crown; spores from a diseased seedling thus can be spread at transplanting time to many other plants if they are pulled and soaked in water before they are set in the field. The fungus usually is confined to the crown, but sometimes it grows up into the outer leaf stalks far enough to turn them a dark bluish-green color and cause them to break over. Crown lesions take on a dark, brown, rough, scurfy appearance and frequently crack open in later stages. Plants may be killed in the field, although usually they linger on.

The fungus prefers a comparatively low temperature, 61° to 65° F., and requires oxygen and moisture for its most rapid development. Therefore it causes trouble principally on the spring crop and sometimes the late fall crop when temperatures and moisture are most favorable.

The pycnidia of the fungus, filled with very small one-celled spores, may be found partly embedded in the root lesions at any time. The fungus can occasionally become embedded in the seed coat, and it has been introduced by this means into new territories where it caused bad local seedling infections. Free spores once extruded from their pycnidia, however, cannot survive more than 30 days on the surface of seeds at room temperature.

No varieties are known to be resistant, although White Plume, Giant Pascal, and Easy Bleaching seem less susceptible. The fungus is not adapted to the climate of California, where most of our seed is grown. It has not been found in Florida, where much of our winter celery is grown. Losses can be kept down by treating infected seed with hot water, sterilizing infested seedbed soil, rotating crops, and destroying plants that show symptoms.

Brown spot is a new fungus disease of leaf stalks, petioles, and leaflets. It is caused by Cephalosporium apii. It occurred in Colorado in 1943 and later in New York, Ohio, and Ontario.

It has been confused with one or another of the blights of celery and with brown check and cracked stem but differs from them in several important respects. M. A. Smith and G. B. Ramsey, of the Department of Agriculture, have described the chief symptoms of brown spot as irregular, light-tan or reddish-brown, shallow lesions, which occur on any of the above-ground parts of the plant. The lesions may unite to form a scurfy brown streak all the way up the inside surface of the stalk. Transverse cracks may develop across the large lesions and the fungus fruits in the cracks as well as on the surface of stalk and leaf spots.

A certain amount of distortion of growth may occur. The fungus produces many small, elliptical or elongate, one- and two-celled spores on the surface of infested areas. Although the fungus was first found and is much worse on the Utah Pascal types of celery, it occurs also on the Golden Self Blanching types and has affected as high as 85 percent of the plants in a field.

Growers are concerned about this disease for several reasons. Because its fungus is a rapid, heavy sporulator, it probably requires more frequent applications of fungicides—if satisfactory fungicides can be found. Because it often attacks inner stalks and heart leaves, the plant cannot always be trimmed down to a sightly, marketable product. Furthermore, plants from diseased fields, which look fairly free at harvest, when packaged at the wash house directly from the field for retail markets may develop unsightly reddish-brown freckles in transit or in storage.

The spores of Cephalosporium apii germinate best between 68° and 75° F. and not at all above 90° or below 45°. The fungus grows best at 75°.

Bordeaux mixture is more effective than wettable sulfur in inhibiting spore germination in the laboratory, but control measures have not been
worked out in the field. Growers in New York up to 1952 failed to get very good control with either a low-soluble copper or a liquid Dithane spray applied as for blight control. First attempts to isolate Cephalosporium from seed have failed. Fortunately a number of varieties are apparently resistant. These include Summer Pascal, Utah 52-70, Utah 15, a Department of Agriculture plant introduction 176789, and Tall Fordhook. Very susceptible varieties include Cornell 19, Golden Plume, Top Ten, Ten Grand, and Non Bolting Green Nos. 12 and 13 (from Hart and Vick), according to 1952 tests made at Cornell University by Ralph Segall.

Stem check, brown check, or adaxial crack stem is another new disease of celery which has caused heavy losses from coast to coast since the introduction, in 1943, of the splendid variety Utah 10B. It begins as light-tan, shallow, sunken, greasy-looking spots on the inner surface of leaf stalks after plants are half grown. The spots or streaks turn dark brown and open up with a series of unsightly horizontal cracks. Sometimes typical symptoms of crack stem (known to be boron deficiency symptoms) occur on the outer ridges of the stalk but not always.

Affected plants are not stunted; in fact, the disease seems to be worse where ample fertility increases growth rate. The disorder has been traced by P. A. Minges, J. T. Middleton, and other California workers to a deficiency of boron in the presence of excessive supplies of potash within the plant. Susceptible varieties seem unable to take up as much boron as needed to protect them. This inability is probably an inherited character as certain strains of Utah, notably 10B and Utah Special, are very susceptible. Utah 16-5 and Top Ten are also moderately susceptible, while Utah 52-70, Utah 16-8, Utah 16 PC, and Summer Pascal, in field tests by the California scientists, were practically free from the disease.

Control is only a matter of avoiding the use of susceptible strains, or if they are grown, then withholding of potash and excess nitrogen, or spraying with boron solution, or both, may be desirable.

At least nine virus diseases attack celery. Three or four of them are widespread and cause heavy losses. None is seed-borne. None remains in the soil after infected roots decay. Most of them have several common wild or cultivated plant hosts, which act as perennial reservoirs of infective virus. Aphids are the usual vectors, but thrips carry spotted wilt and leafhoppers carry virus yellows.

Cucumber mosaic virus, of which there are a number of strains, is common from coast to coast. The first symptoms are vein clearing and mottling of inner leaves. The most prominent symptoms develop about a month later and include stunting, fern-leaf growth of some leaflets, and raised, dark-green, blisterlike areas on others. A closely related virus, causing southern celery mosaic, is established in Florida, Cuba, and Puerto Rico. It also occurs in the Northern States, where it caused heavy losses in 1950.

Often buff-colored and translucent, sunken spots develop on outer petioles. F. L. Wellman correlated the spread of the disease in Florida with east winds and the spread of winged forms of the melon and cotton aphids. The corn leaf aphid and others also can transmit the virus. The disease has often been observed to start nearest to weeds or diseased economic plants. Eradication of Commelina nudiflora—dayflower or dewflower—in the Sanford area of Florida gave a large measure of control. The more than 140 host plants of the cucumber mosaic virus belong to more than 30 families, among them pokeweed, groundcherry, milkweed, and catnip.

Western celery mosaic occurs in California and Colorado. Its symptoms resemble those of southern celery mosaic, except that the leaf
mottling is usually followed by necrotic spotting. On the petioles white spots or streaks develop instead of brown sunken ones. The disease became destructive in Los Angeles County, Calif., in fields where celery was grown continuously. It can be controlled if growers in an area observe a 3-month celery-free period beginning in September each year. The virus is restricted to umbelliferous hosts—celery, carrots, celeriac, dill, caraway, coriander—and wild weed hosts are unimportant. At least 11 different aphids carry the virus.

The viruses that cause southern and western celery mosaics apparently belong to the nonpersistent group of viruses. They are easily transmitted mechanically. A vector does not retain for long the ability to transmit it. This ability may be lost during the first feeding or in less than 15 minutes.

Spotted wilt occurs on celery chiefly in the cooler, coastal fog belt of California, where the virus attacks a wide range of truck crops and ornamentals.

Symptoms of spotted wilt on celery are most pronounced on the outer rather than inner stalks and begin on older leaf blades as numerous small yellow spots, which later become necrotic. Internal pockets of dead brown tissue develop inside the petioles and become more or less visual from without as sunken brown patches, which may rot and result in death of the entire leaf. Plants are stunted and worthless.

The vectors of spotted wilt virus are the tiny thrips, *Thripis tabaci* and *Frankliniella insularis*, which must pick up the virus while still a nymph and in which a period of 5 to 9 days must elapse before the insect can transmit it. Once infectious, the insect remains so throughout pupation, emergence as an adult, and often until death. The virus is not transmitted through eggs of the infective female.

Control is through elimination of the host plants, including ornamentals, that harbor the virus in the off-season when celery is not being grown.

Spraying with one of the newer organic insecticides may be helpful in some cases. Tomatoes have been bred for resistance, but attempts to do that for celery have not been undertaken.

Celery virus yellows is caused by the aster yellows virus so common on lettuce and carrots. It is not to be confused with fusarium yellows, which is caused by a fungus in the soil. The symptoms on celery include shortening, twisting, yellowing, and delicate mottling of inner petioles and leaves; later many new shoots develop, and there is some stunting and a general yellowing. In California, 23 to 100 days may elapse before symptoms begin showing after inoculation of celery.

The vector is the six-spotted leafhopper. That insect overwinters in the egg stage on winter barley and to some extent on native grasses. After developing into adults, the leafhoppers begin in June to migrate to more succulent host plants; they do some feeding on infected plants, among them wild carrot, plantain, dandelion, chicory, perennial sowthistle, and some species of wild aster. After the insect has picked up the virus, an incubation period of 10 days must elapse, during which time the virus multiplies within the vector. The incubation period can be lengthened by heating the leafhoppers for periods up to 11 days at 91° F. After 12 days at this temperature they are no longer infective unless they feed again on a diseased plant. That accounts for the slower rate of spread of virus yellows during a hot summer.

Other celery virus diseases of less economic importance have been described in California under the names of western cucumber mosaic, celery calico, celery yellow spot, crinkle leaf mosaic, and tobacco ring spot.

Control of virus diseases depends upon doing away with the wild host plants harboring the virus, destruction of insect vectors, or use of resistant varieties. The first has been used in the control of the southern celery mosaic.
with considerable success in Florida. Destruction of weed hosts around celery seedbeds and plant houses in the north is being employed to reduce losses in the field. It is well known that when hay is cut, when pastures dry up, or when weeds mature, great migrations of aphids and leafhoppers take place when the weather is warm and the air calm.

R. C. Dickson in the Imperial Valley of California calculated some 40 million winged aphids on a mile front may pass in an hour and flights may keep up for many days or weeks. He found that an individual aphid may feed for less than a minute, before flying on to another host, so each plant may play host to many aphids a day.

Weekly spray or dust programs against the insects after the diseases appear have been disappointing in California, probably because the migrating females that bring in the viruses are not killed quickly enough to prevent their first feeding.

Celery is also subject to attack by several parasitic nematodes such as the root knot nematode (Meloidogyne species), the sting nematode (Belonolaimus gracilis), the stubby root nematode (Trichodorus species), and the awl nematode (Dolichodorus heterocephalus), as well as to damping-off disease (Pythium species), pink rot (Sclerotinia sclerotiorum), black crown rot (Centrospora acerina), rhizoctonia crater spot, a fusarium seedling root rot, a bacterial soft rot (Erwinia carotovora), bud failure, and two or more physiogenic diseases, such as black heart, crack stem (boron deficiency), and a pale-yellow mottle leaf (magnesium deficiency).

The Important Diseases of Lettuce

Guy Weston Bohn

American gardeners grow several types of lettuce—the loose leaf varieties, cos or romaine, butterhead, and iceberg. All are in the botanical species Lactuca sativa.

Most of the commercial acreage of lettuce is in the Southwestern States, where lettuce, most of it the iceberg type, is grown the year around and shipped in refrigerated cars to all parts of the country.

The lettuce plant has a compact mass of edible, tender leaves on a short stem. Its structure makes it very perishable. Harvesting and handling must be prompt. Lettuce is subject to a variety of diseases during its growth and its distribution to consumers.

Seed decay and seedling blight, diseases that reduce plant stands, are caused by several soil-inhabiting fungi, such as Rhizoctonia solani and Pythium ultimum.

The fungi attack the tender plants before and shortly after they emerge from the soil and cause the stems and roots to rot. Young plants may be attacked only at the soil surface. If that happens, a short section of the stem rots and the seedling falls over. The injury is called damping-off. Older plants are seldom attacked.

Conditions that reduce the rates of germination and emergence increase losses from seed and seedling rots in heavy, wet, poorly aerated soils, which tend to puddle. Losses in such