Hazards to Onions in Many Areas

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Onions are grown in every State. In the South, onions are an early spring crop, mostly for immediate shipment, and Yellow Bermuda, Excell, and Crystal Wax are the chief varieties.

In the North, the earliest crop is grown from sets produced the previous season, and the major part of the acreage, much of it on muck soils, is sown in early spring and harvested in September and October. Strains of Yellow Globe, Yellow Danvers, and Sweet Spanish predominate. White Globe and Red Globe also are planted.

Onion sets are grown mainly in northeastern Illinois and southeastern Wisconsin and near Greeley, Colo. The chief set varieties are Ebenezer, Yellow Strassburg, White Portugal, and Red Wethersfield. All northern-grown varieties are suited to winter storage. Onion seed is grown chiefly in California, Idaho, and Oregon.

Garlic, chive, and shallot are grown from sets. Welsh onion and leek are grown from seed. Welsh onion, like shallot, produces many small bulblets and both are used chiefly as "green" onions.

While many diseases affect onion and its close relatives—garlic, chive, shallot, Welsh onion, and leek—a few stand out as potential hazards, particularly to onions, in many areas.

Downy mildew is most destructive in New York, Michigan, Louisiana, California, and Oregon in an average year. In unusually cool, rainy seasons it is a major disease in other Midwestern States and once in a while in Texas and Colorado. It affects onion, Welsh onion, leek, shallot, chive, and garlic.

It usually appears in midseason as yellowish spots on the upper half of leaves of the onions. The fungus fruits on the surface of the spot as a bluish-gray, fuzzy mildew when humidity is high. The spots increase rapidly if moist weather continues. Spores produced on the surface are carried widely by air currents to cause new infections. The tops die back. The advance of the disease increases with high humidity and declines in dry spells. Plants are seldom killed, but growth of bulbs is reduced and the bulb tissue is inclined to be spongy and of poor keeping quality.

When expanding stems in the seed crop are infected, uneven, stunted growth follows. Spots on one side cause the stem to bend in the direction of that side. As the seed top grows heavier, weakened stems break over and seed is light in weight and poor in germination.

The causal fungus, *Peronospora destructor*, is spread by wind-borne, short-lived spores. In old leaves are formed winter spores, which remain viable in the soil until the next season. The fungus threads—mycelium—may also live in the bulbs and sets. From them infected plants may arise when they are used for the seed crop or for an early bulb crop.

Perennial onions may also become a source of summer spores in early spring. Summer spores are produced most abundantly during the night at about 55° F. They are spread during the day. As dew accumulates the following night, they germinate most rapidly at about the same temperature and penetrate the onion leaf or stem. Dew is required for germination and penetration. Windy weather favors spread of spores, but there is less dew then. That is why low muck areas with
poor air drainage are the ones where onion mildew often appears first and causes greatest damage.

Downy mildew diseases usually can be controlled by protective sprays or dusts. Onion downy mildew has been an exception; many experiments have been conducted on it, but to little avail. At the Michigan Agricultural Experiment Station, Ray Nelson in 1951 reported encouraging results with a mixture of Dithane Z-78 and sulfur applied as a dust. We expect improvements in that line of control as other fungicides are developed.

Localities with dry summers have little to fear from mildew. The production of onion seed therefore has increased in Idaho and declined in California and Oregon.

A resistant variety, Calred, was developed by workers of the California Agricultural Experiment Station and the Department of Agriculture from a cross between a resistant strain of Italian Red and an Australian variety, Lord Howe Island. Its seed stalks are highly resistant and the leaves are moderately so. It is adapted to growing districts in California. We need to breed the resistant character into the more widely used varieties.

Neck rot is one of the most serious of the storage rots of onion. It appears shortly after harvest as a softening of the scale tissue. It begins usually at the neck and occasionally at a wound elsewhere on the bulb. The affected tissue takes on a sunken, cooked appearance as it advances steadily down one or more of the bulb scales. There appear later on the decayed tissue grayish masses of fungus threads, which gradually form a compact mat on the surface. If conditions are even moderately moist, a gray, powdery mass builds up on the surface. Meanwhile the cooked-appearing zone advances while the fungus mass follows it down the scale. The scale gradually shrivels. If many scales are affected, the entire bulb dries down to a crisp mummy.

The causal fungi are three closely related species, of which Botrytis allii is the most widespread. The gray, powdery mass on the surface of the decaying scales consists of myriads of spores of the fungus, which are picked up readily by the lightest of air currents. They will live for some days or weeks, but not through the winter.

In the fungus mats there sometimes appear hard black bodies (sclerotia), about the size of a barley kernel. They are made up of finely woven fungus threads, which can survive freezing winter weather.

When cull onions are dumped from warehouses in the spring, the sclerotia give rise to spore masses in moist weather. The spores are carried to onion fields by air currents. They do not infect the growing plant, but when they germinate they grow saprophytically, principally on the oldest leaves which are sloughed off as the plant develops. As the plant matures it becomes susceptible at the neck. If the tops are cut while still green, the wounded neck is ideal for penetration and infection by the fungus.

The saprophytic stage of the fungus builds up most effectively in cool, moist seasons. If such weather persists into the harvest period, spores are most abundant and infection is greatest. If the crop matures in dry, warm weather, the build-up of spores is reduced to a minimum and the disease which follows is negligible. That is why neck rot is not a major disease in areas where the crop matures in dry climate, such as the Rio Grande Valley, central California, Utah, and Idaho. In the more humid upper Midwest and Northeast, neck rot varies from season to season, depending on the climate just before and during harvest.

With those facts in mind, growers there can do much to reduce neck rot. They should allow the bulbs to mature well before being topped. Bruising in harvest should be avoided. If there is adequate ventilation in storage, the disease does not spread very much.
Artificial drying at harvest and during early storage reduces somewhat the advance of neck rot, and many growers use it as a standard procedure.

All varieties of onion are susceptible once penetration has taken place, but a great difference still exists between varieties. White varieties are most easily infected. They therefore need the most attention at harvest. Yellow and red varieties are more resistant, but one must be careful with them also, especially when weather favorable to neck rot prevails. The mild varieties of all colors are more susceptible than pungent varieties of corresponding colors. It is therefore important that such types as Sweet Spanish be allowed to mature well and be given the best possible airing. They should be protected from rain and dew during the curing process. The best storage conditions for onions include a temperature of 32° F. or slightly above and a relative humidity of about 65 percent.

**Pink root** first came into prominence in the Rio Grande Valley after 1921. It soon became important in central California. Since then the causal organism has been reported on onion in other areas. It is, in fact, a rather common soil inhabitant, which attacks the roots of many of our crop plants.

On onion the disease becomes manifest in young seedlings and at any subsequent time in the growth period of the host. Abnormal yellowing of roots is commonly associated with pink root but is not necessarily a stage of the disease. Affected roots turn pink, shrivel, and die. As the plant sends out new roots, they in turn become diseased and functionless. That happens throughout the growing season. The affected plants are not usually killed, but the reduced food supply results in the formation of mere scallions or small bulbs.

The causal organism, *Pyrenochaeta terrestris*, is made up of many races, which vary in growth characters and in virulence upon onion. Black fruiting bodies smaller than a pinhead sometimes appear on the diseased onion roots. Within them myriads of microscopic spores are formed. They are not important in the spread and perpetuation of the fungus, because the fungus seems to depend upon fungus threads, which grow and persist more or less indefinitely in infected soil.

I know of no practical way to eradicate the fungus from infested soil. The development of resistant varieties is therefore important. Such a program is under way in the Department of Agriculture and several State experiment stations. At the Wisconsin Agricultural Experiment Station, R. H. Larson has worked out a method of subjecting breeding progenies to pure cultures of the fungus as they grow in white quartz sand at controlled, constant temperatures. After 2 weeks of growth in a liquid medium, the fungus threads are chopped into fine particles, which are mixed in the clean, sterile sand. The sand is placed in shallow metal trays supported in tanks of water regulated at a constant temperature of 80° F. Seeds are sown in the sand, and after 28 days the diseased seedlings are discarded and the resistant ones are transplanted to soil and grown on to bulbs. Thousands of seedlings can be tested in a month in this way. Resistant individuals are then used for further breeding.

Yellow Bermuda is one of the most tolerant of the common varieties. Plant breeders have discovered that they can increase that level of resistance by rigid selection. Resistance is an hereditary character that can be transferred to other types by breeding.

Chives, the Nebuka type of Welsh onion, and Giant Musselberg variety of leek also have considerable natural resistance. The Evergreen shallot, developed at the Louisiana Agricultural Experiment Station, and the Beltsville Bunching, a nonbulbing onion derived from a cross between onion and Nebuka Welsh onion and introduced by H. A. Jones of the Department of Agriculture, are resist-
ant types developed by selection and breeding.

Onion smut was first reported in 1869 in the Connecticut River Valley. By 1888 it was of great economic importance there on old onion soils. It has become an important disease in most of the onion-growing areas throughout the Northern States as far west as Oregon and central California. In the United States the disease has remained strictly a northern one, although very likely the fungus has been transported frequently to southern regions. The disease also occurs on leek and Welsh onion.

Smut appears on the first leaf (cotyledon) soon after it emerges above ground as a dark, slightly thickened area. If most of the first leaf or later leaves is involved, they are swollen and tend to bend downward. On plants starting to bulb, raised black blisters appear near the bases of the scales. Lesions may break open and expose black, powdery masses of spores.

Most infected seedlings die within 3 or 4 weeks after they emerge from the ground. Some plants survive weakly until midseason or later, and occasional plants produce bulbs with lesions on the outer fleshy scale and in one or more underlying scales. The fungus does not produce a rot in storage, but affected bulbs may be more subject than healthy ones to invasion by storage-rotting fungi and bacteria.

The causal organism, Urocystis cepulae, as seen in the black smut pustules in the leaves, consists of microscopic spores, which can live for many years in the soil. When soil is infested it remains so for many years, although there is no evidence that the organism grows and multiplies in the soil. The spores are not ordinarily seed-borne but are transferred widely on diseased sets and plants and locally by wind and water-borne soil.

The onion seedling is susceptible to infection by fungus threads growing from the spores only during the early seedling stage. If the plant escapes infection until the first leaf has reached its full growth it will continue entirely free from disease. Healthy sets or transplants that are planted in infested soil grow with complete immunity from infection. The fungus is sensitive to high temperatures, and if the young seedlings are growing in soil with temperatures of 80° F. or above they escape infection, because the fungus is very inactive and the plant grows through its susceptible period more rapidly. This phase of the disease cycle was worked out by the writer, L. R. Jones, and F. L. Wellman, of the Department of Agriculture and the Wisconsin Agricultural Experiment Station. We interpreted the results as explaining why the disease is of no importance in southern areas where seed is sown in late summer in very warm soil.

A great deal of research has been carried out on resistance of onion and its relatives to smut. R. I. Evans, of the University of Wisconsin, found that as the first leaf grew it became gradually more and more resistant and even though the fungus continued to enter, it had less and less success in establishing itself.

Welsh onion, especially the Nebuka type, is more resistant than onion, because the tissue of its first leaf becomes incompatible to the fungus earlier and much more rapidly. Three of us at the Wisconsin Agricultural Experiment Station and the Department of Agriculture studied resistance in crosses between onion and Welsh onion. Resistance was highly dominant and the hybrid scallion onion, Beltsville Bunching, has nearly as high resistance as Welsh onion. In 1952 we had not been able to introduce the resistance of Welsh onion to the bulb-onion type, by backcrossing the hybrid to onion.

Control of onion smut centers around protection of the young seedlings from infection. About 50 years ago at the Ohio Agricultural Experi-
Control of Diseases of Potatoes

Eugene S. Schultz

The Irish potato is susceptible to many diseases. The fungi that might attack it range from the slime molds to the smuts and rusts. It is subject to several viruses of the yellows and mosaic groups. Such nonparasitic diseases as black heart, sunscald, freezing injury, and a malnutrition caused by deficiency in magnesium, potash, and boron may cause damage. Several nematode diseases have been found on it.

Unless effective methods of control are practiced, serious diseases, such as late blight, ring rot, and leaf roll, can cause the total loss of a crop.

**Late blight** of potato is a downy mildew caused by a fungus, *Phytophthora infestans*. The mildew, or flour-like spots, usually on the lower surface of the leaf, distinguishes the disease from other leaf spots on the potato plant. Humid conditions favor it. Despite its name, the first infection often occurs soon after the plants emerge when favorable moisture and temperature prevail. At 70° to 75° F. the fungus grows so fast inside the leaves that within a week after infection it causes dead spots one-half to 1 inch in diameter. The entire plant may be killed within 2 weeks. The brown discoloration of the foliage brings to mind the terms “blight” and “rust.”

Late blight destroyed potato crops so often during the nineteenth century...