

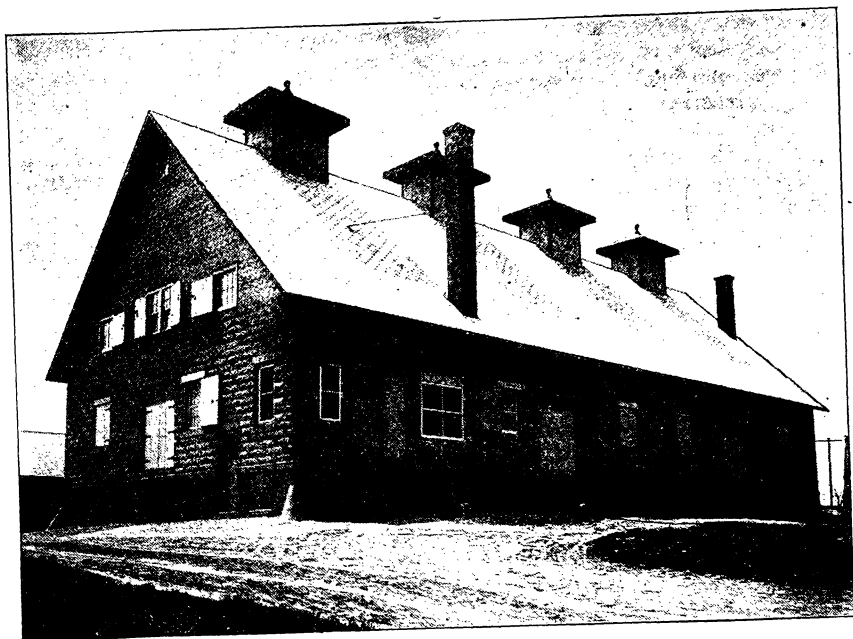
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A GOOD ONION STORAGE HOUSE.

ONION NECK-ROT IN STORAGE HOUSES.

SUMMARIZED BY
F. H. HALL
FROM BULLETIN BY
M. T. MUNN.

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OF

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ONION NECK-ROT IN STORAGE HOUSES.

F. H. HALL.

**Old, but not
well-studied
disease.**

In the fall of 1913 word was received at the Station of an outbreak of disease in an onion-storage house in western New York. The disease was said to threaten the entire stock of onions in the house.

Examination proved the trouble a serious one, of which the exact cause was unknown, but which had previously been reported from many places under various names, as mold, gray mold, storage rot, onion rot, onion bulb rot, dry rot, black-neck rot, dry neck-rot, stem rot and neck-rot. As neck-rot is simple and appropriate it has been chosen as the common name for the disease.

**Trouble of
fungus
origin.**

Only casual study was needed to prove the trouble due to a fungus, and to identify the organism causing it as one of a large group of disease-producing fungi. The disease, or others similar to it in some respects, had been ascribed by plant pathologists to different members of the genus *Botrytis*, or to species of allied genera; but careful study of the fungus and comparison of it, point by point, with more than a dozen other species reported as causing onion rots of this type or known to affect other species of the onion family, proved it a new species and resulted in giving it the name of *Botrytis allii*.

**Nature and
extent of
the disease.**

The disease is most common on stored onions, on which it usually appears, externally, as large black bodies or crusts, generally on the bulb near or surrounding the neck, less commonly on the sides, and occasionally at the base. Beneath these bodies or crusts one or more of the scales, or the thickened leaf bases that make up the bulb, are rotted — but without the production of much moisture, thus leading to the name “dry rot.” On the onions the disease may also show as a dense ring or band of closely interwoven threads covered with smoke-gray fruit-bodies of the fungus, hence the name “gray mold.” Occasionally, an onion attacked by this

* This is a brief review of Bulletin No. 437 of this Station, on Neck-rot Disease of Onions, by M. T. Munn. Anyone specially interested in the detailed investigation will be furnished, on request, with a copy of the regular edition of the bulletin. Names of those who so desire will be placed on the Station mailing list to receive future bulletins as issued, either popular or complete edition as indicated.

fungus will be found softened all thru, moist, and with a very offensive odor; but such rotting is believed to be due to bacteria which follow the true neck-rot fungus.

In some outbreaks, as in the one which led to the investigation, the loss of the stored onions from this disease may be almost complete in many houses, especially those poorly ventilated. This was the case in western New York in the winter of 1912-'13. Again in 1915-'16, following a growing season very unfavorable for onions, storage losses were enormous. In some Michigan storage houses where the disease was also studied, the loss from neck-rot early in the winter of 1915 averaged one crate out of every six stored; while by January 4, the losses were over 50 per ct. of the total stored crop. One grower who put in storage 2200 bushels was later obliged to dump 1200 bushels of these on the fields because of the neck-rot. Of the entire crop only two bushels were fit to save for seed bulbs. Ordinarily the neck-rot injury appears only as one factor in the "shrinkage" of stored onions, the others being smut fungus, onion maggots and sprouting of the bulbs. In several instances neck-rot was responsible for more than 60 per ct. of the shrinkage, and was undoubtedly the cause of part of the sprouting, also, since the attacks of the fungus released some moisture and induced premature growth.

The neck-rot fungus may attack the growing crop onions in the field at almost any stage. Even early in the season it may produce white, circular or elongated spots on the leaves, surrounded by areas with a yellowish or water-soaked appearance. Later, the fungus, going down thru necks and bulbs or attacking thru the roots and working upward, checks the growth of the bulbs and thereby causes a large proportion of "seconds" or "picklers" thus reducing the yield and lowering the value of the crop; or else the fungus in the bulbs may pass unnoticed into the storage house, where, under favorable conditions, severe rotting may take place. On the seed crop the attacks of the fungus, which usually accompany a period of excessive moisture, cause a failure of the seed heads to produce seed — a condition almost identical with the so-called "blast" of the seed crop, thought to be due to either extreme dry or wet weather. Such failures to secure seed in New York in 1913 and in Michigan in 1915 are believed to have been due largely to attacks of this fungus.

How the disease starts.	Like other fungus diseases this one is distributed mainly by spores (minute bodies which correspond to the seeds of higher plants). These may be carried by the wind to the onion plants or remain in the soil and infect the bulbs thru the roots.
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The fungus does not pass readily from a diseased bulb to a healthy one in storage because of the resistance offered by the one or more parchment-like dry scales which cover the onion; but where this dry covering is broken or removed and the skin of the fresh, succulent bulb-scale beneath is ruptured, as by a cut or bruise, the bulb may

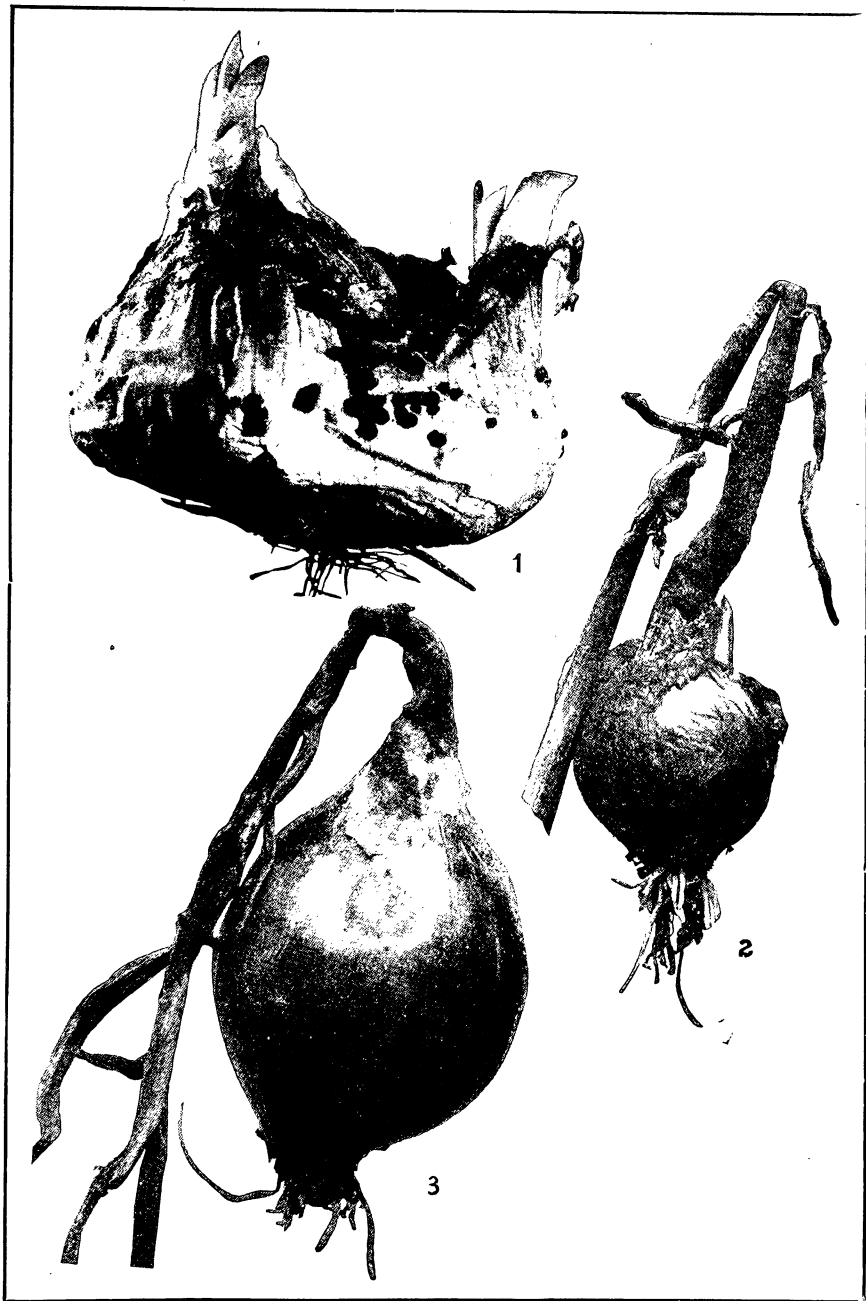


PLATE I.—NECK-ROT ON ONION BULB AND NECKS.



PLATE II.—NECK-ROT IN AND ON ONION BULBS.

easily become infected. When healthy onions are in close contact with a mass of wet, sprouting and rotting specimens, or when, for any reason, the outer, papery covering and the scale beneath it are kept moist for some time, even tho not in direct contact with the rotting bulbs, the disease may spread to them, since the presence of moisture causes germination of the spores and softens the tissues so that the fungus finds an entrance. A spore in a single drop of water that evaporates slowly may be all that is needed for a center of infection. Investigation of many possible ways in which the disease may start indicates that the most common origin is thru the lodgment of the dry, wind-borne spores, either between the bases of two leaves where moisture remains after a shower or heavy dew, or on the surface of the bulb or neck during continued wet weather. The leaf tissue is specially subject to infection when the leaf is beginning to decline and turn yellow. Injuries to the growing plants, such as those made by insects and the breaking of the leaves by wind, or injuries to the bulbs during the process of harvesting or topping, afford ready access to the disease.

How the fungus destroys tissue. The germinating spores send out thread-like tubes which pierce the skin of the moist bulb-scale and then divide and sub-divide both on and in the scale. The tips of the branches are provided with special organs of attachment which hold them to the surface of the scale until it can be penetrated

and softened. Frequently these organs secrete a mucilaginous substance which aids in holding them in place until the tube can force its way into the onion tissue. Where the threads remain upon the surface or where they force their way there from within they unite in dense masses to form the characteristic bodies or crusts called sclerotia. These are covered with a dense black enamel-like coating. Thru this coating and also directly from the threads there grow long dirty-white or smoke-gray branches upon which are borne millions of spores to infect new points.

Factors affecting growth and fruiting. Investigations to ascertain the factors which influence the growth of the fungus were made in the laboratory under very carefully controlled conditions upon pure cultures of it; that is, the fungus, and nothing else, was grown in dishes and tubes containing materials on which it thrived. Com-

paratively low temperatures proved most favorable to growth of the mycelium or fungus threads, the range within which branching and multiplication of these threads took place being from about 45° to 86° F., but very few spores were produced below 50° or above 80°. Excessive moisture induced rapid and copious growth of the threads and of the dark collections of these threads on the surface (sclerotia), but spore formation did not begin until the culture material was moderately dry. Free access of air was necessary for

production of spores, but the threads and sclerotia were formed abundantly even in tubes of culture media with scanty air supply.

These factors explain the rapid development of the fungus in the cool, moist air of storage houses and the very profuse formation of spores when the rotting bulbs are exposed to warm, dry air.

The spores or conidia of the fungus, when again moistened, germinated freely after being held in a thoroly dry condition for two years, but their power of germination rapidly declined during the third year of such drying. The sclerotia, or crusts of fungus threads, when dry, would live for nine months to a year, but failed to grow after half that time if kept in moist earth. Both spores and detached bits of mycelium, then, may live in the soil long enough to infect the crop of the following year. The growing crop and the seed crop may thus be infected by the fungus on diseased tops or necks of refuse onions or directly by the fungus in the soil. Probably the dumping of decaying onions near fields on which a new crop is to be grown is the most dangerous source of infection.

Method of control.

Spraying experiments with bordeaux mixture, made in an attempt to control the neck-rot fungus, did not prove very successful, as there was only a slight decrease in the amount of onion shrinkage. There are certain difficulties in the way of successful spraying of onions, like the glaucousness of the foliage which prevents spray mixtures from adhering, and the breaking down and tangling of the leaves between the rows just at the time when spraying should be done to be effective. A combination spray of bordeaux mixture (5-5-50), Black Leaf 40 ($\frac{3}{4}$ pint to 100 gallons) and soap (5 pounds to 100 gallons) seems promising, as it adheres well and seems to control onion mildew and thrips, both of which injure the onion foliage so the neck-rot fungus gains easier entrance.

Fumigation of the onions with formaldehyde gas before placing them in storage was tested quite thoroly but proved ineffective, since the gas did not reach the living fungus threads which were already in the necks of the onions and closely crowded between the bulb scales. Furthermore, the gas failed to penetrate thruout crates of onions because of the usual amount of loose, dry skins. Also, the gas injured the bulbs in some cases. The average onion storage house is not tight enough to retain the gas.

Control of the disease must come thru careful cultural methods and providing proper storage conditions. Since most of the infection takes place late in the season, especially when the crop is ripening and curing, all possible means should be used to have the onions mature and the tops die early. Fertilizers that stimulate excessive growth, including rich manure, should not be used too freely, and not at all late in the season. Seed stock should be carefully selected to avoid types of onions with thick, succulent necks ("bottlenecks") which are especially subject to attack. Air drainage should be

carefully looked after since poor air circulation promotes onion mildew and, indirectly, increases the liability to neck-rot. The growing of onions in fields surrounded by hills or by dense woods should be avoided if possible; and tall weeds along ditches should be removed. The more quickly the bulbs can be dried the less the danger of infection with neck-rot. Since bruises make entrance of the fungus easy, great care should be used in harvesting and topping not to cause such bruises. Short tops — 1 to 2 inches — are probably better than longer ones.

After thoro drying in the windrows the onions should be screened to remove excess soil, tops and other refuse matter, thus making it easier to dry the crop in the crates. The bulbs should be kept in the cribs or drying sheds as long as possible, and placed in storage, wherever it can be done, in slatted crates of standard size, stacking the filled crates with 1 x 3 inch binders between to make ventilation easier. Putting onions in large, loose piles induces sweating that aggravates neck-rot.

Good circulation of air in the storage houses must be provided if neck-rot is to be controlled. Such houses should have ventilators at both top and bottom that can be opened and closed at will; and the temperature should be held as close to 35° F. as possible. Also, the house should be kept closed during warm spells in winter, especially if damp; otherwise the moist outside air rushes in, the moisture condenses on the cold bulbs and makes them so wet that neck-rot rapidly develops if the fungus is present. If heating is necessary, it is best to use stoves or dry heat, as steam pipes, when not in use become covered with moisture or with frost, which evaporates as soon as steam is turned on and makes the house damp.

Houses with low, flat roofs and poor top and bottom ventilation should be avoided, if possible; and all houses should be made double thruout, using a good quality of lining for the walls. Concrete houses should have air spaces between double walls and should be sheeted inside. Roofs should be of sharp pitch, with ventilators at the very top, and floors of heavy narrow pieces with half-inch spaces between them, especially in cellars or basements.

The old, rotting bulbs should not be placed on fields where onions are to grow, as they are a proven source of infection for the new crop, nor should they even be left near onion fields. Sound, healthy "mother bulbs" should be selected for seed fields, and it is best to treat seed to destroy fungus germs by soaking it 20 to 30 minutes in a solution of 1 ounce of formalin in 2 to 3 gallons of water. This may prevent onion smut, is a helpful precaution where onion blight is liable to occur, and may be valuable in preventing neck-rot, altho not many spores of the neck-rot fungus were found on the seed examined. The prevention of onion blight or onion mildew by spraying will have a marked effect upon the neck-rot which follows when poorly-cured, soft, blighted stock is placed in storage.