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NECK ROT OF ONIONS

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NECK ROT OF ONIONS

By E. L. LeCLERG

The neck-rot disease has been present on onions in Colorado for a number of years, but has only been in evidence to a minor degree in shipments. At low market values it has not appeared as a serious factor. During the past season, however, the increased production in some sections occasionally resulted in the use of houses unadapted for storage. In addition to this there were periods of unfavorable weather in some sections which prevented proper curing before storage. The result was an unusual amount of neck rot on improperly cured and poorly stored onions. In some storage houses this loss amounted to 20 to 30 per cent.

Market conditions may govern the economy of control of storage rot, and at present a knowledge of the behavior of the disease seems to be of value. It is the purpose of this bulletin therefore, to describe and illustrate the chief cause of storage rot of onions in Colorado and to give the factors which favor the disease and to suggest conditions and practices that will reduce the neck rot disease.

Description of Neck-rot Disease

Neck rot is one of the most important diseases in onions. In the field this disease seldom causes damage, but considerable losses result in storage and transit

Diseased bulbs appear to be normal at harvest, but after 2 or 3 weeks in storage the first signs of the disease become manifest. At this time the neck becomes soft and discolored and slight pressure applied at the neck forces out a watery liquid The base of the neck generally becomes sunken and spongy. Decay rapidly breaks down the underlying tissues about the neck (Fig. 1). Another symptom of the disease sometimes manifest is a brownish-black, surface growth of the mold. Many bulbs in this section show this symptom (Fig. 2).

The mold can gain entrance into the onions thru surface wounds and rapidly progress thruout the scales of the bulb. Infection, however, generally takes place thru the neck, but can gain entrance thru bruises or cuts in the outer scales. No doubt the severe hails during the past year made infection possible in most instances by producing bruised areas thru which the mold entered.

After the disease gets a start, the succulent tissue is rapidly broken down, giving the bulbs a water-soaked appearance. The diseased tissue is brown in color. In most instances the outer three or five scales are affected (Fig. 3), but occasionally the middle scales or heart are attacked (Fig. 4). This latter condition is, however, the least common. Sometimes the effects of the disease are not manifest

in the entire onion. The killing of the tissue is usually in advance of the fungus which accounts for the rapid appearance of the affected tissues. Figure 5 shows such a bulb which is only partially affected.

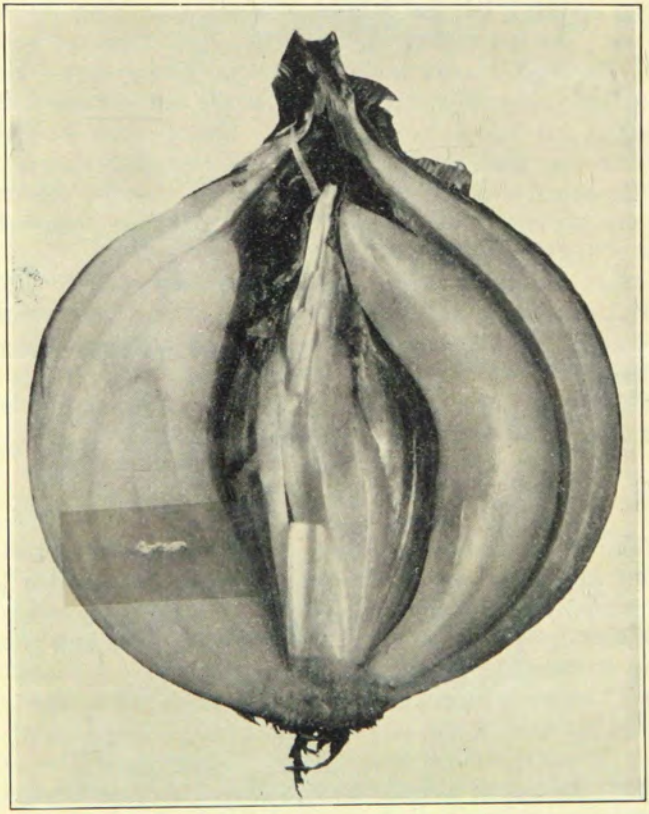

Fig. 1.—Longitudinal section of diseased onion showing decayed tissue at neck which causes it to become sunken and spongy.

Cause of Neck Rot

Neck rot in this section is caused by a fungus or mold known as *Botrytis allii.* This organism lives in the soil on trash and organic matter. At time of harvest the organism gains entrance thru the cut neck of the onion or thru cuts or bruises. Hail injury furnishes a ready means of entrance.

The body of the organism as characteristic of fungi, consists of a mass of fine, white, thread-like cells that extend into all parts of the oinon tissue, thus rotting and destroying the bulb. As the season advances and the spread of the fungus in the onion increases, enormous

quantities of spores are produced on the outer scale. These spores are the "seeds" of the fungus. They form in patches, often covering the entire bulb giving it a greyish appearance (Fig. 6).

Examination of a number of storage houses last year showed that the production of spores does not appear to any great extent until late in the storage period. The spores are very small and light and can readily be shaken off and blown from place to place. The disease in this way can be spread from trash in the soil to onions in the field or from crate to crate in storage. Dirt and trash in storage houses may contain spores which are a source of infection.

Black, hard bodies, known as sclerotia, are generally produced at the neck of the bulb. This is one way that the fungus lives over winter and causes infection of the succeeding crop.

It has been demonstrated that the white varieties are most susceptible to neck rot. Investigations have shown that the disease seldom gains entrance into the colored varieties, which is due to the presence of a toxin in the dry outer scales of these varieties. This toxin prohibits the entrance of the fungus into the yellow and red onions. Under the most favorable conditions for infection, however, the disease becomes of consequence even in the colored varieties.

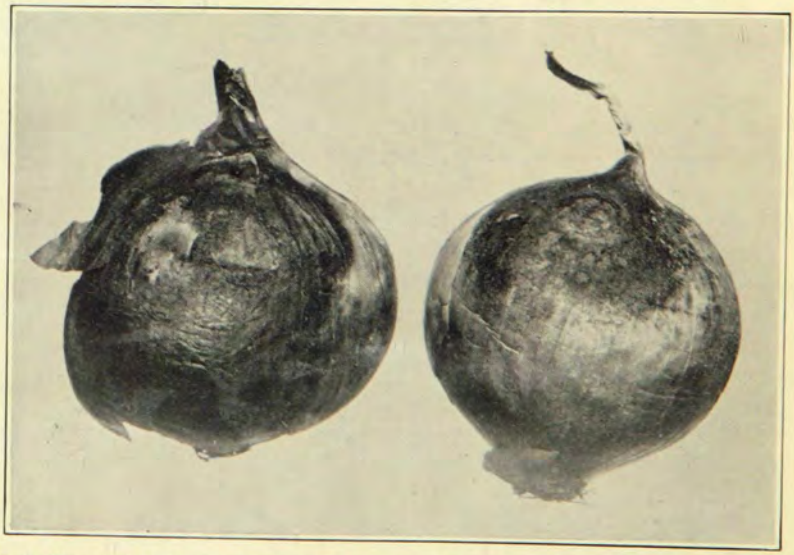

Fig. 2—Diseased onions showing discoloration of the surface of the bulbs. In the center of these dark areas are dark masses of the mold growing on the surface.

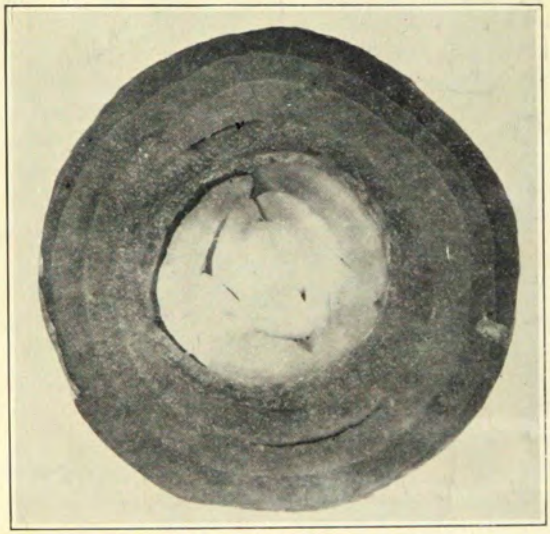

Fig. 3—Cross section of diseased onion showing darkened diseased region limited to the outer scales.

Prevalence of Neck Rot

During the past season neck rot became a serious factor in some of the onion-growing sections of the state. In the field the disease was not much in evidence, but after storage neck rot showed marked development. This appeared to be due to wet weather at time of harvest which prevented proper drying of the onions before storage. In some instances 20 to 30 percent of the crop was lost from the disease.

Altho neck rot attracted especial notice last season in storage, the disease has been present in the state for some time and has been increasing from year to year in prevalence. Car-inspection reports made at terminal destination and issued by the United States Department of Agriculture give some indication of the prevalence of onion neck rot in the state.

In the following table is given a summary of the car-inspection reports for the past 3 years showing the number of cars of onions shipped from Colorado containing neck rot.

Table 1. Amount of Neck Rot in Car Shipments From Colorado

Year	No. cars inspected	Cars containing neck rot	Cars containing less than 1 percent neck rot	Ave. percent loss from neck rot
	Western Slope district			
1926	41	24	15	8
1927	67	38	21	3
1928	24	19	3	14
	Greeley-Brighton district			
1926	13	6	1	7
1927	3	3	0	1
1928	3	3	0	7
	Denver district			
1926	6	6	6	5
1927	9	7	2	14
1928	5	4	0	8
	Entire State			
1926	60	33	22	7
1927	81	51	23	6
1928	36	30	3	12

It may be noted in Table 1 that of the 36 carloads of onions shipped from the state in 1928 which were inspected, 30 cars had neck rot in them and all but 3 of these cars had more than 1 percent loss from this disease. The loss, it will be seen, varied in different years and was greatest in 1928 when the cars containing infected bulbs averaged 12 percent loss from neck rot. The figures also indicate that neck rot has increased during the past 3 years, with heaviest losses from the western part of the state.

While an average of 12 percent loss may not be high as compared to losses sometimes occurring in other onion-growing sections, yet it is perhaps more than should result under our dry atmosphere, which normally is not conducive to the mold. Market conditions some years may magnify this loss in shipment. Proper curing, sorting and storage would greatly reduce shipping losses.

Factors Favoring the Development of Neck Rot

In the Field.—Neck rot seldom causes damage in the field and its appearance is sporadic, depending upon climatic conditions. Damp, cool weather during the growing season is most favorable to the development and spread of neck rot. It is during this kind of weather that the development of the fungus progresses rapidly on trash and organic matter in the soil. Such climatic conditions also delay the maturity of the onions which results in the production of more succulent plants. These plants are slower to dry, especially at the neck where neck-rot fungus from the soil readily causes infection. Hot, dry weather conditions, on the other hand, are unfavorable to the development of the disease during the growing season and render the onions more resistant to infection.

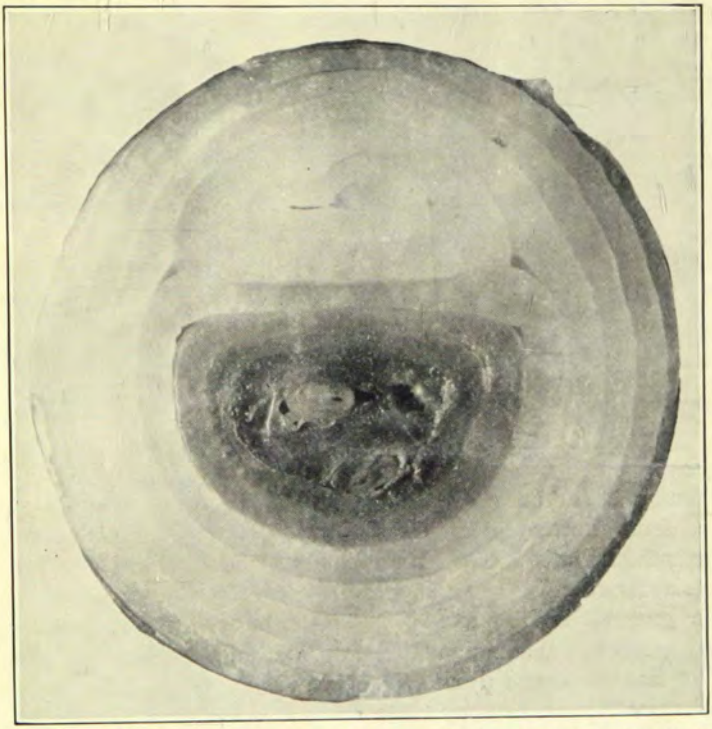

Fig. 4.—Cross section of diseased onion showing disease limited to inner scales or heart.

In Storage.—Storage conditions are the most important of the various factors which affect the development of neck rot. High temperature, humidity and poor ventilation in storage favor the development of this disease.

Immature bulbs are succulent and high in water content. They produce humid conditions in the house which are not favorable for carrying a crop safely thru the storage period. High humidity can be avoided to a certain degree by storing only well-matured, firm and dry onions.

High temperature causes a rapid loss of water from the bulbs, especially from immature onions, resulting in a marked rise in the humidity of the storage house. This condition favors the growth of the neck-rot mold and results in an increase in the amount of decay.

Ventilation is of primary importance in the storage of onions and checking of neck rot. If ventilation is not properly practiced the air soon becomes warm and high in humidity. As stated above, these conditions all favor the rapid spread and growth of the neck-rot fungus. Houses should be held as nearly as possible at a temperature of

34 to 36 degrees Fahrenheit. If the weather permits, they should be opened at noon or early afternoon for at this time the air is drier and ventilation takes place more readily. Since all the onions are stored in crates (Fig. 10), it is advisable to leave a space of about 8 to 12 inches between the crates and the walls of the storage house. Also a space should be left between crates about every 5 or 6 tiers. This practice will insure good cross circulation of air when ventilating and aid materially in keeping the crop thruout the storage season.

Conditions of Onions.—The condition of the bulbs at harvest has a very important bearing upon the prevalence of neck rot which may later appear in storage. It has been demonstrated that bulbs with green tops are very susceptible to neck-rot infection. Growers should not pull the onions until the tops are thoroly ripened and begin to shrivel. This is in accordance with the results obtained in eastern states.

The practice in some sections of Colorado has been to store the crop as field-run, especially when threatening weather hastens harvest. This results in a large quantity of scallions, doubles, splits and onions high in moisture content being stored with good bulbs. Most often it is these undesirable onions that show signs of neck rot. In order to eliminate the unfavorable conditions caused by these objectionable bulbs, the practice of grading before storing should be adopted.

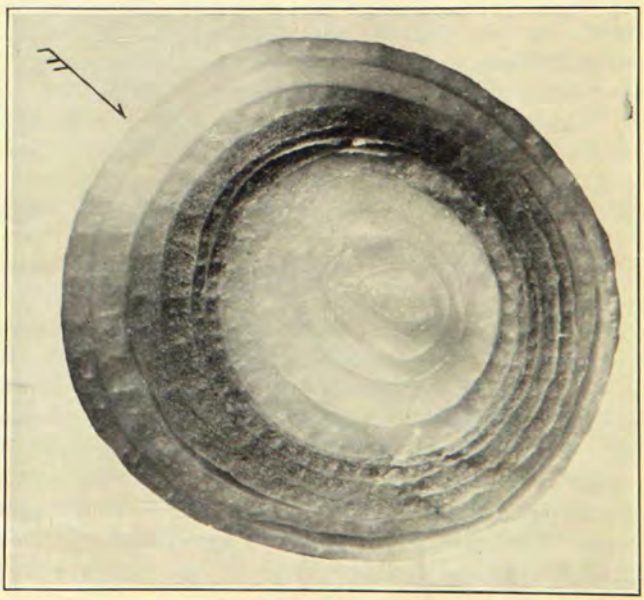

Fig. 5.—Diseased onion showing where disease has not become entirely distributed thruout the bulb. Arrow indicates area of outer unaffected tissue.

Fig. 6.—Diseased onion in final stage of decay and covered with a thick mass of loose grey spores of the neck-rot fungus.

scallions, doubles, splits and onions high in moisture content being stored with good bulbs. Most often it is these undesirable onions that show signs of neck rot. In order to eliminate the unfavorable conditions caused by these objectionable bulbs, the practice of grading before storing should be adopted.

Onions should be dry before storing. It very often happens, however, that the onion harvest coincides with a period of rainy weather, so that it is difficult to thoroly dry the bulbs before storing. In the East where the onions cannot be thoroly dried in the field, growers have resorted to a method of artificial drying. This plan consists of (a) exposing the onions to a high temperature, (b) exposing them to forced air currents, or (c) a combination of both methods.

It has been the experience of many growers in Colorado, that the percentage of bulbs infected was doubled when the neck tissue was still succulent at the time of harvest as compared with those in which the tops were dry. One grower lost between 15 and 20 percent of his crop in storage because he pulled and cut his onions when the tops were still green.

The succulent neck forms an excellent place for the neck-rot fungus to enter the bulb and begin to cause damage after the onions have been in storage 2 to 3 weeks. A thoro drying of the neck is, therefore, very essential during the first few weeks of the storage period.

Humidity.—It is a known fact that the humidity of the atmosphere in Colorado is considerably lower than in the eastern part of the

United States. From this it would appear that conditions are much better in this state for natural drying of onions before storage than in the onion sections of the eastern states, if it were not for the rain that sometimes occurs during harvest in some of the onions sections.

High humidity is very detrimental to onions in storage and favors the growth and spread of neck rot.

A survey of the government weather records for the past 3 years is given in Table 2. This table shows the average humidity thruout the storage season taken in morning, at noon and in the evening.

Table 2. Average Humidity During Months of Storage (1925-1928)

Section	Month	Humidity (percentage) 6 a. m.	Noon	6 p. m.
Pueblo:	January	70.5	44.2	49.5
	February	64.2	33.2	37.2
	October	64.7	35.5	38.2
	November	65.7	37.5	46.0
	December	70.7	48.0	56.0
Grand Junction:	January	83.0	69.2	62.0
	February	76.5	48.2	49.2
	October	63.5	35.5	38.5
	November	74.5	47.7	52.0
	December	82.0	58.0	62.5
Denver:	January	62.2	44.0	51.7
	February	60.5	38.7	46.2
	October	67.7	41.5	45.7
	November	61.0	42.0	49.5
	December	65.7	49.5	61.7

From the figures given in the above table it may be seen that humidity is lowest at noon. At this time or shortly after, the air is driest and storage houses should be opened for ventilation. Ventilation at this time would insure the supplanting of the moisture-laden air in the house with drier air from outside.

Conditions Affecting Neck Rot in Transit

A careful study of the car-inspection reports showed that heavy losses due to onion neck rot resulted where (1) the percentage of sprouts was high; (2) root development was present; (3) bulbs were improperly cured; (4) bulbs had been frozen in transit; (5) percentage of doubles and splits was high, and (6) sacks were damp.

The early shipments were found to be free from sprouts and root development, but this condition appeared about the middle of January and reached the peak during the month of February. Sprouts and root development are very favorable to neck rot since they result in the exposure of succulent tissue and raise the humidity of the atmosphere.

Bulbs frozen in transit generally showed considerable neck rot and an abundance of soft rot when examined at points of destination.

Freezing causes a breakdown of the tissues of the bulb which readily become attacked by disease-producing organisms and often by saprophytic organisms.

Cars containing bulbs that were firm, dry and well matured, almost without exception, were found to have less than 1 percent neck rot. Onions shipped in sacks that had become damp during the transit, due to faulty ice boxes or roofs generally were covered with a surface growth of the fungus in varying amounts regardless of how dry and firm the bulbs were when packed..

Doubles, like sprouts and new root growth, raise the humidity of the atmosphere. This high humidity brings about ideal conditions for the growth of the neck-rot fungus. Splits are very susceptible to invasion of this fungus since the more tender tissues of the bulbs are exposed and this forms ideal places for infection.

Infection in transit was in most instances limited to the three outer scales of the bulbs. Complete breakdown of the bulbs was not uncommon, especially after a long time enroute and under poor conditions of packing.

The data in Table 3 tends to show that the early shipments are most liable to become seriously infected with neck rot. This is undoubtedly due to the earlier packing which gives less opportunity for curing and sorting out diseased bulbs. In the early part of the storage period it is difficult to pick out affected bulbs since the incipient infections have not had time to develop sufficiently before shipping. The sudden increase in neck rot during March is probably due to the large amount of sprouts and roots that begin to develop at this time.

Table 3. Percentage of Neck Rot in Shipments from Colorado each Month During the Shipping Season in 1926-1928 Inclusive.

Month	Percentage of Neck Rot
1926	
August	17
September	49
October	6
November	2
December	3
1927	
January	4
February	18
March	5
October	2
November	8
December	6
1928	
January	5
February	26
March	7

Storage Conditions in Various Types of Houses

A survey of 16 storage houses made during the first part of January, 1929, showed that some of the houses used by growers for onion storage were entirely unsuited for this purpose.

In one instance, onions were stored in a large hollow-tile building which had a metal ceiling, only a few small windows and two doors at each end. It was almost impossible to properly ventilate such a house with the few windows available. Due to the poor air conditions inside, the metal ceiling dripped with water of condensation. This meant that the air was exceptionally high in humidity and the temperature was not as low as it should have been, due to the impossibility of being able to change the air properly. Losses in this house ran as high as 30 to 40 percent for some lots of onions.

Several growers used open-front chicken houses. It is doubtful if these make good storage houses since the ceilings are so low and the crates are piled up to within a foot or so of the top. Warm, damp air collects near the ceiling and the top layers of crates are always in improper atmospheric conditions. The temperature is very hard to regulate in such a house and bulbs are very apt to become frozen.

A number of the houses visited were adobe (Figs. 7 and 8) with 12 to 18-inch walls and pitched roofs. In all but one house a ceiling was present and the floors were used for the making of crates, etc. Such construction does not furnish good ventilation, especially as these houses had no ventilators thru the roofs. When filled with crates of onions it is almost impossible to change the dead air between the ceiling and crates, and warm moist conditions result that favor development of neck rot.

One large house (Fig. 9) was found to be an ideal place for storage of onions. It was 135 feet square with two pitched roofs, thru which projected 56 air ducts or ventilators. The walls were 30 inches thick and of a double tier of adobe bricks with a 6-inch air space between. The temperature was easily maintained at 36-27 degrees F. and the doors were opened every day regardless of the temperature outside. No heat was necessary to maintain this temperature. The onions were exceptionally free from disease and the small amount of disease that was present was limited to the culls and scallions. The onions stored in this house were dry before being pulled and were left in the field 7 to 10 days before storing.

While as large a house as just mentioned could not be built by the average grower, yet the principles could be applied to a small building. Such features as the double walls, high ceiling and ventilators in the roof are things that can be used in the smaller houses to make it easier to maintain proper storage conditions.

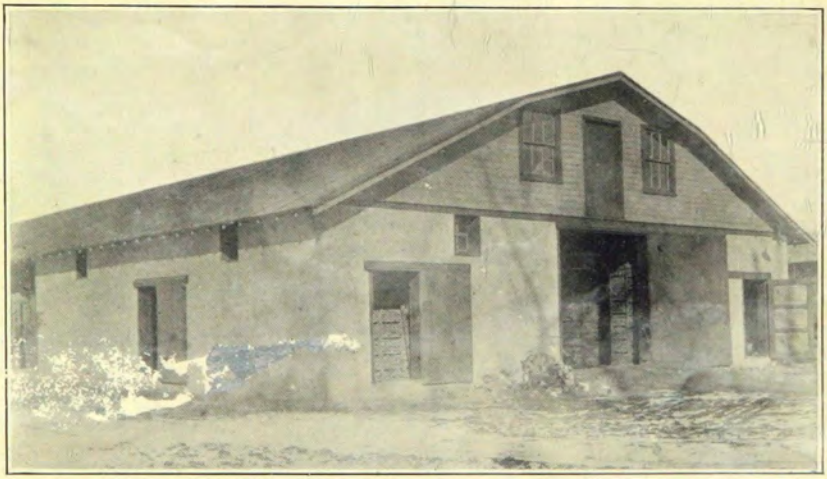

Fig. 7.—Adobe house used for storage of onions. There are no ventilators in the roof and conditions are not as good in this type as in houses with ventilators.

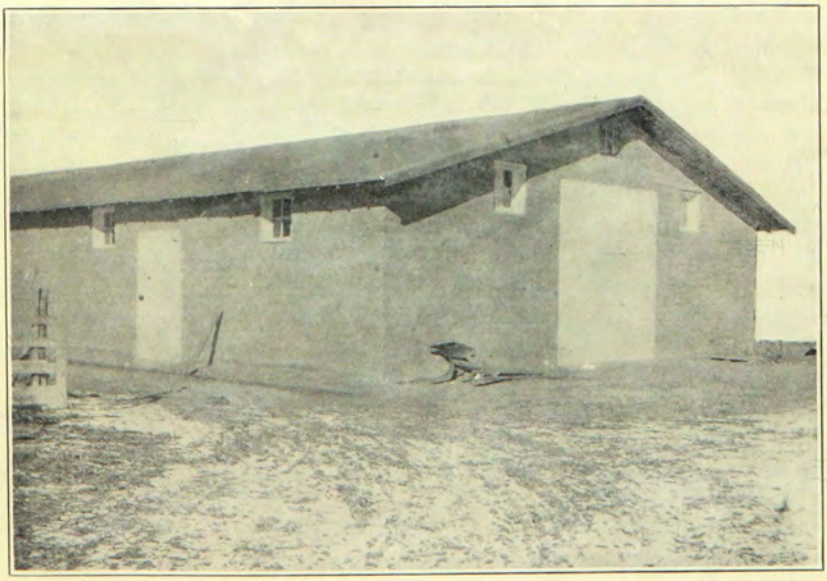

Fig. 8.—Adobe house used for storage of onions. The outside of this house has not been covered with cement.

Fig. 9.—A double-walled adobe storage house with air space between walls and ventilators in roof. This house was successfully used for onion storage.

Recommendations for Control of Neck Rot

In keeping down neck rot it must be remembered that this disease is caused by a mold or fungus that lives from year to year in the soil. The fungus spreads by spores, microscopic cells, that are the seeds of the mold. These spores germinate and grow in wet places such as the moist tops or necks of freshly cut onions. If the necks do not dry out quickly the mold grows down into the onion bulb. Proper drying before storage hinders the growth of the neck-rot mold. Onions should be dried a week to 10 days in the field before storage, if weather is favorable.

Split onions, scallions, doubles are more easily attacked by the mold because they contain more water. In storage the bulbs which contain considerable water are more subject to rot and also raise the humidity in the storage house. Sorting before storage will remove these susceptible bulbs and cut down neck-rot infection.

The neck-rot mold grows best in moist humid conditions. Storage houses should therefore be opened during the drier part of the day to get rid of the moist air arising from the onions. Storage houses should be well supplied with doors and with ventilators in roofs in order to get rid of the damp air.

The neck-rot mold grows best under warm conditions while at the lower temperatures of 34 to 36 degrees F. the growth of the organism is checked. Storage houses should be kept as near these temperatures

as possible to avoid neck-rot and care should be aken in opening houses on warm days so that the temperature inside the house does not rise too much.

When grading, diseased onions should be removed and not left stacked in some corner of the storage house. Such onions offer a source of infection for healthy bulbs and under conditions of high humidity and temperature may result in serious losses in storage or in transit.

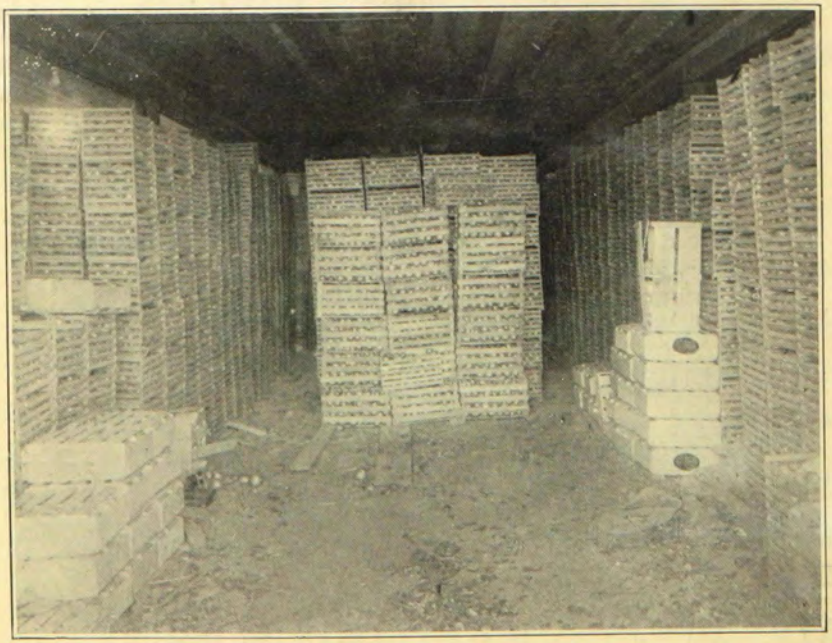

Fig. 10.—Interior view of storage house showing how onions are stored in crates.