Circular No. 473-A
American Railway Perishable Freight Association

THE PLANT DISEASES OF IMPORTANCE IN THE TRANSPORTATION OF FRUITS AND VEGETABLES

By
G. H. Coons, Ph. D., and Ray Nelson, B. S.
Plant Pathologists

FIRST EDITION

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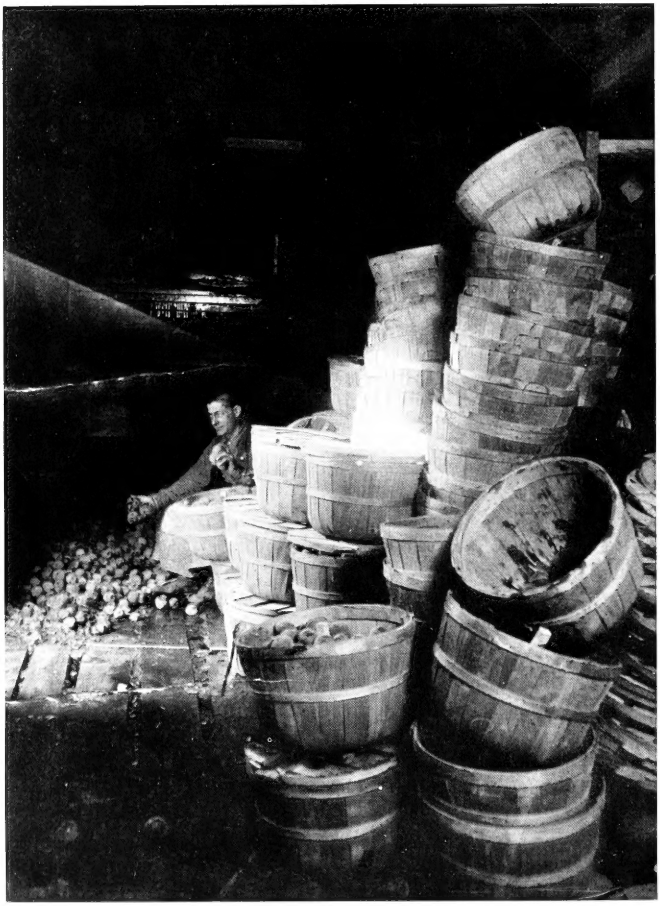

Fig. 1. The empty baskets show the shrinkage in a car of peaches caused by the Brown Rot. The purpose of this bulletin is to teach how to avoid such wanton waste.

THE PLANT DISEASES OF IMPORTANCE IN THE TRANSPORTATION OF FRUITS AND VEGETABLES[1]

PART I. THE RELATION OF PLANT DISEASES TO TRANSPORTATION

THE PURPOSE OF THIS BULLETIN

This bulletin, which is, of course, subject to revision and amplification, has been prepared for a triple purpose.

This bulletin is a handbook of plant diseases important in transportation. It seeks first to give access to the facts of those plant diseases which are factors in the commercial handling of fruits and vegetables. It aims to be a brief guide for the grower, and to teach by simple statement and by pictures the diseases important in the produce business. The identification of many of these diseases is a matter for the expert plant pathologist, but the trade in general which has either been ignoring the diseases or lumping them all as rot, black rot, or soft rot, must, if it is to be efficient, master the characteristics of the diseases and understand their causes.

The control of disease is important. Where possible the control measure is indicated for certain plant diseases. The grower must learn to control the parasitic fungi and bacteria because they are thieves which steal his profits. The commission man, the man in the market, and the railroad employee must know and preach the control of these diseases because indifference in this regard means loss to the farmer. The success of the farmer is vital to the success of the produce business and to the success of the railroad business.

The literature of plant diseases. The facts of plant pathology which can be turned to direct use and profit in this regard are numerous. This presentation is purposely brief. Instead of attempting to cover all points it seeks merely to make available the books and bulletins on the subject.[2] It is up to all concerned to study the details of the produce business.

Claims. In the second place this bulletin seeks to present facts that will enable a fairer adjustment of claims. If a fruit or vegetable is diseased when it starts it never gets better in transit. If a railroad mishandles a shipment it must expect to pay the bill. Each case presents its own peculiarities. The grower and railroad must have a common basis of understanding and must use the same terminology if cases are to be settled on their merits.

The public is concerned. In the third place, regardless of the party to blame, the great body of consumers is ultimately paying for the present wanton loss of food stuffs. The city never has enough good fruits or good vegetables. The sound fruit must pay for the imperfect fruit, the healthy, crispy vegetable must pay for the soft-rotted one which yields no return to the farmer and is a bill of expense to the railroad. The improper handling of perishables is a game in which everybody loses. This bulletin seeks to benefit the general public by focusing attention on the present needless wastes, and to make a start toward their elimination by indicating the role which plant disease plays.

THE CAUSES OF PLANT DISEASE

The causes of plant disease such as concern us in this bulletin are chiefly parasitic fungi and bacteria.

Plant Diseases Caused by Fungi:

A fungus is a mold. A parasitic fungus is a microscopic plant which makes no food for itself, but which steals its living from another plant, called its host. The body of the fungus-parasite consists of minute threads which grow either upon or through the tissues of the host and thus secure food. Fungi spread by means of small seed-like bodies called spores, which are commonly produced in enormous numbers, and which are blown or washed about, thus insuring the dispersal of the parasite.

BIBLIOGRAPHY

(Prepared for railroad man or market man as well as for grower)

The bibliographies given do not pretend to be a complete list of all valuable or available bulletins. They seek rather to serve as a guide to enable anyone interested to get in touch with the important transportational disease problems. The books of the working library should be available at the offices of all who are actively engaged in transportational work. For a small expenditure a fairly complete set of handbooks is thus available.

As complete a set of these bulletins and books, as possible to obtain, has been assembled at the office of the American Railway Perishable Freight Association and these are available for loan to members of the Association. All the literature mentioned in this bulletin may be obtained at the larger scientific libraries, such as those connected with universities, the John Crerar Library, etc. The bulletins still available at the experiment stations and Farmers' bulletins are marked with a *. Government bulletins with a price quoted may be obtained from the Superintendent of Documents at Washington upon receipt of cost price. (Stamps not accepted.)

The life story of a typical fungus. Many of the fungi causing plant diseases of importance in shipments have a type of life story similar to that of apple scab. The apple scab fungus lives over winter on the fallen leaves

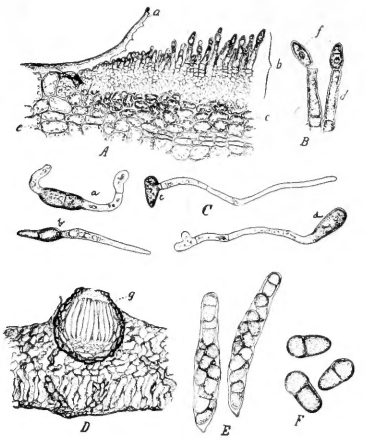

Fig. 2. Apple Scab *(Venturia inaequalis)*. Microscopic structure of the scab fungus. Section through a scab spot on an apple showing the fungus (b) spreading under and lifting the cuticle (a) from the partly disorganized cells of the apple (c); healthy cells of the apple; B, two spore-bearing stalks giving rise to summer spores (conidia) (f); C, spores germinating; D, portion of section through an affected leaf of apple which has lain on the ground over winter and has given rise to the winter spore stage of the disease, (g) spore case (perithecium) containing a bundle of spore sacs (asci); E, two spore sacs (asci), more highly magnified, each containing eight two-celled winter spores three of which are shown at F. All highly magnified. (After Longyear.)

of the apple. About blossoming time, the sexual or "winter" stage of the fungus (Fig. 2D) matures its spores (Fig. 2F), which under moist conditions are popped from the sac-like structures in which they are formed (Fig. 2E). Some of these spores, blown about by minute air currents, reach the unfolding apple leaves and lodge there. These spores, if given several hours of proper conditions of temperature and moisture, such as come with warm rains of considerable duration, sprout (Fig. 2C) and bore into the apple leaf. In about a week or two the fungus will have grown so that a noticeable spot is formed at the site of infection. Soon a crop of spores is produced giving the scab spot an olive-green appearance. (Fig. 2A.) These spores are the asexual or "summer" spores. (Fig. 2B.) They mature rapidly and are blown about the orchard. At rainy periods, spores, lodging on leaves or young fruits, infect them and soon produce spots with another crop of spores. Over and over again the process of infection and spore formation takes place, leading, unless control measures are adopted, to severe injury to leaves and a blemishing of the fruit.

The life stages show many variations. Other types of life history are known, as well as other methods of infection, but in the majority of fungi there is formed a sexual stage which carries the organism over winter; and an asexual stage, which repeated over and over in the summer, spreads the fungus throughout the field or orchard. The study and interpretation of the life histories of parasitic fungi and the devising of appropriate control measures is a part of the science of Plant Pathology.

Plant Diseases Caused by Bacteria:

Bacteria. Bacteria are microscopic plants, each consisting of a single cell, commonly in the form of a small rod or sphere. Bacteria reproduce by simple cutting in two.

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[1]GENERAL WORKS TO OUTLINE THE SCOPE OF THE SUBJECT

Of use to executives, lawyers, and those who wish to see transportational disease problems in their entirety

CORBETT, L. C., 1912. A successful method of marketing vegetable products. Dept. of Agr. Yearbook, 1912: 353-362. No sep. $1.00. A plea for standardization of grade and pack as well as co-operation among shippers.

POWELL, G. H., 1905. The handling of fruit for transportation. Dept. of Agr. Yearbook, 1905: 349-362. No sep. $1.00. Discusses decays of various fruits resulting from improper treatment before transportation; also gives a discussion of various fungous diseases.

STEVENS, F. L., 1915. Some problems of plant pathology in reference to transportation. Phytopathology 5: 108-112. Reprinted with author's permission as Circular 473 of Amer. Ry. Perishable Freight Association.

STUBENRAUCH, A. V., 1909. The handling of deciduous fruits on the Pacific coast. Dept. of Agr. Yearbook, 1909: 365-374. No sep. $1.00. "Sound fruit of good quality, honestly and uniformly graded and packed, is the fundamental factor upon which success of the business depends." Pages 372-374 deals with refrigeration and precooling.

WEED, L. D. H., 1916. The marketing of farm products. MacMillan Co.

[2]WORKING LIBRARY OF PLANT PATHOLOGY

STEVENS, F. L. and HALL, J. G., 1910. Diseases of Economic Plants. MacMillan Co., $2.00. Very useful work by competent authorities. Non-technical. Written from the viewpoint of the grower or field worker. Subject matter arranged under host plants, which are grouped so that related crops come together.

STEVENS, F. L., 1913. The Fungi Which Cause Plant Disease. MacMillan Co., $4.00. Companion volume to preceding, but written for student or technically trained man. Illustrated to show microscopic characters of the genera of fungi, extensive citations of authorities.

DUGGAR, B. M., 1909. The Fungous Diseases of Plants. Ginn and Co., $2.00. A textbook of plant diseases. More technical than Stevens and Hall but containing much information of value to practical grower or shipper. A list of the diseases found upon each host plant makes the subject matter readily available.

COOK, M. T., 1913. The Diseases of Tropical Plants. MacMillan Co., $2.75. Non-technical. Excellent discussion of tropical diseases from the standpoint of the grower.

BANCROFT, K., 1910. Handbook of the Fungous Diseases of West Indian Plants.

HESLER, L. R., and WHETZEL, H. H., 1917. Manual of Fruit Diseases. MacMillan Co., $2.00. Admirable presentation of facts of fruit (other than tropical) diseases from point of view of fruit grower. Complete discussion with well chosen bibliography.

MARSHALL, C. E., 1916. Microbiology. Blakiston, $3.00. Textbook of applied bacteriology. Besides covering field of general bacteriology, this book discusses the general problems of hygiene and sanitation. One section by W. G. Sackett is devoted to bacterial diseases of plants.

SMITH, E. F., 1905. Bacteria in Relation to Plant Diseases. Carnegie Publ. 27, $4.00 per volume. Three volumes have appeared. Monograph of bacterial plant diseases.

This process takes place in a very short period when conditions for growth are favorable. In 24 hours from a single germ there may arise millions of germs. Some of the kinds of bacteria are able to attack living plants and take from them food materials. In such a group the parasitic bacteria fall. They produce diseases of plants comparable to tuberculosis or typhoid in the higher animals, but of course, it should be understood that the bacterial parasites of plants are not the cause of animal diseases.

The life story of a parasitic bacterium. The life story of a bacterial parasite is simple. The bacteria are washed or carried to the host plant (by insects, etc.) and enter the host commonly through wounds or at the so-called "breathing pores" of the leaves. As the ultimate result of their rapid growth in a favorable site they cause spotting, rotting, or interference with the plant's functioning. They may dissolve the cementing material of the host, thus causing soft rot, kill the tissues outright, cause excessive growth or plug the water channels, etc.

The types of disease produced, the points of attack, and the effects under various conditions, determine the control measures which are effective.

A disease is a battle. The plant disease caused either by fungi or bacteria is the struggle between the cells of the host plant and an invader, the parasite. The marks of battle may be mere blemishes, or they may be so severe that the plant is worthless. The science of Plant Pathology classifies the various forms of disease, determines their cause, and seeks to find practical control measures.

The Control of Plant Disease

The control of a plant disease is ordinarily based upon our knowledge of the life history of the parasite. Each disease is a separate problem and for each crop a set of control recommendations must be formulated.

In general, plant disease control measures (aside from exclusion or quarantine measures) fall under three heads, namely:

1. Sanitation and Hygienic Measures.
2. Plant Protection Measures.
3. Use of Resistant or Disease-escaping Varieties.

Sanitary Measures. The first group of control measures recognizes that clean seed in clean ground tends to produce a clean crop. Clean seed may be such as comes from areas or fields free from disease; or it may be seed that is freed from contamination by some form of seed treatment. Soil may in many cases be freed from infestation by a proper rotation, by destruction of trash from the preceding crop, etc. It may be ground which is freed from its infestation by actual soil treatments—for example, it may be disinfected with formaldehyde, steamed as is commonly done in greenhouses, or treated with lime, as for cabbage club root.

Get rid of the source of infection. In all of these measures the attempt is made to get rid of the source of infection. Trash, infested seed, diseased plants are to be so treated as to remove the points of danger. Certain insects are known as carriers of infectious material or they may open the way for infection. As a hygienic measure insect pests must be controlled.

The means of control of plant diseases included in this group, are many and they are available to every grower at slight expense. They merely require vigilance and care in the growing of the crop.

Spraying. Under the head of Plant Protection is included the covering of plant parts with a protecting, germicidal coat which prevents the entrance of the parasite into the host. Spraying operations seek to protect the growing plant by repeated applications so that the parasites cannot get in to do damage. A leaf or fruit once sprayed is probably protected throughout the season so far as the spray material reaches, but as new leaves unfold or the fruit grows, new tender surfaces are produced which must be covered. The spray material must "get there first," not only in the case of the particular leaf or fruit, but as a seasonal practice. Spraying must begin early in the season to prevent the establishment of centers of infection.

The spray mixture. Bordeaux mixture (Fig. 3) has the widest range of applicability. Conditions of various fruits, the parasite to be handled, weather conditions, etc., determine the spray to be used. For example, with certain plants, apples in the northern states, and plums and cherries, lime-sulphur preparations are to be used. For the peach, self-boiled lime-sulphur or some other weak sulphur and lime compound is recommended. In California, sulphur dust is used on grapes, while in the New York and Michigan grape districts Bordeaux is the only spray mixture that is successful. Dusting of apples for scab and codling moth in New York State with mixed sulphur dust and arsenicals has recently come into prominence. Spraying is undoubtedly our best and most efficient remedy for many fruit and vegetable diseases, but it must be used to supplement sanitary and hygienic measures.

The best control measure. By the use of resistant or disease-escaping varieties, the easiest and best control of plant diseases will come. Several notable advances have been made which clearly demonstrate that the hope of the

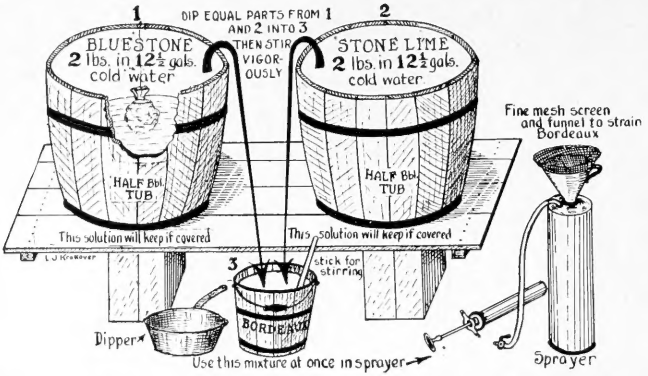

Fig. 3. Making Bordeaux mixture for small acreages. Good Bordeaux is easy to make if these directions are followed. Note.—Where much Bordeaux is needed, use method of making a strong stock solution by dissolving 25 pounds of Bluestone in 25 gallons of water. Make a milk of lime using 25 pounds of stone lime to 25 gallons of water. These stocks will keep. Then one gallon of stock carries one pound of Bluestone (or one pound of lime). To make 100 gallons of spray, dilute eight gallons of stock Bluestone to 50 gallons, and eight gallons of stock lime to 50 gallons and pour together. Bordeaux may be tested to determine if enough lime is present by means of blue litmus paper. If blue litmus turns red, add more lime. With good lime, using the amounts given, no test is needed.

future in the elimination of losses will come from this type of endeavor. The "yellows"-resistant cabbage selected in Wisconsin, the resistant watermelons bred by Orton, the "rust"-resistant cantaloupes developed by Blinn and the disease-escaping beans advocated by the Michigan Station point the way for effort by pathologists and plant breeders.

The control of plant diseases and insect pests is the great problem in American agriculture. We must not expect to increase production by phenomenal increases in yields from new varieties or new cultural practices. The great gains are rather to come from a greater conservation of the crop we already produce.

The Causes of Decay in Shipments

The packing of infected produce. Fruits and vegetables decay in shipment due to the activity of fungi and bacteria. Some of these fungi and bacteria are the parasites which are capable of causing disease in the field. In many cases, partially decayed fruit or vegetables are packed. These are cases of incipient disease. Some fungi which appear only as a cause of blemishes in the field, are sometimes found under the conditions of shipment to increase enormously or to open the way for severe rotting. In many cases the decay in the car is merely the outcome of a latent infection which started in the field. Such fruits and vegetables are diseased when loaded in the car and they never improve. Rotting fruits and vegetables are notorious in bringing about conditions which promote infection of neighboring plants and in furnishing the inoculating material as well.

Infection within the car. Again, infection may take place in the car as a result of the conditions there presented, and although this decay arises from the same fungi as cause disease in the field, and although the spores lodged upon the fruit or vegetables in the orchard or field, such a case must be carefully distinguished from the types of infection previously mentioned.

Bruising, and rough handling. The most prolific cause of decay in shipments is the group of weakly parasitic forms which are completely excluded by the unbroken skin of the plant, but which quickly cause rot when once the skin is broken or bruised. To this group of decay-producers the great bulk of losses may be attributed. Rough, careless handling either in picking or packing, or by the carrier is, therefore, responsible for the large percentage of our losses.

The breaking down of natural resistance due to car conditions. There is still another class of decay-producing organisms. These are fungi and bacteria which are not parasites at all; such organisms when inoculated into the healthy living fruits or vegetables do not produce disease. Yet such organisms in many shipments bring about, more rapidly than is normal, what is called "inherent decay." All are familiar with the fact that apples will keep well in the cellar until late winter. The fruit becomes more and more mellow. Then comes a period when the fruit rapidly decays—molds attack through the sound skin, and around the stem end. It would seem that a certain maturity was reached and the cells began to lose their tone, perhaps to die. The native resistance dis-

appears and the fruit decays rapidly. In this illustration we have a parallel to what is frequently seen in shipments. Due to conditions in the car, period on the road, or age of the plants when shipped, etc., the resistance of the host suddenly breaks down and the car becomes a mass of rotted produce. Such a breakdown starts with the older leaves on the older parts of the product. These decay first and quickly involve the remaining parts. It is evident that we have to do here with the physiology of plants under storage conditions. The problem of keeping fruit or vegetables so that they will put off the condition of "inherent decay" is more than a mere problem of refrigeration. The presence of some rotting vegetation in the car has its effect on the carbon dioxide relation and upon the humidity relation and these factors must not be neglected. It must be confessed that in but few instances[3] has plant physiology given us the data on which to determine the optimum conditions for storage. The inauguration of studies along this line will open an almost untouched field and we may expect great advances in our knowledge and in our practices when plant physiology turns attention to this important line of endeavor.

The Problem of the Elimination of Waste in Shipments

Find the cause. The elimination of wastes in shipments depends fundamentally upon the discovery of the causes of the losses. In the preceding section several groupings were made of the causal factors. With the discovery of the cause of loss usually comes the fixing of responsibility.

Prevent claims instead of fighting them. The fixing of responsibility should not end the matter. It is often the case that the shipper is just as well satisfied to realize on a claim as he is to sell at the market. It is claimed that some firms make a practice of collecting a high-grade price on second-grade fruit, paying the farmer only a pittance. On the other hand, the railroad cannot be satisfied with being able to fight claims successfully. It has the larger duty of preventing claims if it expects those along the line to prosper.

Educate the shipper. If the cause of a loss is a plant disease which begins in the field and which can be prevented by proper control measures by the farmers and fruit growers, this fact must first be established. Then no effort must be spared to enlist the services of all concerned in the doing away with this needless condition.

The colleges and experiment stations have for years taught the proper methods for controlling fruit and vegetable diseases. They speak to large groups, and those whom the college extension forces reach soon learn to avoid trouble. On the other hand these educational forces do not ordinarily have the intimate relation with the man having trouble that the market man or the carrier has. The railroad and commission man can reap great returns if they will assist in bringing the teachings of the college to their customers.

Care in handling is first essential. Much of the loss comes from careless handling in picking or packing. Without exception it may be said that the first essential for shipment is freedom from wound or bruise. Fruit must be picked without bruise, cut or injury, carefully handled in the various grading operations, and carefully packed by experienced and careful packers. Mold fungi are always present on fruit and the least bruise or wound may open the avenue for them.

Eliminate losses due to faulty stowing, etc. If the cause of loss depends on conditions in the car, be it faulty packing, stowing, bracing, lack of ventilation channels, overloading, these must be remedied. The railroad cannot be satisfied with a mere notation on the billing which will protect it. Better business demands that losses be prevented. The railroad must educate its shippers. Part III deals with the general principles underlying this phase of the problem.

Train the inspectors. If the cause of loss is due to faulty icing, faulty car construction, etc., these should be readily avoided. The inspection service on most railroads needs an overhauling or checking.

In self protection all railroads should have some definite system, such as has been developed on

[3]THE PHYSIOLOGY OF PLANTS IN STORAGE

Bigelow, W. D., Gore, H. C., and Howard, B. J., 1905. Studies on apples; storage, respiration and growth. Bur. of Chem. Bul. 94: 1-100; 20 cents.

Corbett, L. C., 1916. Color as an indicator of the picking maturity of fruits and vegetables. Bur. Plant Ind. sep. 686: 6 pp. Dept. Agr. Yearbook 99-106.

Fulton, S. H., 1907. The cold storage of small fruits. Bur. Plant Ind. Bul. 108: 1-28; 15 cents.

Gore, H. C., 1911. Studies of fruit respiration. Bur. Chem. Bul. 142: 1-40; 5 cents. This pamphlet contains three separate studies: (a) The effect of temperature on the respiration of fruits; (b) The effect of picking on the rate of evolution of Carbon Dioxide; (c) The rate of accumulation of heat on the respiration of fruit under adiabatic conditions.

Greene, Lawrence, 1913. Cold storage for Iowa grown apples. Iowa Sta. Bul. 144: 357-378.

Hill, Geo. R., 1913. Respiration of fruits and growing plant tissues in certain gases, with reference to ventilation and fruit storage. N. Y. (Cornell) Sta. Bul. 330: 379-408.*

Langworthy, C. F., and Milner, R. D. Some results obtained in studying ripening bananas with the respiration calorimeter. Yearbook 1912: 293-308. Sep. 5 cents. A study of the change which take place in ripening and after ripening in order to determine principles underlying the successful handling of fruits.

Morse, Fred. W., 1908. The respiration of apples and its relation to their keeping. N. H. Sta. Bul. 135: 87-92.

Powell, G. H., and Fulton, S. H., 1905. The apple in cold storage. Bur. Plant Ind. Bul. 48: 1-64.

some lines, for proving that icing service has been performed according to instructions. This system should make possible accurate determination as to the condition of the car in respect to position of ventilating devices and contents of bunkers at the time of arrival at all icing stations and at destination as well. It should also afford complete record of the quantity of ice added at all icing stations, as well as the time at which this service was performed.

Prof. Stevens of the University of Illinois, made an admirable start when he established a short course to teach the facts of plant diseases in relation to transportation. Men so trained become doubly valuable in the handling of shipments. Their reports become intelligible documents available for claim decisions and their recommendations can become the basis for a rational program of improvement.

The Bureau of Markets. The method of shipment, the demands as to icing, ventilation, containers, etc., present a very important problem. This matter has been solved very satisfactorily for citrus and for many other fruits. The Bureau of Markets is very actively engaged in exactly this line of work. It is not too much to expect that the efforts of the scientists of the Bureau will codify and improve present practices and give us a working body of recommendations.

The new Food Products Inspection Law. As a food conservation emergency measure, Congress on August 10, 1917, passed most important legislation, bearing directly on the conditions dealt with in this bulletin. It established under the Bureau of Markets an inspection service for shippers in order that the true condition as to the soundness of a shipment may be investigated and certified to by an official agency.* It is extremely likely that this service as yet limited to shipper's demands will be extended to include requests from consignees and carriers. As it stands, while not planned to determine responsibility for damage, it gives a working basis for accurate loss determination and for the eradication of serious malpractices arising in the commerce of perishables. A Food Products Inspector of the Bureau of Markets will be located in the principal markets and he should be appealed to in cases of controversy as to condition, since the law provides that the findings of the Bureau are to be accepted as prima facie evidence.

Pack a worthy product. The problem of elimination of loss is an enormous one and touches the shipper, the market man, and the carrier. Each must work for the greatest good, if the growing needs of the public are to be met. But there is no method of handling, icing or marketing which will overcome the effects of a lack of integrity of the producer or shipper. This is fundamental. Goods of high quality, free from disease, properly packed mean safety; the other sort—hazardous business.

*Public No. 40, 65th Congress. "An Act to provide further for the national security and defense by stimulating agriculture and facilitating the distribution of agricultural products, for enabling the Secretary of Agriculture to investigate and certify to shippers the condition as to soundness of fruits, vegetables, and other food products, when received at such important central markets as the Secretary of Agriculture may from time to time designate and under such rules and regulations as he may prescribe: *Provided*, That certificates issued by the authorized agents of the department shall be received in all courts as prima facie evidence of the truth of the statements therein contained."

PART II. THE DISEASES COMMONLY FOUND IN SHIPMENTS

Fruits

Plant diseases play an important role in the handling of fruits. Some fruits show but little loss in shipment, while others are extremely perishable. The fruits that are common on the markets have received considerable investigation and a large literature list dealing with important plant diseases is available. Many states have issued handbooks of plant diseases.[4] For many of the tropical fruits, for fruits that are found only in special markets, but little investigation has been made. These are not included in this presentation. Diseases of such fruits should be referred to the pathologists of the states of origin. (For list see page 64.)

For the most part, only the more important diseases to be met with in shipments are here considered. In the bibliography, however, are included titles of bulletins dealing with diseases of importance in causing losses in the field, but which do not produce rots or decays of the transported product. In certain cases bulletins concerned with the horticultural and entomological phases are also included.

Citrus Fruits[5]

Introduction: At one time the transportation of citrus fruits was an uncertain proposition full of loss for both shipper and railroad. The handling of citrus fruit shipments today, as contrasted with the period before 1908, shows what may be accomplished by properly directed effort. Largely from the investigations of Powell and his associates the principles underlying successful fruit shipments were determined. These were simple. Disease-free fruit, if picked, handled and boxed so as to avoid bruising, scratching or puncturing, is reasonably sure of safe transit unless so packed in the car as to permit heating or "sweating," or otherwise mishandled.

Blue Mold. *(Penicillium sp.)*

This is the common cause of loss in shipments. Blue mold causes a rot, quickly involving the whole fruit. Lemons harden and dry up, but oranges become watery and soft. It may be recognized readily by the filmy, white growth, (which soon becomes blue-green), of the causal fungus which quickly springs up covering the rotted area. (Fig. 4.) This fungus enters through wounds or bruises on fruits, and is to be controlled by care in handling. In former years the loss from this organism made orange shipments unprofitable. Millions of dollars were lost each year because of unchecked rotting. Now oranges are picked and packed under careful inspection and losses from blue mold are reduced to a minimum.

Fig. 4. Blue Mold of orange. Note softening of fruit, the white tufts of the fungus, which become dark as spores mature.

Brown Rot.[6] *(Pythiacystis citrophthora)*

This disease is probably the greatest cause of loss in lemon shipments, now that careful handling avoids Blue Mold. In this rot the fruit shows first a greasy, scalded spot which becomes brown. The fungus soon appears at the rotted spot as a white, filmy or cobwebby growth.

[4]STATE HANDBOOKS

Longyear, B. O., 1904. Fungous diseases of fruits in Michigan. Mich. Sta. Special Bul. 25: 1-68. No longer available for distribution—may be seen in larger libraries, etc. Copiously illustrated with photographs and drawings by the author.

Selby, A. D., 1910. A brief handbook of the diseases of cultivated plants in Ohio. Ohio Sta. Bul. 214: 397-456. This pamphlet contains discussions and illustrations of various diseases affecting fruits, vegetables, and flowers.

Smith, R. E., and Smith, E. H., 1911. California plant diseases. Cal. Sta. Bul. 218: 1039-1193. This pamphlet contains discussions and illustrations of various diseases affecting fruits and vegetables, of especial value for citrus fruit diseases.

Bentley, G. M., 1917. Suggestions for the control of injurious insects and plant diseases. Tenn. Sta. Bul. 117: 111-123. Spraying directions for various insect and fungous pests.

Departments of Entomology and Plant Pathology, 1915. The control of insect pests and plant diseases. Cornell Sta. Bul. 283: 463-500. (Revised June, 1915.)

Robbins, W. W., and Reinking, O. A., 1915. Fungous diseases of Colorado crop plants. Col. Sta. Bul. 212: 1-54.

Stakman, E. C., and Tolaas, A. G. Fruit and vegetable diseases and their control. Minn. Sta. Bul. 153: 1-67.

(Fig. 5.) Blue mold quickly involves the entire fruit. Brown Rot of citrus fruits is not related to the Brown Rot of stone fruits. The disease

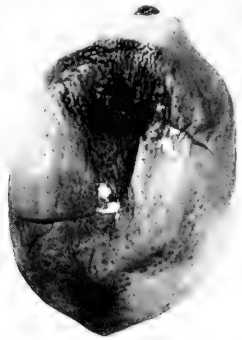

Fig. 5. Brown Rot of lemon. Note scalded appearance.

spreads by contact and one affected fruit in a box may communicate the disease throughout the whole container. A box of affected fruit can be

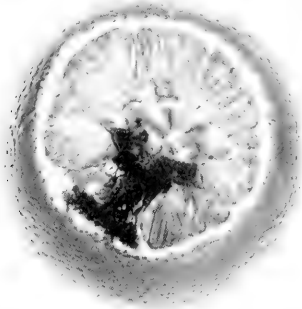

Fig. 6. Black Rot of navel orange. This may be hardly noticeable from the outside. (Photo by J. E. Coit.)

detected by its strong rancid odor. The control of Brown Rot consists of orchard treatments, such as spraying, heavy mulching and cover cropping, and the use of disinfectants in the washer in the packing house. Rarely found except on shipments from California.

Black Rot. *(Alternaria citri)*

This is a disease limited to the navel orange. The fruit as seen at market is apparently sound, but on being cut shows blackened flesh. (Fig. 6.) The causal organism enters the fruit at some imperfection at the navel end. Affected fruit may be recognized in the orchard by its premature ripening, deep color, and large size. Control measures consist of sanitary measures which aim to destroy sources of infection as well as by the use of the better varieties for budding.

Fig. 7. Cottony Rot of lemon. Note white fungous growth and black resting bodies of the fungus. (Photo by R. E. Smith.)

Cottony Rot of Lemons. *(Sclerotinia libertiana)*

This disease is recognized easily from the large mass of cottony, fungous growth surrounding the infected fruits. (Fig. 7.) Within this mass there rapidly develop several or many firm bodies from

CITRUS FRUITS

Diseases of citrus fruits and trees, as well as insect pests, are covered by a voluminous literature chiefly published by the Department of Agriculture and by the Experiment Stations of Florida, California and other citrus growing states. The few bulletins here listed cover only the important diseases.

Culture:

Rolfs, P. H., 1913. Propagation of citrus trees in the Gulf States. Farmers' Bul. 539: 1-16.*

Coit, J. E. Citrus Fruits. MacMillan Co., $2.00.

Transportational Diseases and Transportation Problems:

Powell, G. H., and others, 1908. The decay of oranges while in transit from California. Bur. Plant Ind. Bul. 123: 1-71. 20 cents. Records extensive experiments which laid the foundation for the successful handling of California fruit.

Tenny, L. S., and others. The decay of Florida oranges while in transit and on the market. Bur. Plant Ind. Cir. 19: 1-8.

Ramsey, H. J., 1915. Handling and shipping citrus fruits in the Gulf States. Farmers' Bul. 696: 1-28. Deals with the causes and prevention of decays in transit; refrigeration.

Stubenrauch, A. V., and others, 1914. The factors governing the successful shipping of oranges from Florida. Dept. Agr. Bul. 63: 1-50; 15 cents. "The condition of the fruit after arrival in market depends largely upon the character of the work done in grove and packing houses..... it is possible to so conduct operations of picking, packing and shipping as to inflict a minimum of mechanical injuries from which decay may develop." "Precooling may not safely be depended upon to offset decay following mechanical injuries due to improper methods of handling fruit when preparing it for shipment, but it is a valuable and legitimate means of insuring arrival on the market in sound condition after each grower, packer and shipper has done his share in properly handling the fruit."

Rolfs, P. H., Fawcett, H. S., and Floyd, B. F., 1911. Diseases of citrus fruits.* Fla. Sta. Bul. 108: 27-47.

Smith, R. E., and Smith, E. H., 1911. California plant diseases. Cal. Sta. Bul. 218: 1039-1193.

*Brown Rot:

Smith, R. E., and others, 1907. The Brown Rot of the lemon. Cal. Sta. Bul. 190: 1-70.

the size of a buckshot up to that of an orange seed. These bodies are at first white but soon become black externally. From one diseased fruit the rot spreads rapidly to the adjoining ones. This is largely a disease of the curing house but may spread from fruit to fruit in shipment if refrigeration is faulty.

Anthracnose. *(Colletotrichum glocosporioides)*

Anthracnose occurs as a rot of grape fruits and less often of oranges from Florida and Cuba. It shows as hard, brownish spots, somewhat depressed, varying from less than one-fourth inch up to more than an inch in diameter. (Fig. 8.) These spots finally become gray, and at length

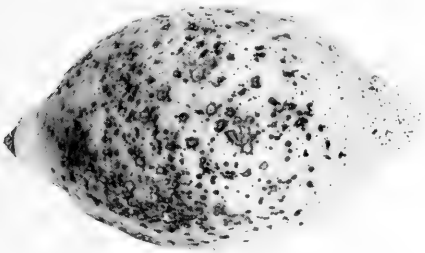

Fig. 8. Anthracnose of lemon. (Photo by R. E. Smith.)

black and the tissues underneath the rind begin to decay, the progress being most rapid along the partitions. The taste of the flesh beneath the diseased areas becomes bitter while the rest of the fruit may remain unchanged. Infection starts on the tree but is sometimes not very noticeable when the fruit is packed, the diseased areas developing their dark masses of spores in shipment if the car is too warm or poorly ventilated.

Stem End Rots.[7] *(Phomopsis citri* and *Diplodia natalensis)*

These rots occur principally on grape fruits and oranges, shipped from Florida. They are caused by two or three different kinds of parasitic fungi. The characteristic symptoms are a soft rotting which begins at the stem end of the fruit and may progress rapidly, soon destroying it entirely. The infection occurs while the fruit is still attached to the tree, and begins to appear as a rot after a few days if the temperature is not kept low. Under proper cold storage the decay will not show up for several weeks.

Blemishes

By the term blemishes is understood a type of injury that affects the rind only, and does not produce a decay. The damage is chiefly from the unattractive appearance given to the fruit, although in some cases the quality is lowered somewhat. The commoner blemishes may be classified as follows:

Black, flaky patches, especially at the stem end of the fruit, removable by rubbing with a damp cloth.—Sooty Mold.

Black or brown streaks running from the upper (stem) end of the fruit, sometimes reaching the lower end; not removable by rubbing.—Tear Stain.

Brown or black streaks which are narrow and usually in curves or irregular rings, the adjacent portions of the rind often covered with scattered minute brown dots, the affected dots or streaks being slightly raised and giving a rough feeling to the fruit.—Melanose.

Rusty to dark-brown or gray patches covering only one side of the fruit or the whole fruit, the oil glands destroyed in the affected areas, quality of the fruit often not changed.—Russeting.

Gray to tan-colored, corky projections from the surface, in the form of warts or larger elevated areas, the surface between these areas being normal in appearance.—Scab.

Sooty Mold is a fungus which feeds, not upon the fruit but upon the sugary excretions of scale insects and white fly. It does not lead to decay. It may be prevented by controlling the insects.

Tear Stain is mostly caused by the same fungus that causes Anthracnose, but represents an infection when the fruit is approaching maturity and is confined to the outer layers of the rind. On the leaves dry patches are produced and the dying back of younger twigs—withertip—is common. The control consists of pruning out diseased twigs and in severe cases spraying with Bordeaux mixture.

Melanose is caused by the same fungus that causes one form of Stem End Rot, but represents a superficial type of infection. The infection occurs before the fruit is picked. It is also found as a disease of leaves and twigs. Spraying is recommended.

Russeting is caused by the attacks of various species of mites, thrips, etc., while the fruit is still immature.

Scab is caused by a parasitic fungus, the infection occurring while the fruit is quite immature. Leaves and twigs are usually affected as well. Control is accomplished by copper sprays.[8]

[7]Stem End Rot:
Fawcett, H. S., 1911. Stem End Rot of citrus fruits.* Fla. Sta. Bul. 107: 1-23. Discusses a cause of decay in transit. Contains as an appendix a catalogue of rots, spots and blemishes on citrus fruits in Florida.
Floyd, B. F., and Stevens, H. E. Melanose and Stem End Rot. Fla. Sta. Bul. 111: 1-16. Continues work of previous bulletin. States that "Stem End Rot as well as Blue Mold is most likely to develop on defective fruits. It is, therefore, important to cull out closely all clipper cuts, long stems, and fruit injured in any way and to handle all fruit carefully."

Pineapple

Pineapple Rot.[9] *(Thielaviopsis paradoxa)*

This is the most serious disease of pineapples under transportation; often one-fourth of a carload (Fig. 10) will arrive at destination in a worthless condition. Green as well as ripe fruit is affected. This soft rot is caused by the fungus *Thielaviopsis paradoxa.* Beginning at various parts of the fruit, usually the base, as a soft, water-soaked spot, the decay quickly progresses on pineapples under shipment and causes blackening of the flesh to the core. (Fig. 9.) The fungus commonly enters through the freshly cut stem at the base of the pineapple. The fungus can, however, penetrate the unbroken skin if the pineapples are kept moist. This disease is found

Fig. 9. Pineapple Rot. The rotted fruit shows sunken discolored areas from without.

in the fields and causes a considerable percentage of loss there. All rotted pineapples should be removed from the fields and destroyed. The pineapples should be cut with rather long stems.

Fig. 10. Pile of rotted pineapples about a car. Such waste piles are usually to be found.

Sanitation about the packing shed is essential. Bruising must be avoided. The fruit, especially the cut stems, should be dry when packed. It is likely that some treatment of cut stems, such as advocated for watermelons, would be highly successful. In shipment both in boat and in the car proper temperature and thorough ventilation are necessary to minimize losses.

Laboratory experiments of the Department of Agriculture indicate that some form of disinfection of cargoes with formaldehyde gas would be successful. The development of control measures for this disease presents great possibilities to stabilize the handling of this important tropical fruit.

Banana

The Anthracnose of Banana. *(Colletotrichum musarum)*

The blackening of the skins of ripe bananas in small circular spots or in definite areas is familiar to every one. (Fig. 11.) Instead of this being a mere normal ripening process, this blackening of the skin and the softening of the flesh is really a rot, caused by a fungus, *Colletotrichum musarum,* which attacks mature or nearly mature fruits. The fungus seemingly has no bad effects upon the tree or the green fruit in the field.

[8]Citrus Canker:

Due to the importance of Citrus Canker in quarantine legislation some bulletins upon this subject are listed.

Stevens, H. E., 1915. Citrus Canker.* Fla. Sta. Bul. 128: 1-20.

Hasse, C., 1915. *Pseudomonas citri,* the cause of Citrus Canker. Journ. Agr. Res. 4: 97-100; 25 cents.

Wolf, F. A., 1916. Citrus Canker.* Ala. Sta. Bul. 190: 91-100. A summary of a technical article which appeared in Journ. Agr. Res. 6: 69-100.

[9]Pineapple:

Patterson, Flora W., and Charles V. Bur. Plant Ind. Bul. 171: 15-35.

Higgins, J. E., 1912. The Pineapple in Hawaii. Hawaii Sta. Press Bul. 36: 34 pp.

Larsen, L. D. Hawaiian Sugar Planters Assn. Exp. Sta. Bul. 10.

[10]Mango:

McMurran, S. M., 1914. The Anthracnose of mango in Florida. Dept. Agr. Bul. 52: 1-15.

Nevertheless the fungus lives everywhere in the plantations and probably all fruit that is shipped carries the latent infection. The handling of ripe bananas, therefore, requires facilities for quick disposal of the fruit.

Bananas are transported while still green, and while care must be taken in freezing weather, the main objects in transportation depend upon keeping moderate, even temperatures in the car in order that ripening may be retarded and come on evenly for the whole bunch.

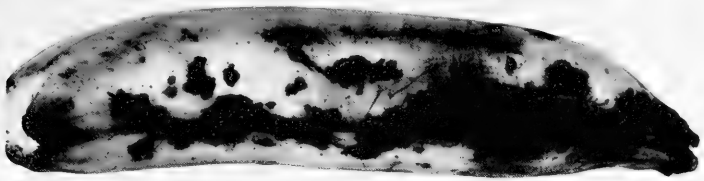

Fig. 11. The Anthracnose of banana.

Mango

Anthracnose.[10] *(Colletotrichum gloesporioides)*

The Anthracnose disease of the mango bears to this increasingly important fruit the same relation as the bitter rot to the apple. The fungus produces a blackening of the skin, which sinks as the flesh becomes dry rotted. (Fig. 12.) Under moist conditions the fungus fruits, producing masses of pink spores from rifts in the epidermis. Spraying with Bordeaux mixture is recommended to protect the young fruit.

Fig. 12. The Anthracnose of mango. Note the blackening of the skin, and the rifting in small areas where the fungus is fruiting.

[11]Apple Diseases*

ROTS OF THE FRUIT

Soft, watery, tan-colored rot, starting as a soft speck at a worm hole or wound, soon involving the entire fruit which becomes dotted with white or blue fungous masses. Blue Mold.

Large, rotted spots, fruit gradually drying to a mummy. Sunken, *firm*, brown or black rot; bitter taste; usually seen in shipments as a circular spot ¾ to ½-inch in diameter, gradually involving the whole fruit which wizens to wrinkled mummy. Fungus fruiting in concentric rings of pink spore masses. Chiefly of Southern distribution. Bitter Rot.

Not sunken, *soft*, brown rot at start; taste not bitter; spot becoming mottled or zoned with black; usually starting at a worm hole; gradually involving whole apple which dries to a smooth mummy dotted with the pycnidia** of the fungus. Chiefly of Northern distribution. Black Rot.

Small shallow rot following scab. Rot firm, dry or spongy; spot white or pink with fungous growth. Pink Rot.

SKIN BLEMISHES

Of fungous origin (that is, showing velvety fungous growth or some type of fungus-fructification)

Circular spots ⅛ to ¼-inch (or larger) in diameter, olive-green to black, or with corky centers, epidermis rifted. Apples may be cracked or distorted. Scab

Sooty, blackish mold formed by a superficial fungous growth. May be scraped off leaving the epidermis intact. Sooty Blotch

Groups of dots appropriately named. Fly Speck.

Coal-black, wavy-bordered blotches, either raised or sunken, dotted with black pycnidia. Of Southern distribution. Blotch

Skin speckled with small circular specks, (1-16 to ⅛-inch) flesh not involved deeply. Fruit Spot. (Commonly confused with Bitter Pit.)

Non-parasitic (Fungi or bacteria not primarily responsible)

Fruit not pitted. Skin corky or russet-like; or cracked due to chemical burning. Bordeaux Injury.

Skin smooth, brown, discolored, half to whole fruit involved, flesh only slightly affected. Scald.

Skin showing smooth, circular, yellow or brown areas. Flesh not involved, chiefly on Jonathan. Jonathan Spot.

Fruit pitted. Sunken areas on surface, becoming brown or black, flesh beneath (⅛-inch) brown and dead. Often showing bitter tasting flecks or pits deep in the flesh. Bitter Pit. (Baldwin Fruit Spot.)

*The diseases of pears are very similar to the diseases of apples.

**Some fungi produce their asexual or "summer" spores in minute spherical or egg-shaped cases. These are called pycnidia. They appear on the fruit as small pimples or pustules. The pycnidia usually have small mouths from which the spores are pushed out in *tendrils or gummy* masses.

Scab.[12] *(Venturia inaequalis)*

This is probably the most common apple disease to be found in shipments of other than the fancy grades. The life history of apple scab has been given on another page. The cuts show the characteristic blemishes—circular spots ⅛ to ½-inch in diameter—which may be larger due to running together of spots. (Fig. 13.) The spot

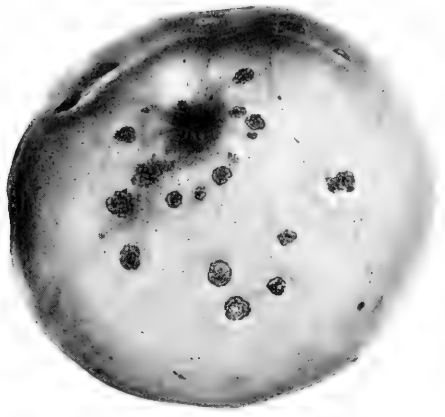

Fig. 13. Apple Scab.

is velvety, olive-green or black due to the fungous growth. The epidermis is broken away and its remnants are seen at the edge of the spot. Scabby apples or pears are frequently distorted and cracked. (Fig. 14.) The disease spreads slowly in storage or shipment, arising either from latent infection or from spores which germinate and infect under moist conditions. Such infections show up as small, black, pin-point spots. From another point of view than the blemish apple scab is serious. The rifted epidermis exposes the apple to various secondary rots.

Apple and pear scab can readily be controlled by summer spraying. Pear Scab is controlled fairly well the first year and more readily in each succeeding year. In regions where Bitter Rot is not a factor, timely applications of lime-sulphur, either commercial or home made, is effective in giving 95 to 97 per cent of fruit free from serious scab infestation. Apple scab and its attendant serious secondary rots must be looked upon as unnecessary in properly handled orchards.

Pink Rot.[13] *(Cephalothecium roseum)*

Chief of the secondary rots, which follow scab is that caused by the Pink Mold *(Cephalothecium roseum)*. This fungus makes a soft area about each scab spot and renders an otherwise salable product worthless. The rot caused is a shallow brown rot in which the flesh dries to a spongy consistency. The scab spot is overrun with the white growth of the fungus (Fig. 15), which soon becomes pink when spores are produced.

Fig. 14. Pear Scab on leaves and fruit. (Photo by B. O. Longyear.)

Cephalothecium roseum is widely distributed in nature and commonly infection of apples takes place in the orchard. Greenings are especially susceptible. Pink mold injury may be expected

[11]APPLE DISEASES

Handbooks:

Quaintance, A. L., and Scott, Wm., 1912. The more important insect and fungus enemies of the fruit and foliage of the apple. Farmers' Bul. 492: 1-48.* "Apple Bitter Rot is often the cause of most refrigerated fruit going down in transit. In the same way, Apple Scab furnishes an entrance point for pink mold and other rot fungi by which the fruit goes down rapidly in transit when not properly cooled or refrigerated."

Brooks, Charles, 1909. Some apple diseases. New Hampshire Sta. Bul. 144: 109-138. New Hampshire Sta. Bul. 157: 1-32.

Morse, W. J., and Lewis, C. E., 1910. Maine apple diseases. Maine Sta. Bul. 185: 337-392.

Clinton, G. P., 1902. Apple Rots of Illinois. Ill. Sta. Bul. 69: 189-224. Various fruit rots described and figured.

Smith, R. I., and Stevens, F. L., 1910. Insects and fungous diseases of apple and pear. N. C. Sta. Bul. 206: 43-120.

Fire Blight:

Whetzel, H. H., and Stewart, V. B., 1909. Fire blight of pears, apples, and quinces, etc. Cornell Sta. Bul. 272: 31-51.

Stewart, V. B., 1913. The fire blight disease in nursery stock.* Cornell Sta. Bul. 329: 328-371.

Pickett, B. S., 1914. The blight of apple, pears, and quinces.* Ill. Sta. Bul. 172: 3-8.

Insects:

Britton, W. E. The San José Scale and methods of controlling it. Conn. Sta. Bul. 165: 1-24.

Quaintance, A. L., 1915. The San José and its control. Farmers' Bul. 650: 1-27.* San José causes reddish blotches on fruit.

Samson, G. H., 1912. Some apple insects of Connecticut. Conn. (Storrs) Sta. Bul. 71.

O'Kane, W. C. The Apple Maggot. New Hampshire Sta. Bul. 171: 1-120.* Discusses life history, importance of control of Apple Maggot or Railroad Worm.

[12]Scab:

Wallace, E., 1913. Scab diseases of apples. Cornell Sta. Bul. 335: 545-624. Monograph of this disease with full bibliography.

Morris, H. E. A contribution to our knowledge of Apple Scab. Montana Sta. Bul. 96: 69-102.* Deals with western conditions; colored plates, extensive bibliography.

[13]Pink Mold:

Eustace, H. J., 1902. A destructive apple rot following Scab. New York (Geneva) Sta. Bul. 227: 367-389. Pink Mold invades the apple tissue where the epidermis is broken by Scab. Greening especially affected.

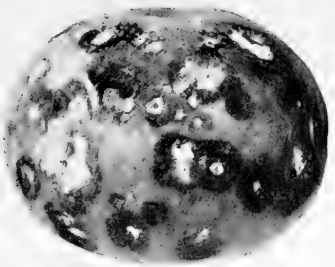

Fig. 15. Pink Rot following Scab. (Photo by B. O. Longyear.)

in years when excessive rainfall makes scab attacks severe. The control of Pink Mold hinges upon the control of scab.

Bitter Rot.[14] *(Glomerella rufo-maculans)*

Bitter Rot is the serious apple disease of the Southern orchards. It is typically a ripe rot of the fruit although it also causes cankers on the twigs and branches. These furnish the winter quarters for the fungus. Bitter rot is seen in shipments as large, sunken, rotted spots, of brown or black color. The rotted flesh is not soft and watery but firm and corky. It has a characteristic bitter taste. The whole fruit is gradually involved and wrinkles to a mummy. On the rotted spot, under moist conditions, the fungus fruits by producing concentric rings of pink spore masses. (Fig. 16.)

Fig. 16. Bitter Rot. Note sunken area dotted with the spore masses. (Photo by B. O. Longyear.)

The disease is severe in a wet growing season. It appears suddenly upon the fruit at harvesting time and may destroy the entire crop. Under warm, moist conditions three days are sufficient for the production of good sized spots. Infection starting in the orchard may progress in shipment so that the fruit arrives in a worthless, rotted condition.

Bitter rot is prevented by summer sprays of Bordeaux mixture. Lime sulphur is not effective. Numerous spraying experiments have established the proper practice for the southern apple regions and fruit 90 per cent free from Bitter Rot is a possibility. Spraying is therefore a necessary orchard insurance.

Blue Mold. *(Penicillium expansum)*

Blue Mold causes a very soft, tan-colored, watery rot of the apple. The disease starts as a small speck at a wound, scab-spot or worm hole, etc., and soon involves the entire fruit, which becomes dotted with white or greenish-blue fungous masses. (Fig. 17.) This rot, and others which greatly resemble it in behavior—called collectively—Bin Rots—are caused by organisms

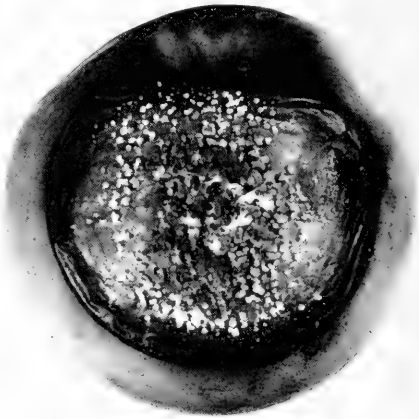

Fig. 17. Blue Mold of apple.

against which apples, except at the time of full maturity, are completely protected so long as the skin is intact. The spores of the causal fungi occur everywhere in nature and rot invariably follows in wormy, bruised, or carelessly handled fruit. Apples must be picked with care, never shaken from the trees, and packed so that the skins are left to give the necessary protection. Carelessly handled fruit in which stems break the skins, severe barrel bruises, codling moth holes, invariably give bad results in shipment and storage although refrigeration delays decay. Wounded apples are sure to prove a loss.

The orange industry has learned that careful handling is vital to successful shipment. The apple industry must profit by the experience of the successful California and Florida shippers.

[14]Bitter Rot:

Burrill, T. J., 1907. Bitter Rot of apples.* Ill. Sta. Bul. 118: 554-608.

Schrenk, H. von, and Spalding, P., 1903. The Bitter Rot of apples. Bur. Plant Ind. Bul. 44: 1-54.

Scott, Wm., 1906. The control of Apple Bitter Rot. Bur. Plant Ind. Bul. 93; 10 cents.

Black Rot.[15] *(Physalospora cydoniae)*

Black Rot probably stands next to Blue Mold in causing rotting in apple shipments. The rot caused is ordinarily not sunken at the beginning of decay. The apple shows a moderately soft, brown rot which becomes mottled or zoned with black as the disease proceeds. (Fig. 18.) This

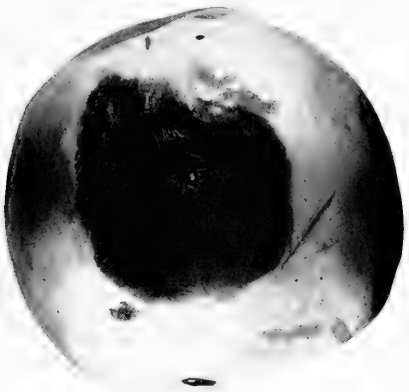

Fig. 18. Black Rot of apple. Note that the rot starts at a worm hole.

rot usually starts at a worm hole since the organism is not of so virulent a type as the Bitter Rot fungus. As the rot progresses the fruiting bodies of the fungus (small black pycnidia) are produced and show as small dots or pimples on the skin. Gradually the fruit wizens to a mummy.

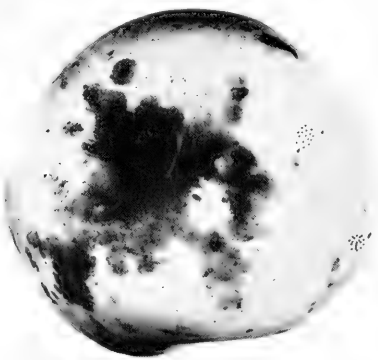

Fig. 19. Sooty Blotch and Fly Speck. Superficial but very disfiguring

The fruit may rot upon the tree, or the rot may develop in shipment or storage. The loss from fruit rot is ordinarily not extensive in well cared for orchards.

Probably no orchard is free from infestation with the Black Rot organism. As a pest of apple this fungus is chiefly important because of its effect upon the leaves and the cankering of the main limbs and branches. The control of this disease is largely a matter of selective pruning so as to give the healthy limbs a chance, along with the general sanitation and protection that comes from regular spraying.

Sooty Blotch, Fly Speck. *(Leptothyrium pomi)*

These blemishes are caused by the same fungus which grows superficially on the apple, appearing either as a branching fern-like colony or as clusters of small dots, resembling fly specks. The presence of apples of this sort in shipment is indicative of low-grade fruit not properly sprayed. Many orchardists in Michigan are using a Bordeaux spray late in July or about the middle of August to supplement the regular lime-sulphur spray.

Blotch.[16] *(Phyllosticta solitaria)*

This is a serious disease in southern orchards. Shipments sometimes arrive with the bulk of the

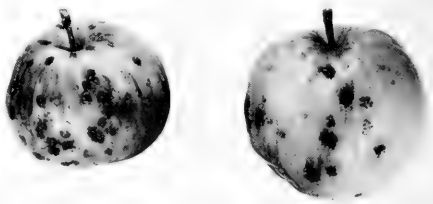

Fig. 20. Blotch. Early stages. In later stages the blotches are larger and dotted with black specks. The apple frequently cracks.

fruit spotted with this disfiguring disease. The diseased areas at the start are coal-black, wavy bordered blotches, usually somewhat raised, and soon become dotted with the pycnidia of the causal fungus. (Fig. 20.) The blotch gradually increases in size and may cause sunken areas, cracking, etc. This disease is controlled by the Bordeaux spray supplemented with pruning to destroy the hold-over cankers which the fungus forms upon the twigs.

[15]Black Rot

Hesler, L. R., 1916. Black Rot, Leaf Spot, and Canker of pomaceous fruits." Cornell Sta. Bul. 379: 51-148.

[16]Blotch:

Scott, W. M., and Rorer, J. B., 1909. Apple Blotch, a serious disease of Southern orchards. Bur. Plant Ind. Bul. 144: 1-28; 15 cents.

Lewis, D. E. The control of Apple Blotch. Kansas Sta. Bul. 196: 521-574.

Bordeaux Injury

In wet seasons, apples are scalded or russeted by the action of the copper in the Bordeaux mixture. The skin of the fruit roughens or cracks due to chemical burning. (Fig. 21.) Lime-sulphur burns the calyx end of the fruit somewhat similarly, if the spray be applied so heavily that it collects in large drops. Serious rotting does not usually follow such injuries as the fruit is heavily corked over at the injured areas.

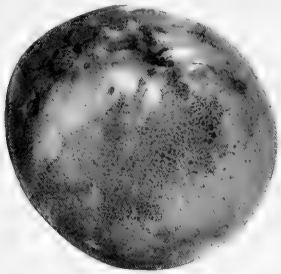

Fig. 21. Bordeaux Injury.

Various Blemishes

In this group are listed the common blemishes found in shipments. The two diseases, Fruit Spot and Bitter Pit, have been largely confused and lumped together under the one head "Baldwin Fruit Spot." They resemble each other somewhat. Fruit Spot is a fungous disease which shows up as small, circular, dead areas about 1/8 of an inch in diameter. (Fig. 22.) The flesh beneath the spot is not involved to any extent. As a fungous disease contracted in the field, it is controlled by a late spray, preferably Bordeaux mixture.

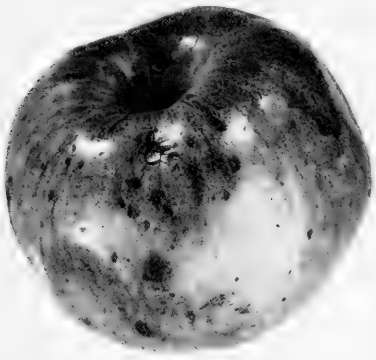

Fig. 22. Fruit Spot. The flesh is not deeply involved.

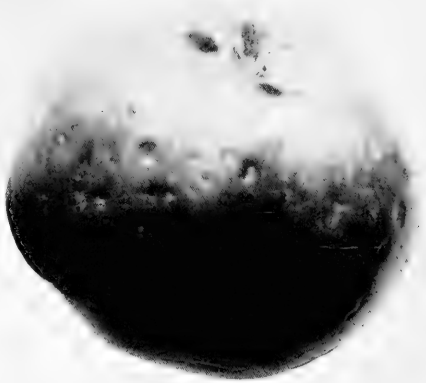

Fig. 23. Bitter Pit. The fruit shows shallow depressions.

Bitter Pit[17] shows up as a small dent or pit in the apple which gradually turns dark as the skin dies (Fig. 23.) In this disease deep pits or flecks are formed in the flesh. (Fig. 24.) The dead areas have a slightly bitter or rank taste resembling raw asparagus. This disease is not caused by a fungus or bacterial organism, but seems to be due to irregularities in the water supply, and probably in causing the trouble a deficient water supply is the most important. It is evident that the control of the disease depends upon judicious pruning, thinning, manuring and cultivating. The development of the disease in storage is greatly retarded by uniform, low temperatures and dry air.

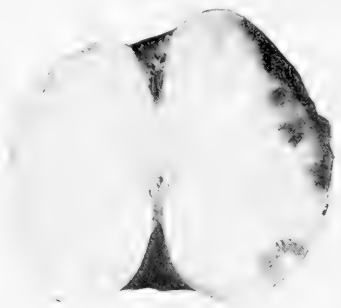

Fig. 24. Bitter Pit. The flesh is deeply involved.

[17]Bitter Rot:
McAlpine, D. Bitter Pit investigation. 1911-1915, first, second, third and fourth report. Dept. Agr. Melbourne, Australia.

Brooks, Chas., and Cooley, J. S., 1917. Effect of temperature, aeration and humidity on Jonathan-Spot and Scald in storage. Journ. Agr. Res. 11: 287-317.

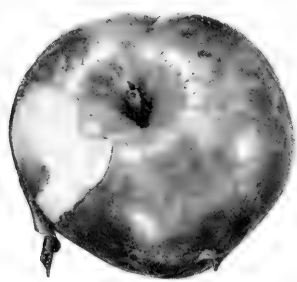

Fig. 25. Scald. Note that the flesh is not involved.

The Scald of apple and the Jonathan Fruit Spot seem to be diseases of the same type as Bitter Pit. They are evidences of disturbed physiology of the plant. In Scald the whole apple, or half of it, will show a brown, discolored skin. (Fig. 25.) The fruit takes on a rank, bitter taste. In Jonathan Fruit Spot small circular spots, ¼ to ⅜ of an inch across, appear on the fruit. (Fig. 26.) Jonathan or Wealthy apples which seem perfect when picked may develop these unsightly yellow or brown blotches upon them in shipment or storage. As in Scald the flesh beneath is either not involved, or only discolored for a very slight depth. The disease seems best controlled by the use of cold storage at an even temperature as near 32° F. as possible.

Fig. 26. Jonathan Spot. Related to Scald and limited in effect to the skin.

The fruit should promptly be put under these storage conditions and irregularities avoided. The chief complaints have come in Jonathans transported from the western apple regions to eastern markets. Proper handling under refrigeration with good ventilation is essential to successful shipments. Sweating of the fruit must be avoided. The disease needs further investigation. At present, the Jonathan apple is viewed with much disfavor by shippers because of the uncertainty of its behavior.

Stone Fruits[18]

Under this head are included peaches, plums, cherries, apricots, etc. These fruits are closely related and have practically the same parasites. Undoubtedly the transportation of the peach presents the greatest problem of all fruits considered in this section. The grower usually waits too long and attempts to ship fruit already mellow. The best success in shipment can come only if the fruit is picked when colored but still firm. Cars are almost invariably overloaded and poorly stowed. (Fig. 27.) Four hundred bushels should be considered the maximum load and three tiers is high enough. The stowing of baskets to give maximum protection against shifting and to secure proper distribution of weight is the only means of avoiding the crushing of the baskets in the lower tier. It is needless to say that fruit picked immediately after rainy weather is unsafe.

[18]Peaches, Plums, and Cherries, Prunes, etc. General:
Borden, F. M., and Eustace, H. J., 1914. Essentials in peach production. Mich. Sta. Spec. Bul. 63: 331-357. Gives summary of best Michigan practices.
Gould, H. P., 1915. Growing peaches: Sites, propagation, planting, tillage, and maintenance of soil fertility. Farmers' Bul. 631: 1-24.*
Niven, C. F., 1913. Peach culture for South Carolina. S. C. Sta. Circ. 21: 1-11.
Gould, H. P., 1916. Growing cherries east of the Rocky Mountains. Farmers' Bul. 776: 1-32. Complete account of culture and management of cherry orchards; picking and handling the fruit; fungous diseases and insects and other pests.
Handbook:
Cook, M. T. Common diseases of peach, plum, pear, and cherry. N. J. Sta. Circ. 45: 1-16.
Sprays and Spraying:
Keffer, C. A. Insuring the peach crop. Tenn. Sta. Bul. 88: 25-33.* Demonstrates value of self-boiled lime-sulphur under Tennessee conditions.
Gillon, G. C., 1917. A substitute for self-boiled lime-sulphur and other summer sprays for peaches. N. J. Sta. Circ. 63: 1-4.* Sulphur, hydrated lime, and glue.
Stanchier, G. C., 1916. A stone fruit spray made from hydrated lime and sulphur.* Va. Sta. Bul. 210: 1-14.
Scott, W. M., and Ayres, T. W., 1916. The control of Peach Brown Rot and Scab. Bur. Plant Ind. Bul. 174: 1-31; 10 cents. Self-boiled lime-sulphur recommended. Page 10 deals with losses in transportation. Price 10 cents.
Shot-hole of Plums and Cherries:
Higgins, B. B., 1914. Contribution to the life history and physiology of Cylindrosporium on stone fruits. Amer. Journ. Bot. 1: 145-173. Scientific paper detailing discovery of "winter" or sexual stage of the shot-hole fungus. Extensive bibliography given.
Stewart, V. B., 1914. The Yellow Leaf Disease of cherry and plum in nursery stock. Cornell Sta. Circ. 21: 1-10.
Stewart, V. B., 1915. Some important leaf diseases of nursery stock.* Cornell Sta. Bul. 358: 184-192.
Peach Yellows, Rosette, and Little Peach:
Essig, E. O. Three destructive diseases of the peach. State Commission of Horticulture, Monthly Bul. 1, No. 8: 337-359. Compilation of present facts known about these diseases.
Blake, M. A., 1910. Peach Yellows and Little Peach. N. J. Sta. Bul. 226: 3-26.
Caesar, L., 1912. Peach diseases. Ontario Agr. Dept. Bul. 201: 43-59.
Insects:
Quaintance, A. B. The principal insect enemies of the peach. Dept. Agr. Yearbook 1905: 325-348; sep. 10 cents No. 386.

The fruit from a large section appears upon the market at one time and this coupled with the high perishability of the fruit makes marketing a trifle precarious. While the market will take a large amount of first-class fruit at a profitable price, a very few cars of "Specked" fruit glut the market and ruin the price. The success of peach shipments is thus seen to depend upon the individual shippers. If all put sound fruit upon the market, all may do well, yet a few rotted carloads may ruin the whole trade. Uniformly successful peach shipments can only come when shippers generally adopt proper methods of shipment and disease control.

Fig. 27. Faulty methods in stowing lead to this sort of damage.

Diseases of Stone Fruits

Rot:

Soft, brown, discolored areas, quickly involving the whole fruit, which becomes dotted with ashy tufts of the fungus. On peach, plum, cherries. Brown Rot

Blemishes:

Olive-green freckles which may merge into an olive-green blotch. Fruit may crack or be deformed. On peach. Scab.

Corky wounds showing as a corky line, causing distorted, lumpy fruit, usually marked with beads of gum. On peach and plum. Curculio Injury.

Small (1-16-inch) dead, cracked areas. On peach and Japanese plum. Black-Spot.

Brown Rot of Stone Fruits.[19] *(Sclerotinia cinerea)*

This disease is well described by its name. It is a rot of both green and ripe fruit, but its softening effects naturally show most when the cementing walls of the cells of the fruit dissolve in the ripening process. Aside from avoiding crushing and from securing proper grading the whole problem of handling peaches and plums centers about the control of Brown Rot. The disease

[19]Brown Rot:

Scott, W. M., and Quaintance, A. L., 1911. Spraying peaches for the control of Brown Rot, Scab, and Curculio. Farmers' Bul. 440: 1-40.*

Brooks, C., and Fisher, D. F., 1916. Brown Rot of prunes and cherries in the Pacific Northwest. Dept. of Agr. Bul. 368: 1-10; 5 cents.

Valleau, W. D., 1915. Varietal resistance of plums to Brown Rot. Journ. Agr. Res. 5: 365-395; 10 cents. Infection of both green and ripe fruit takes place through the uninjured skin at the lenticel as well as through wounds. The fungus does its greatest damage as the fruit begins to soften. Infection spots increase in size rapidly in the susceptible varieties and soon completely cover the plum. This often requires not longer than 24 hours after infection has taken place. On the resistant forms, however, the spots increase in size slowly, sometimes taking several days before they entirely cover the plum.

arises in the field and the fruit either carries an incipient case of disease or at least the spores of the causal fungus when it is put into the car. A rotted peach or plum infects its neighbor by contact. (Fig. 28.) The humid conditions of the

Fig. 28. Brown Rot of plum. Note ashy tufts of the fungus.

car give ideal conditions for the inauguration and progress of the rot. (Fig. 1.) Peaches picked during rainy periods are notorious for their poor carrying quality. Apparently sound fruit will soften in from two to three days. Luscious, mellow fruit, may be turned into an unrecognizable, rotted mass almost over night by the specking of Brown Rot. (Fig. 29.) The control of this form of transportation loss depends upon spraying peaches, plums, and cherries. For peaches and Japanese plums self-boiled lime-sulphur, (or some of the newly devised substitutes) is advised. For plums and cherries dilute lime-sulphur is a cheap and efficient remedy. Sprayed fruit, if picked when well colored, but not at all mellow, carries well and commands the top price on any market. Good fruit holds the market firm, when specked with Brown Rot it is cull fruit and a few carloads will demoralize any market.

Peach Scab.[20] *(Cladosporium carpophilum)*

Peach Scab is an unsightly blemish of peaches which is reduced to a minimum by the sprays which control Brown Rot. Some growers think the greenish, black freckles are natural to the peach—they grow second grade and cull fruit, and are wasting their opportunities. (Fig. 30.)

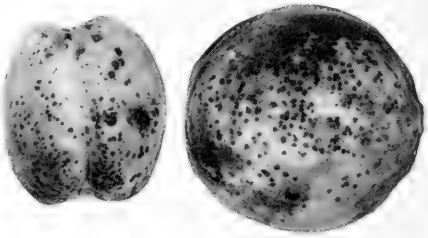

Fig. 30. Peach Scab.

Fig. 29. The effect of Brown Rot on the peach.
Compare with Fig. 1.

[20]Peach Scab:
Keith, G. W. Peach Scab. Dept. Agr. Bul. 395: 66 pp. Monograph of the disease with full account of control measures.

[21]Black Spot of Plums and Cherries:
Rolfs, F. M., 1915. A bacterial disease of stone fruits.* Cornell Sta. Memoir 8: 381-436. Serious disfiguring disease, especially severe on Japanese plums, nectarines, and Elberta peaches.

Peach Scab is controlled by the same spraying schedule as is used for Brown Rot.

Curculio injured peaches and plums are lumpy, distorted fruits, commonly showing beads of gum. The curculio puncture shows as a curved, corky scar. The insect is controlled by adding poison to the summer sprays.

Peaches and Japanese plums frequently show small, black, crusty spots about 1-16 inch across. These spots are caused by the invasion of the tissue by a bacterial parasite which kills the flesh. The control consists in improving cultural conditions in the orchards, nitrogen fertilizers and spraying.[21]

Grape[22]

Grapes in shipment present two distinct problems. The California and Spanish product is largely one free from field diseases but presents serious problems due to Blue Mold decay in shipment. This comes about from the long haul and the long period over which the grapes are held. The native grapes have at least five serious field diseases, but commonly present but few difficulties in transportation, aside from crushing of fruit and the losses attendant upon improper grading, loading, and stowing.

The difficulties with the California and imported table grapes are largely overcome by the utilization of wooden drums and cork or redwood fillers, while the native grape diseases demand proper field treatments. The California grape shipments show greatest loss due to improper containers, loading and bracing. (Fig. 31.)

Fig. 31. California wine grapes in open lugs, showing loss from poor container, faulty stowing and bracing

[22]GRAPES

Handling and Culture:

Stubenrauch, A. V., and Mann, C. W. Factors governing the successful storage of California table grapes. Dept. Agr. Bul. 35: 1-32; 10 cents.

Husmann, G. C., 1911. Grape propagation, pruning and training. Farmers' Bul. 471: 20 pp.

Spraying:

Hawkins, L. A. Grape spraying experiments in Michigan in 1909. Bur. Plant Ind. Circ. 65: 1-14. Outlines best spray practice for Michigan vineyards.

Grape Diseases

Western Grapes

Tokay, Malaga, etc., Grapes, (European varieties):
Soft rots of fruits, white or blue tufts of fungus, developing from cracked, bruised, or wormy berries, or from dead stems. Blue Mold, Pink Rot, etc.
Corky, deformed berries, often cracked. Fungus makes fern-like brown blotches. Powdery Mildew.

Eastern Grapes

Concord, Moores Early, etc., (American varieties):
Soft rot of berries, white or blue tufts of fungus developing from cracked, bruised, or wormy berries, or from dead stems. (Usually from crushing in basket.)
Blue Mold, Pink Rot, etc.
Brown rotted berries, readily falling from bunch, rotted portion dotted with black pycnidia. Berries bitter, shriveling to a hard raisin-like mummy. Bunches scraggly.
Black Rot.
Hard, red, or brown berries, flesh brown, readily shelling from bunch. In wet seasons berry covered with a white mold.
Red Grape (Downy Mildew.)

Blue Mold

The soft rot of California grapes in shipment is largely to be charged to Blue Mold (Fig. 32), Pink Mold and Botrytis. Bacteria are found but are probably not primarily responsible for the

Fig. 32. Malaga grapes showing loss from Blue Mold, which entered the grapes at the dead stems.

decays. The molds may be distinguished by the typical growths on the cracked or bruised fruit. In the closing shipments of the season, or with fruit that has been under improper conditions, the stems wither and die. Rotting of the fruit is caused by fungi which enter the berries through these dried and withered stalks.

These forms of loss need further attention, but undoubtedly the principles which have worked so successfully for oranges, apples, etc., will hold here where we are dealing with the same type of decay. The shipper must use care in handling, must use the best recommended containers, and must move the shipment in time to insure the placing on the market before the death of the fruit stems.

Western shipments frequently show the results of a serious fungous disease found in the vineyard. The berries of the grape show corky fern-like blotches or markings—the result of the warding off of a fungous invader — the Powdery Mildew, *(Uncinula spiralis)*. Affected grapes

Fig. 33. Rotted fruit, and wizened mummies caused by the Black Rot of Grapes. (Photo by B. O. Longyear.)

[2] Diseases:

Quaintance, A. L., and Shear, C. L., 1907. Insect and fungous enemies of the grape east of the Rocky Mts. Farmers' Bul. 284: 1-32.

Black Rot:

Shear, C. L., and Hawkins, L. A., 1909. The control of Black Rot of grape. Bur. Plant Ind. Bul. 155: 1-42; 15 cents.

Reddick, D., 1911. The Black Rot disease of grapes. Cornell Sta. Bul. 293: 289-313. Monograph of the most serious grape diseases; with full bibliography.

Downy Mildew:

Gregory, C. T., 1915. Studies on *Plasmopara Viticola*. Int. Cong. Vit. Rept. 1915: 126-150.

Powdery Mildew:

Bioletti, F. T., 1907. Oidium or Powdery Mildew of the vine. Cal. Sta. Bul. 186: 315-351. Mildew causes dark fern-like markings or blotches on the fruit of California grapes. In severe cases the berries are deformed and may crack. The cracked berries either dry or are completely destroyed by Blue Mold.

Bioletti, F. T., and Flossfeder, F. C. H.,* 1915. Oidium or Powdery Mildew of the vine. Cal. Sta. Circ. 144: 1-12.

may be cracked or deformed. Such fruit is open to invasion by Blue Mold or other secondary rots.

Various Rots

While the American varieties show soft rots due to Blue Mold, Pink Mold, etc., these are the exception and come only at the close of the season. The mold develops on cracked, bruised, or wormy berries. The common cause is from crushing in the basket.

Fig. 34. Downy Mildew. On young grapes. Note the white fungous growth.

Black Rot

The most serious grape disease is Black Rot. This fungous disease causes brown-rotted berries which fall readily from the bunch leaving scraggly, low-grade fruit. (Fig. 33.) The rotted fruit is bitter, and soon becomes dotted with the black pycnidia of the fungus. The berries shrivel to a hard raisin-like mummy. This is a field disease which starts in the vineyard, where it is known to cause injury to the leaves and canes. It is severe in wet seasons and may cause complete loss of the crop in unsprayed fields. Spraying with Bordeaux mixture, if timely, is a sure remedy.

Downy Mildew

In cold, wet seasons Downy Mildew, which produces on the fruit a firm, brown or red rot, may be important. Affected fruit, if kept moist, becomes covered with a white mold. (Fig. 34.) Such grapes shell badly, the diseased berries rattling from the bunch, leaving skeleton bunches. This disease is also controlled by spraying with Bordeaux.

Small Fruits[24]

The problems of small fruit transportation are not essentially different from those just discussed. Some, such as cranberry, are not excessively perishable, but show enormous losses in the marshes due to the diseases which attack the growing fruit. Carried at the cooler time of the year, they ordinarily keep well and if properly packed show only the common rots which come from bruised or wounded berries.

On the other hand, certain berries, such as strawberries, red raspberries, and blueberries are highly perishable and present different problems. It may be said, however, that if shipments are not unnecessarily delayed, sound, dry fruits, properly cooled, carry safely. Bruised, wet or sweating fruits rot with a great variety of molds. Raspberry shipments have been studied in Oregon by Ramsey, and it was found that the rots due to Blue Mold, and Botrytis, came on fruit carelessly handled, either in picking, hauling to market, or in packing.

Strawberry shipments have recently been studied by pathologists and a discussion of the diseases of this crop may be taken as typical of this class of perishables.

[24]Strawberries:

Fletcher, S. W. Strawberry Growing. Culture, marketing, etc. MacMillan Co.; $1.75.

Wilkin, F. A., 1913. Small fruit culture. Mich. Sta. Spec. Bul. 59. Discusses culture, varieties, insects, and diseases.

R. M. Kellogg Co., 1918. Great crops of strawberries and how to grow them. Annual catalogue.* (Three Rivers, Michigan.)

Schleussner, O. W., and Gilbert, J. C., 1917. Marketing and distribution of strawberries in 1915. Dept. of Agr. Bul. 477: 32 pages. Price 10 cents.

Raspberry:

Ramsey, H. J., 1915. Factors governing the successful shipment of red raspberries from the Puyallup Valley. Dept. Agr. Bul. 274: 1-37; 10 cents. "The most common causes of decay of berries in transit and after arrival on market are mold fungi, principally gray or black mold (Botrytis) and blue mold (Pencillium). Neither of these two fungi seriously attack firm, sound berries, but they quickly attack and cause the decay of berries injured or bruised in handling or soft from being overripe." "The results of these investigations demonstrate that the care exercised in handling and the promptness with the fruit is cooled are among the most important factors determining the distance over which red raspberries can be successfully shipped."

Darrow, G. M., 1916. Dewberry culture. Farmers' Bul. 728: 1-18.*

Darrow, G. M., 1915. Blackberry culture. Farmers' Bul. 643: 1-13.*

Diseases—Anthracnose:

Lawrence, W. H., 1910. Anthracnose of the blackberry and raspberry. Wash. Sta. Bul. 97: 3-18. Discusses disease in general and its control. Points out the importance of causal fungus in producing a rot of the fruit.

Paddock, W., 1897. Anthracnose of the black raspberry.* N. Y. (Geneva) Sta. Bul. 124: 261-274.

Cane Blight:

Stewart, F. C., and Eustace, H. J., 1902. Raspberry Cane Blight and Raspberry Yellows. N. Y. (Geneva) Sta. Bul. 226: 331-366.

Leaf Curl or Yellows:

Melchers, L. E., 1914. A preliminary report on Raspberry Curl or Yellows. Ohio Naturalist, 14: 281-288.

Strawberry Diseases

Rots:

Soft, "leaky" berries. Rhizopus Rot (Black Mold).

A tan-colored, firm rot; fruit sour and bitter, gray mold soon present. Botrytis Rot.

A hard, cork-like rot, involving ¼ to ⅓ of berry. Patellina Rot.

Leaf Diseases (causing shortage of crop).—Not discussed.

Spots on leaves with red or purple margins about gray centers. Leaf Spot.

Dull-red blotches on stunted leaves; mold-like web on under side inhabited by minute red mites. Red Spider

Leaky Strawberries.[25] *(Rhizopus sp.)*

In this rot the fruit is soft and its juice runs out and stains the box and crate. The contents of boxes shrink to one-half or one-fourth their normal size. The causal organism, *Rhizopus sp.*, is one of the black molds and fruits on the flattened berries (Fig. 36) as a grayish-black mold, seen under a hand lens as small, white, hair-like filaments, 1-16 to ¼ of an inch tall, capped with round, black heads. (Fig. 37.) The softening and leaking of the fruit are characteristic of this rot.

Fig. 35. Sound strawberries. (Photo from Kellogg Strawberry Nursery.)

Fig. 36. Leaky strawberries. This rotting is caused by *Rhizopus sp.*

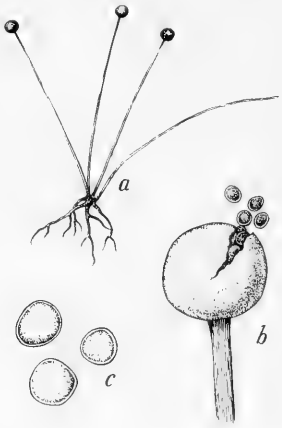

Fig. 37. Fruit Mold. *(Rhizopus sp.)* (a) The common spore form of this fungus consisting of minute stalks each bearing a globular, black spore case at its apex. Somewhat magnified. Spore case breaking open to discharge its spores. (c) Mature spores highly magnified. (After Longyear.)

Botrytis or Gray Mold

In this rot, which is a firm, tan-colored rot, at the start, the fruit does not lose its natural consistency, unless other fungi invade it. A slight surface mold appears which soon becomes brownish-gray due to the fruiting of the fungus. (Fig. 38.) This disease is a prolific cause of loss of fruit in the field, green as well as ripe, and is one of the important causes of loss in transit.

[25]Strawberries:

Stevens, Neil E., 1916. Pathological histology of strawberries affected by species of Rhizopus. Journ. Agr. Res. 6: 361-366.

Stevens, Neil E., and Wilcox, R. B., 1917. Rhizopus rot of strawberries in transit. Dept. Agr. Bul. 531: 21 pages.

Stevens, F. L., 1914. A destructive strawberry disease. Science 39: 949-950.

Cranberries:

Shear, C. L., 1907. Cranberry diseases. Bur. Plant Ind. Bul. 110: 2-38; 20 cents.

Shear, C. L., 1905. Cranberry diseases. Farmers' Bul. 221: 1-8.*

FIG. 38. Botrytis Rot of strawberries. This rot occurs in the field.

Diseased berries quickly mold. Botrytis rot seems to be of field origin and may be a serious factor in shipments.

The Patellina Rot is a firm, spongy rot which shows up on fruit in transit as a sunken tan-colored spot in which the diseased area is sharply differentiated from the sound part. The rotted portion can be removed whole from the healthy surrounding tissue. The fungus fruits on the diseased portion in yellowish, waxy, spore agglomerations. These can be seen with a hand lens as small, rounded, bead-like masses between the seeds. This fruit rot is a field disease of some importance in shipments.

The Control of Strawberry Rots

The control of strawberry rots is a necessary part of successful transportation. The diseases causing loss are, with the possible exception of "Leak" (Rhizopus), contracted in the field. The rotted berries in the field and the great piles of rotted berries about the packing sheds furnish an unlimited source of infection. The removal of the piles of refuse berries, or the burying of them beneath a thick layer of soil are helpful sanitary measures.

The careful sorting while picking, checked by close inspection in the packing shed is probably the chief essential to safe carriage. This sorting should exclude all fully ripe berries, all showing bruise, or incipient rot. The handling should be careful to avoid bruising. Daily, close picking would seem necessary to keep the berries of even grade and to eliminate over-ripe fruit. The berries should be rushed to the iced car without delay. The practice of holding over pickings from one day to the next is strongly to be condemned, as is the hauling of berries in the hot sun without proper shade or on wagons without springs. Strawberries must suffer no delay in transit. It is needless to say that wet berries will not carry so well as dry fruit, although washing with clean, cold water has recently been advocated as a means of getting rid of field heat.

Vegetables[26]

Rotation necessary in growing vegetables. Vegetables are highly perishable. This is due to a complexity of causes. (1) Vegetables are for the most part grown intensively on fields where rotation is not practiced. This method of culture is necessary with some vegetables—for example, celery in an established celery district like Kalamazoo, Mich., cannot be grown in a rotation, because no other crop will yield high enough returns to pay the rent on the land. With certain other vegetables there is no excuse for failure to rotate crops and such a practice may be looked upon as merely a bad habit. The grower reasons that since cabbage did well one year on a certain piece of land, he will put it in again on the same ground. The prolific source of infection to a growing crop is the trash from a preceding crop. Hence, wherever conditions permit, rotation of crops is strongly to be urged.

The container. (2) In many cases the type of container used is not fitted to the product. It may be said that a container which is tight is to be condemned not only because it does not permit examination at market, but because

[26] Egg Plant:
HARTER, L. L. Fruit Rot, Leaf Spot, and Stem Blight of the egg plant caused by Phomopsis vexans. Journ. Agr. Res. 2: 331-338; 25 cents. Describes a field disease of the egg plant which causes the fruit to become soft and mushy, and later black.
WOLF, F. A., 1914. Egg plant rots. Mycol. Centr. 4: 278-287.
Peppers:
FULTON, H. R., 1908. Diseases of peppers and beans. La. Sta. Bul. 101. Discussion of various diseases and control.
PELTIER, G. L., 1912. A consideration of the physiology and life history of a parasitic Botrytis on peppers and lettuce. Ann. Rept. Mo. Bot. Gard. 23: 41-74.
Parsley:
McCLINTOCK, J. A. A disease of cold frame parsley. Va. Truck Exp. Sta. 18: 379-384.* (Sclerotinia libertiana.)
Spinach—General:
KINNEY L. F., 1896. Spinach. R. I. Sta. Bul. 41: 99-131.
HARTIG, L. L., 1910. Spinach troubles at Norfolk. Va. Truck Exp. Sta. 4:61-80.
Spinach Leaf Spots:
REED, H. S., 1910. *Heterosporium variable* Cke. in its relation to Spinacia oleracea and environmental factors. Va. Sta. Rept. 1909-1910: 78-79.*

Fig. 30. Lettuce in hampers, loaded to top of car. Note absence of ventilation channels.

the lack of ventilation sets up the conditions unfavorable for the vegetable and favorable for the decay organisms. In many sections the hamper type is used. A common fault in handling such a container is that of stowing in the car to the utter exclusion of ventilation channels. (Fig. 39.) Southern vegetables of many sorts are tightly packed in barrels using about one-fifth to one-fourth of the space in the barrel for ice. The heads of the barrels are coopered in place. This type of pack may be successful providing no delay at all occurs, but the excessive amount of water, the lack of ventilation and the bruising make this style a rather treacherous one. The growers whose products have a long haul have more nearly solved the container question than those close to great markets. It will be noticed that the most successful shipments are those made in flat crates with slat tops. (Fig. 90.) These, if stowed in the car to permit air channels about each box, with proper cross bracing and stripping, give the maximum assurance of safe delivery. (Fig. 94.) Shippers will find it profitable to standardize their shipments and to study the methods of the successful shippers of the far west.

Decay in transit. (3) Vegetables are usually shipped with tops intact. They are washed, packed while wet, and handled more or less carelessly in various ways in the packing process. The type of pack is usually tight and more or less bruising occurs. The wet condition, bruising, tight pack lead quickly to a soft, slimy, decay of the green parts. This decay is for the most part due to bacteria which are normally not parasitic. They are invaders in tissues that are not in normal condition.

The solution of the problem. It is seen, therefore, that a number of factors enter into the problem of determining the causes of losses in vegetable shipments. The elimination of losses involves discussion as to the importance of each factor in the situation. It would seem that the control of diseases in the field and the adoption of better types of containers are matters that would soon give excellent returns. It must be confessed, however, that this problem is yet to be met, since for the most part investigation of truck crop diseases and marketing has not been done.

Diseases Found in Vegetables in General

Softening of leafy parts to greenish slimy or gluey mass. Bacterial Soft Rots. (Fluorescent bacteria predominating.)
Soft Rot of roots and tubers, material becoming mushy, accompanied by strong creamy bacterial growth. True Soft Rot. *(Bacillus carotovorus.)*
Softening and leaky condition. Pythium Rot.
Gray mold of leafy parts. Botrytis Rot.
White mold of leafy parts of stems and roots, usually accompanied by sclerotium formation. Sclerotinia Rot.
Dead spots on leaves, rusty spots on stems. Various Leaf Spots.

Certain types of decay occur quite generally on vegetables in transit. These may be described as general disease conditions, and must suffice for such crops as asparagus, spinach, parsley, chicory, peppers, carrots, parsnips, etc., which present but few variations from the train of symptoms described here in a general way.

Soft rotting in general. As has been indicated, the maturing or dying of the tops due to the condition of excessive humidity in the containers, or the car, which results from lack of ventilation, quickly leads to decay. In such cases the older leaves are first involved and they show a soft, greenish, slimy rot. In such rotted tissues the fluorescent bacteria predominate. In vegetables rich in protein putrefaction takes place. Gradually the whole plant succumbs. This type of rotting is to be distinguished from the true soft rots.

True soft rots. The true soft rot of vegetables arises from the attack by one species of bacteria, *Bacillus carotovorus*, which has a wide range of hosts. This disease is found in the field as a soft rot of roots, tubers,

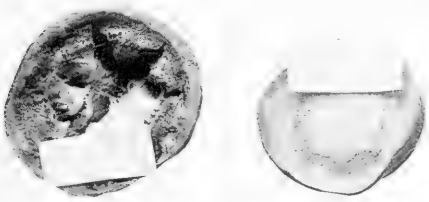

Fig. 40. Carrot at left was inoculated with Soft Rot Bacillus: The one on the right uninoculated; time 36 hours.

or heads, presenting by its attack upon the deeper tissues marked contrast with the previously mentioned rot, which typically begins on the older leaves. In the true soft rots the flesh of the plant becomes mushy, losing all firmness. (Fig. 40.) This comes about because the causal organism forms a substance which dissolves all the cementing layers between the cells. The plant becomes a structure whose bricks (the cells) are without the mortar to hold them together. The rotted plants when in the field or in the car attract insects of various sorts and these are important in the transfer of the germ. The disease is to be looked upon as communicable and must be eliminated from shipments by rigid sorting.

Two common molds are largely responsible. Two molds occur commonly on vegetables in shipment. One of these is the gray mold, Botrytis, and the other is a white mold, *Sclerotinia libertiana*. Both of these molds are common in fields. Botrytis is a weak parasite attacking plant parts that are under humid conditions. *Sclerotinia libertiana* is a more active parasite and is known to produce serious loss of lettuce, celery, parsnips, beans, etc., in the field. (Fig. 41.) This particular fungus does not produce spores on the molded parts, the spread of the disease being wholly by contact. A moldy plant will quickly involve the whole bunch and in a few days the disease will overrun the whole container. After the mold has progressed for some time the fungus produces black bodies, called sclerotia, about the size of a grain of corn. These bodies form a ready means of identification for this mold.

Leak. A soft, leaky condition of vegetables often occurs without the presence of the two molds just mentioned. Many of such cases are due to *Pythium sp.* Again the plants may be overrun with a black mold, *Rhizopus sp.* The latter type of rot can be identified by the fruiting bodies of the fungus, which are threads with black knob-like heads. (Fig. 37.)

Fig. 41. *Sclerotinia libertiana* causing a mold of beans.

Bean Diseases

String or Snap Beans:
- Spots scattered on pod. Maroon to black, circular spots—sunken at maturity; with yellow to pink spore masses. (Most common disease in shipments.) Anthracnose.
- Amber colored to light red blotches. Blight.
- Rotted tips where pods rested on soil. Ground Rot. (Rhizoctonia.)
- White mold, nesting or commonly involving whole package, producing black lumps about size of grain of corn or larger. Sclerotinia Rot.

Dry Beans:
- Black or brown spot, in severe cases rifting skin. Anthracnose.
- Yellow stain, or in severe cases yellowing whole seed, which shrinks slightly. Blight.
- Black or brown, molded seeds. Ground Rot. Caused by various fungi.

Bean Anthracnose.[27] *(Colletotrichum lindemuthianum)*

This disease as seen in the field is to be recognized by the characteristic circular, sunken, maroon or black spots produced on the pod. The spots start as small, reddish dots, which quickly enlarge to about ⅛ or ¼ inch in diameter. They may run together, making a sunken kidney-shaped depression. The diseased areas enlarge, if conditions are humid, and the causal fungus fruits in the sunken portion, forming small, yellow or pinkish masses of spores. (Fig. 42.)

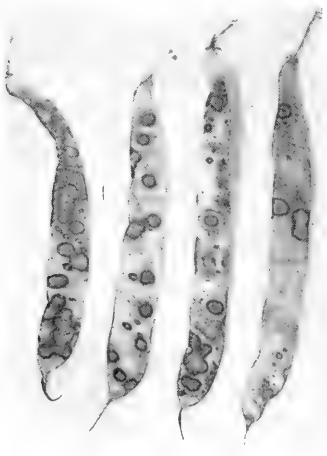

Fig. 42. Bean Anthracnose.

The seeds beneath the spots are affected. In pea beans this infection shows as brownish stains or scars on the seed. Such beans are not marketable, but culls. The pure food law forbids their transportation for use as human food. This disease has given rise to much litigation since unscrupulous canners have sought to can such beans and disguise their inferiority. The small percentage of slightly affected beans that are permitted in the standard market grades of pea beans are not included in the government ruling.

The control of bean anthracnose consists largely in various methods of securing seed free from anthracnose infection. For Louisiana and the southern districts where two crops are grown, the utilization of the beans of the second crop for seed purposes is highly recommended by the Louisiana station, since the hot season effectively rids the beans of infection. For Michigan and the northern bean growing states, short season varieties with seed hand picked to remove all beans with spot or stain are advised. The Michigan Agricultural College has had marked success in eliminating anthracnose from seed stock by growing Michigan beans for seed purposes in the West.

[28]Cabbage Diseases

Cabbage shows the various types of rot described in general for vegetables. In addition two other diseases are of importance in shipments of cabbage.

Found in shipments:
- Heads soft-rotted, usually involving the heart and often associated with true Black Rot; stumps often rotted. True Soft Rot.
- Outer leaves, blackened, soft-rotted, slimy; head within sound. Soft Rot due to fluorescent bacteria. (The Black Rot of the trade.)
- Outer leaves of head showing dead areas with black veins which can be traced down mid rib to heart. Veins show black when stem is cut across. True Black Rot.
- Small circular spots showing concentric markings; on outer leaves only. Alternaria Leaf Spot.

Found in field causing failure of crop:
- Plants with blackened stumps or roots, no heads formed on badly affected plants. Black Leg.
- Plants small, yellow, stunted. Yellows. (Black Rot.)

Black Rot. *(Bacterium campestre)*

This disease is of importance in transportation largely because of the tendency of the diseased cabbage to go down with soft rot which attacks the affected heads. (Figs. 43 and 44.) In the trouble that is commonly called Black Rot in the markets there is merely the blackening and rotting of the outer leaves due to bacterial and

[27] Beans:
Whetzel, H. H., 1908. Bean Anthracnose. Cornell Sta. Bul. 255: 284-307.
Edgerton, C. W., 1910. The Bean Anthracnose.* La. Sta. Bul. 119: 1-55.
Muncie, J. H., 1914. Two Michigan bean diseases. Mich. Sta. Bul. 68: 1-12.
Edgerton, C. W. and Moreland, C. C., 1913. The Bean Blight and preservation and treatment of seed.* La. Sta. Bul. 139: 1-32.

Fig. 43. Soft Rot of cabbage. Note rotted leaves.

Fig. 44. Soft Rot of cabbage. The stumps were rotted so that the tissue was soft and slimy.

mold action. (Fig. 45.) The true Black Rot produces in the outer leaves dead areas which show blackened veins. These can be traced down the midrib to the heart. When the stump is cut across, the water tubes (woody portion) show up as a black ring or as black patches. This disease

Fig. 45. Car of cabbage showing the so-called "Black Rot," that is, outer leaves rotten and blackened as a result of the work of germs made active by the improper conditions within the car.

is caused by bacteria which invade the leaves at the edge, work down the veins into the stump and cause great interference with the water supply of the head.

The disease is controlled by sanitation measures with reference to the soil, coupled with seed disinfection.

Cabbage leaves often show small (⅛ to 1-inch) spots having concentric rings or markings. This is a minor leaf disease, Alternaria Leaf Spot, probably of little importance either in the field or in a shipment.

The cabbage crop in certain sections may fail due to Black Leg *(Phoma lingam)*, a fungous disease introduced on seed into the seed beds. The fungus persists in the soil for several years and thus infested seed beds continue year after year to furnish diseased plants. As high as 90 per cent loss has been found in some fields. (Fig. 46.) Control measures consist in crop rotation, seed bed rotation or disinfection and seed treatment. Cabbage Yellows is a serious disease found in some sections. Affected plants fail to mature heads, dying out before the close of the season. This disease is a "soil sickness" and is controlled by the use of the resistant seed developed at the Wisconsin Station.

Fig. 46. Cabbage Black Leg. Note the rotting off of roots and the form of leaf spot produced.

Celery

Celery is commonly regarded as a highly perishable product. As a matter of fact, properly grown and properly packed celery is one of the least perishable of vegetable products.

The methods in vogue in marketing celery from districts of short haul are sadly in need of improvement. The types and sizes of containers are as numerous as the whims of shippers. One crate manufacturer at Kalamazoo carries in stock 18 different styles and sizes. In such a mixed assortment of cases, stowing in the car to give ventilation is impossible, and bracing to avoid shifting, is difficult. In addition, the market quotations cannot be used to advantage by the grower, since they commonly deal with a different package than the one he uses.

Celery in general is shipped in three ways to meet as many different demands of the market: (1) Washed, in small, tight boxes of one-half dozen or one dozen bunches; (2) Washed, in ventilated crates; (3) In the rough, in open crates.

The first type of container is used for early shipments by express to retail stores, etc., or in straight carloads under fast freight service. This is the container to be recommended for direct shipments from grower to consumer. The celery, being subject to handling and to drying conditions, needs the tight container to protect it from dust and grime and to prevent drying out.

The second type of container—of which the "Michigan High Ball" has proven extremely popular and is quoted in all trade lists—is the container that is of chief value when the crop is moving in quantity. (Fig. 47.) The celery transported in cars or boats with more or less

Insects

Britton, W. E., and Lowry, O. S., 1916. Insects attacking cabbage and allied crops in Connecticut.* Conn. Sta. Bul. 190: 1-23.

Sherman, F., 1911. Insect enemies of cabbage.* N. C. Sta. Bul. 153: 1-43. Besides an account of insect enemies this bulletin has a brief article by F. L. Stevens on cabbage diseases.

Schoene, W. J., 1916. The Cabbage Maggot: its biology and control. N. Y. (Geneva) Sta. Bul. 419: 99-160.* Also published in briefer, popular form.

Chittenden, F. H., 1916. The common Cabbage Worm. Farmers' Bul. 766: 1-16.* Contains also a list of publications by Department of Agriculture on insects injurious to truck crops.

Cabbage, Cauliflower, etc.—Diseases:

Harter, L. L., 1916. Diseases of cabbage and related crops and their control. Farmers' Bul. 488: 1-32.* Discussion and illustrations of the important diseases of cabbage.

Reed, H. S., 1911. Cabbage Club Root in Virginia. Va. Sta Bul. 191: 1-12.

Smith, E. F. Black Rot of cruciferous plants. Bacteria in relation to Plant Diseases. Carnegie Publ. 27 (Vol. 2); 300-353.

Manns, T. F., 1911. Two recent important cabbage diseases of Ohio. Ohio Sta. Bul. 228: 262-275.* Cabbage Yellows and Cabbage Black Leg.

Jones, L. R., and Gilman, J. C., 1915. The control of Cabbage Yellows through disease resistance. Wis. Res. Bul. 38: 1-70. Details investigations in testing resistant winter- and kraut-types of cabbage.

Gilman, J. C., 1916. Cabbage Yellows and the relation of temperature to its occurrence. Annals Mo. Bot. Garden 3: 25-84.

Fig. 47. Michigan "High Ball" crate.

solid stowing does not need to be kept from drying out, but on the contrary needs the ventilation that comes from the open sides and top. The container is large, handling about four times the quantity of the small box. It is clear that this type of container reduces greatly the expense of cases for a crop. As a third important point in the marketing process, the celery within is readily seen—an important feature in making sales. The crates as constructed are light but extremely strong and serviceable. Because of these advantages the "High Ball" crate has become increasingly popular for celery sent to the large markets. Practically all Muskegon, Mich., celery is now shipped in the "High Ball" crate. Other forms of crate are in use, and of these the California (16-inch) is most common.

The third type of shipment—in the rough and in open crates or lugs, is largely used for shipping the crop from districts where celery is grown in large acreages on the one crop basis rather than intensively. Celery is shipped to large warehouses for storage and is washed and trimmed as it is marketed. Since this method economizes labor and permits rapid shipment at the close of the growing season, it seems to be the favorite method for growers with from five to ten acres in celery. The shipments moving in the cool weather in well ventilated crates have little difficulty in transit providing "blight" is not present in the fields.

Celery Diseases Found in Shipments

Large, slate-colored spots on leaves; brown, sunken blotches on stems, disfiguring but not causing rotting.
Early Blight. (Cercospora Leaf Blight.)

Small, brown, sunken spots on leaves, no pycnidia present, disfiguring but not rotting, resembles Septoria Leaf Spot.
Bacterial Leaf Spot.

Small, dead spots on leaves, dotted with black specks (pycnidia). Disfigures leaves, leads quickly to rotting of outer leaves of the plant.
Septoria Leaf Spot. "The Blight."

Soft, slimy rot of outer leaves.
Soft Rot due to fluorescent bacteria. (Cf. page 27.)

Soft, slimy rot of heart leaves.
True Soft Rot.

White mold, involving entire plant or even the whole bunch.
Sclerotinia Rot.

Septoria Leaf Spot or Celery "Blight."[29]
(Septoria apii)

This disease may readily be diagnosed by the small, dead spots which are peppered with small black dots—the fruiting bodies of the causal organism. (Fig. 48.) Blighted leaves lead in two or three days to rotting of the stalks when the celery is kept in a humid condition. The outer leaf stalks soften and rot away, leaving the heart as the only salable portion.

Septoria Leaf Spot is a disease which starts in the seed bed either from spores on the seed or from the trash of the preceding crop. It develops slowly under cool conditions, two to three weeks is necessary to mature spores after infection takes place. The spores are spread by splashing rains or by cultivation when the plants are wet. Infection occurs on the heart leaves from spores

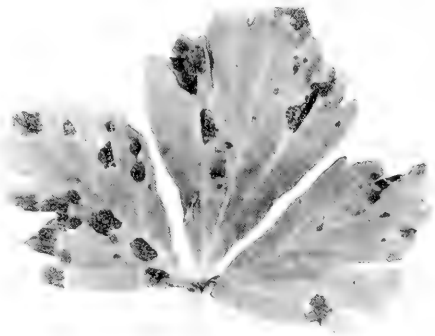

Fig. 48. Septoria Leaf Spot of celery, "The Blight." A diseased leaflet magnified four times. (Mich. Sta. Bul. 77.)

[29]Celery:

Coons, G. H., and Levin, E., 1916. The Septoria Leaf Spot disease of celery or "Celery Blight." Mich. Sta. Spec. Bul. 77: 1-8.* Blighted celery is notorious for its decay under transportation conditions. This bulletin indicates the nature of the problem and its solution.

Rogers, S. S., 1911. The Late Blight of celery. Cal. Sta. Bul. 208: 83-115.* Discusses the Septoria Leaf Spot disease and its control under California conditions.

that wash from older parts. The long growing period of the fungus leads the grower into a false sense of security. The disease may make a field look badly blighted due to the killing of the older leaves. Then the growth from the heart turns the field green again. These leaves, in turn, blight—the disease being present all the time in hidden form. Such a story is repeated over and over throughout the season. The disease is readily controlled by summer spraying with Bordeaux mixture. At a cost of $12.00 a grower saved a $1,500 crop of celery in a Michigan spraying experiment. (Fig. 49.)

Fig. 49. Sprayed and unsprayed celery. Sprayed crop yielded $1500, unsprayed was worthless. Cost of spraying $12.00. (Mich. Sta. Bul. 77.)

This disease must be looked upon as the most important factor in celery growing. Its control is sure if the crop is properly sprayed. Sprayed celery arrives on the market in good condition, blighted celery is notorious for its rotting.

Early Blight. *(Cercospora apii)*

This disease produces large (¼-inch) slate-colored spots on the leaflets of celery. (Fig. 50.) These spots do not show the black specks seen in the Septoria Leaf Spot. On the stalks, brown, sunken, disfiguring blotches occur, but this disease does not lead to rotting. Early blight is more common on celery from the south than on the Michigan or New York crop, but the disease may be expected to be important in the northern districts, especially with the green varieties in hot, dry seasons. It is controlled by the Bordeaux spray.

Bacterial Leaf Spot

This disease greatly resembles the spots found in Septoria Leaf Spot. The spots in the bacterial disease do not show the black dots characteristic of the Septoria trouble. Bacterial Leaf Spot does

Fig. 50. Early Blight of celery.

not lead to rotting in the field or transit. It is likely to be mistaken for the blight. (Fig. 51.) Celery with tops disfigured by this disease does not bring so high a price as the healthy plants. New York experiments indicate the value of Bordeaux mixture in the control of this disease.

Fig. 51. Bacterial Leaf Spot of celery.

Sclerotinia Rot

As has been described for vegetables in general, celery decays through the attack of *Sclerotinia*

Fig. 52. Sclerotinia Rot of celery. This is the so-called "Pink Rot" which causes loss in trenched celery.
Fig. 53. Bacterial Soft Rot of celery.

libertiana. (Fig. 52.) This fungus attacks a wide range of hosts, but members of the parsley, carrot, celery family are especially subject to attack. The chief loss in storage of these vegetables arises from this parasite. With celery the disease starts as small, shrunken areas at the base of the outer leaf stalks, resembling somewhat the injury by slugs, etc. Under moist conditions the celery decays with a white mold which overruns the specimens. Winter celery in dirt trenches is very subject to this disease, which sometimes makes all the celery in a trench worthless. The disease is favored by excessive moisture in the soil and draining does much to eliminate the losses. Frequent cultivation, because of its value in assisting in ventilation, and in the prevention of crust formation on the soil is to be recommended. Spraying is not of use and dependence must be placed upon sanitation methods consisting of destroying diseased plants, etc.

Bacterial Soft Rots

Celery is subject to two types of rotting. The one is the general softening of tissues by the fluorescent bacteria. This type of decay comes on the older leaves and is prevalent on celery which has been kept for a long time in improper conditions. The other type of soft rot is due to a parasite, probably the true soft rot organism, *Bacillus carotovorus.* Celery in the field is commonly attacked and shows rotting of leaves and leaf stalks along with decay of the heart. In cold fall weather, the bacterial leaf spot previously described does damage by causing rotting of the petioles of the leaflets. The Soft Rot commonly starts with the youngest leaves thus differing from the other types of rots. This rot is spread by insects and the germs persist in the soil as the disease seems to become worse on succeeding crops. Rotation and other sanitary measures are all that can be recommended. Close sorting of celery in packing is necessary.

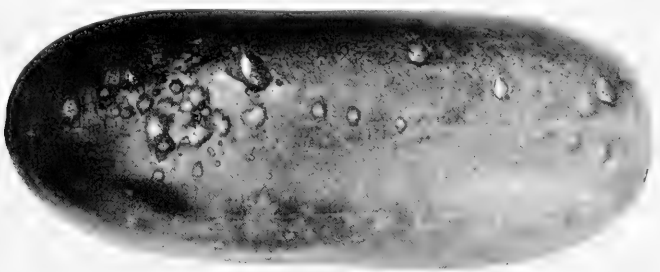

Fig. 54. Anthracnose of watermelon. The sunken spots are often pink with the fungous spore masses.

Diseases of Watermelon, Muskmelon, and Cucumber[30]

Coal-black rot at stem end; skin dotted with pycnidia in late stages; often covered with saprophytic molds; on watermelon. Stem End Rot. (Diplodia.)

Coal-black rot at blossom end usually; skin smooth, spot ½ to 1-inch in diameter in field; increasing rapidly in transit, on watermelon chiefly. Pythium Rot.

Discolored skin and flesh where melons touch floor or sides of improperly cleaned car. Chemical injury. (Lime, etc.)

Sunken spots, soon pink with spore masses of fungus. On watermelon, muskmelon, and cucumber. Anthracnose.

Sunken spots, soon olive-green with fungous growth. On cucumber only. Scab, "Spot Rot."

Fruit sound but of poor flavor, netting, and quality. On muskmelon. Alternaria Leaf Blight.

Fruit soft-rotted, moldy, etc., rot starting from crate bruises or injury on stem end.
Bacterial Soft Rot, Rhizopus Rot, Botrytis Rot, etc.

Fruit showing brown, water-soaked spots, which rapidly enlarge making the fruit leaky. Rotted flesh brown; known only on cucumbers from Florida. Cucumber Rot.

Anthracnose. *(Colletotrichum lagenarium)*

This disease is known as a serious disease of watermelons, muskmelons, and cucumbers. It shows on the fruit by the production of sunken, depressed spots ½ to 1-inch in diameter. (Fig. 54.) These spots may merge, giving the affected fruit a rugged contour. Under moist condition the anthracnose fungus *(Colletotrichum lagenarium)* fruits by the production of pink spore masses. This disease is an important factor in the culture and transportation of cucurbits. The control of the disease in the field depends upon spraying with Bordeaux mixture, crop rotation and the use of disease-free seed.

Stem End Rot.[31] *(Diplodia sp.)*

In this disease which, so far has been shown by investigation is chiefly of importance on watermelon, there is produced a coal-black rot starting at the stem end. The fruit in the later stages is dotted with the pycnidia of the causal organism. Saprophytic molds spring up and complete the destruction of the affected melons. The disease is caused by a wound parasite (Diplodia) which enters the fruit at wounds or at the broken stem. This disease has caused enormous damage. It is probable that a large part of the injury to melons attributed to chemical fertilizer left in the cars, improperly cleaned cars, etc., is in reality due to this and to the anthracnose fungus. The accom-

Fig. 55. Stem End Rot of melon. The fungus enters at wounds or at the cut end of the stem.

[30]Cantaloupes, Cucumbers, Watermelons, etc.—General:

More, C. T., and Branch, G. V., 1916. The commercial grading, packing and shipping of cantaloupes. Farmers' Bul. 707: 1-23.

Blinn, P. K., 1906. Development of the Rockyford cantaloupe industry. Col. Sta. Bul. 108: 1-17.

Schleussner, O. W., and Kitchin, C. W., 1916. Marketing and distribution of western muskmelons in 1915. Dept. of Agr. Bul. 401: 1-35; 15 cents.

Lloyd, J. W., 1912. Fertilizer experiments with muskmelons. Ill. Sta. Bul. 155: 25-64.*

Corbett, L. C., 1906. Cucumbers. Farmers' Bul. 254: 1-30.* General bulletin indicating cultural practices for both field and greenhouse.

Postiff, W., 1913. Cucumbers as a cash crop. Mich. Sta. Circ. 19: 4 pages.* Outlines Michigan field practice.

Spraying:

Orton, W. A., 1905. Spraying for cucumber and melon diseases. Farmers' Bul. 231: 1-24.* (See also Bul. 254.) Discusses briefly various cucumber and melon diseases and details successful spraying experiments at Charleston, S. C.

Johnson, T. C., 1911. Spraying cucumbers and cantaloupes. Va. Truck Exp. Sta. Bul. 5: 85-100.* Discusses successful spraying experiments at Norfolk, Va.

Jarvis, C. D., 1912. Spraying cucumbers and melons. Conn. Sta. Bul. 72:* 1-32. Gives recommendations for control of melon diseases in Connecticut based on nine years' observations. Spraying was found to injure cucumber blossoms.

Soft Rots:

Giddings, N. J., 1910. A Bacterial Soft Rot of muskmelons caused by *Bacillus melonis* n. sp. Vt. Sta. Bul. 148: 392-416. Technical description of a bacterial rot found severe in Vermont fields.

Burger, O. F., 1914. Cucumber Rot. Fla. Sta. Bul. 121: 97-108.* Discusses a rot of Florida cucumbers found to be the cause of serious loss in transit. Gives full advice as to picking and packing of fruit in order to prevent "leaky" shipments.

Bacterial Wilt:

Smith, E. F. Cucumber Wilt. Bacteria in relation to plant diseases. Carnegie Publ. 27 (Vol. 2): 209-299.

Rand, F. W., and Enlows, E. M. A. Transmission and control of Bacterial Wilt of cucumbers. Journ. Agr. Res. 6: 417-434. Wilt germs shown to be carried over winter by the cucumber beetle.

Mosaic:

Gilbert, W. W.; Doolittle, S. P.; Jagger, I. C. Cucumber Mosaic Disease. A new infectious Mosaic. Experiments with the cucumber Mosaic Disease. Phytopathology 6: 143-151.

[31]Orton, W. A., 1917. Watermelon diseases. Farmers' Bul. 821: 1-18.*

Stem End Rot:

Meier, F. C. Watermelon Stem End Rot. Journ. Agr. Res. 6: 142-152; 15 cents. A black rot of watermelons in transit is shown to be caused by a fungus (Diplodia).

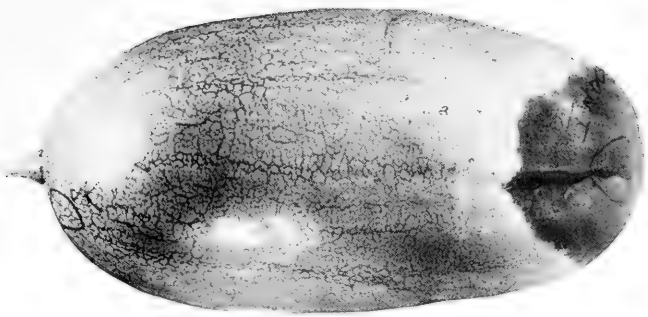

Fig. 56. Rot of watermelon caused by Pythium (artificial inoculation).

panying recommendations of the U. S. Department of Agriculture should be adopted.[*]

Pythium Rot.[32]

This rot greatly resembles the Stem End Rot in its effect upon the watermelon. The fruit turns black, but it does not show the small black dots characteristic of the other blackening disease. The flesh of pink varieties becomes a yellowish white. While Pythium, the causal organism, can produce a rot irrespective of the point of entry, it is usually found in the fields as a rot of the blossom end. (Fig. 56.) Green as well as ripe melons are attacked. This rot progresses very rapidly and can completely involve a melon in a week. Secondary molds and bacteria enter and complete the work. Artificial inoculations into muskmelons and cucumbers have shown that the fungus can produce a leaky condition in these fruits.

This disease is new to science and its importance is not known. The trouble was found in two Michigan fields in 1916. It is undoubtedly of wide distribution and is probably of considerable importance. Control measures are not known. Doubtless some varieties will be found less susceptible than others. This type of fungus is more prevalent in wet than in dry seasons Close sorting in loading is necessary since affected melons will not carry and are a source of danger to other melons.

Cucumber Scab,[33] "Spot Rot." *(Cladosporium cucumerinum)*

Cucumbers alone seem subject to this disease. Small spots about ⅛ inch in diameter appear on the fruit, usually accompanied by beads of gum. These spots are soon felted with the olive-green

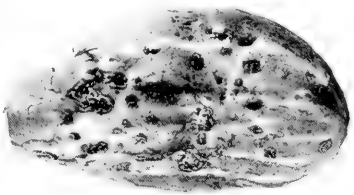

Fig. 57. Cucumber Scab.

growth of the causal fungus *(Cladosporium cucumerinum)*. (Fig. 57.) Scabby cucumbers decay rapidly, softening over night under hot, humid conditions. The term applied by growers, "Spot Rot," is a very suggestive name.

[*](1) Cut and burn all weeds around the field and along ditch banks during the winter.

(2) From the time that the melons set on the vines, all cull fruit should be hauled out of the field weekly and fed to hogs, or deeply buried. Wash the wagons used for hauling culls with a two per cent blue-stone solution.

(3) Spraying with Bordeaux mixture for anthracnose will probably help control stem-end rot.

(4) Laborers harvesting melons should never cut or touch a decayed melon.

(5) Cut melons with long stems and load into cars with the least possible delay and with the utmost ease in handling, to avoid bruising. Open car ventilators.

(6) Most important of all, apply a paste made of common starch with six per cent blue-stone to the freshly cut stems as the melons are being packed in the car. It has been found that disinfecting the stems at other times is less effective, as the paste is rubbed off by handling.

As the packer arranges the melons in tiers, have him place the stem end outward, while a reliable boy cuts off a section of the stem and applies a covering of paste with a small, round brush.

(7) Freight cars that have contained decayed melons or yard refuse should be washed clean and sprayed with a two per cent solution of blue-stone.

[32]Nelson, Ray. A rot of watermelon caused by Pythium. Paper read at meeting of the Bot. Soc. America, 1916. A parasitic fungus, *Pythium sp.*, was found to be the cause of rotting of watermelons in fields of Michigan. The fruit blackens, but the skin remains smooth without evidence of fruiting body formation. Rapid progress of disease in inoculation experiments indicates that the fungus may be of importance in shipments of melons. The rot is usually at the blossom end of the melon.

[33]"Cucumber Scab or "Spot Rot":
Doolittle, S. P., 1915. Cucumber Scab. Mich. Acad. Sci. Rept. 17: 87-116.

This is a field disease which frequently ruins the pickle crop. Its control is difficult, but doubtless applications of Bordeaux mixture timed to give protection at rainy periods, will be found effective.

Cucumber Rot[30]

Cucumbers from Florida have for several years been subject to rot in transit. The cucumbers left the field in seemingly healthy condition, but by the time they reached the market they were leaky. The cucumbers show on the outside a brown water-soaked spot. This starts as a minute dot but enlarges in a few days to a sunken spot ¼-inch to ½-inch in diameter. The fruit goes down rapidly when once the rotting reaches the seed cavity. (Fig. 58.) This disease is caused by a bacterial organism which is capable of causing spots on the leaves and of penetrating unwounded cucumbers. Its effect is much more rapid if the organism enters through a wound. Great care in handling is essential. Affected cucumbers should not be packed. The rotted cucumbers should not be left lying about the packing house. Piles of refuse should be covered with a heavy layer of soil. Spraying with Bordeaux mixture is of some value.

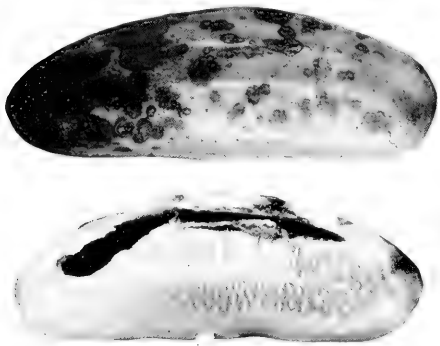

Fig. 58. Cucumber Rot. Note the brown, water-soaked spots on the surface. The rot progresses rapidly in the flesh.

Alternaria Leaf Blight.[31] *(Alternaria nigrescens)*

This disease, which so far as known is restricted to the muskmelon, is one in which there is no rotting of the fruit. It is a trouble which shows up in fields—chiefly in seasons of plentiful rainfall—as a blighting of the foliage. Affected leaves show small, yellow or brown spots, which enlarge and eventually cause drying and death. The killing of the leaves has a profound effect on the fruit. All the starch and sugar in the melon is made by the leaves under the influence of sunshine. When this fungus cripples the leaves the fruit fails to mature properly and a small set of poorly netted fruit of inferior quality results. Many think such a flavorless muskmelon is the result of a cross with a pumpkin! Muskmelons in regions where the crop is grown for some time become an uncertain crop.

The control of this disease is easy. All three of the principles of plant disease control are involved. It is first of all necessary to rotate the crop. Muskmelon growers often refuse to do this and lack of rotation means certain failure. Secondly, the crop must be sprayed regularly with Bordeaux mixture beginning with the plants in the cold frame. And thirdly, the varieties resistant to the disease should be used. In the Rockyford district the Pollock Netted Gem has demonstrated its superiority. It is to be recommended for trial in other localities. All growers should seek to make their own selections of desirable, resistant strains.

Various Rots

Melons, if bruised in handling, or if picked so that the stem is torn off, or if wounded by pressure in the crate, become rotted by a variety of fungi and bacteria. The bacterial soft rots are as yet unstudied. Rhizopus, Penicillium, and Botrytis, well known from their attacks on other products, are found here as agents of decay in the fruits with broken skins. (Cf. Figs. 91, 92, 93.)

Chemical Injury

Much of the damage to shipments of watermelons has in the past been attributed to the action of chemical substances such as fertilizers and lime in the cars. Undoubtedly these will damage watermelons when in contact with the surface for any length of time. Where watermelons touch the sides or floors of cars which are covered with the lime, the point of contact on the melon will be found injured by the caustic action of the chemical. This injury often extends through the rind to the flesh. Saprophytic fungi and bacteria invade this injured area and cause rotting. Rhizopus and Blue Mold are most commonly found associated with this type of trouble. Cars that have been used for transporting lime or chemicals should not be used for melons without thorough cleaning.

[30]Blight or Leaf Rust:
Blinn, P. K., 1905. A rust-resisting cantaloupe. Col. Sta. Bul. 104: 1-14. Details of the discovery of the Pollock variety.

Lettuce Diseases[35]

Slimy, stringy rot involving outer leaves, proceeding from dead tips. Bacterial Soft Rots.

White Mold, usually coming from infected outer leaves or from stump; black sclerotia usually present. Sclerotinia Rot.

Gray mold, usually on older leaves. Botrytis Rot.

Leaves with rusty spots or shot-hole perforations; midribs with elongated, rusty depressions. Anthracnose.

Soft Rot

Shipments of head lettuce either in hampers or boxes, show decay beginning with the edge of a leaf and following the affected leaf into the head. (Fig. 59.) An outer circle of leaves may be sound, while an inner is completely rotted.

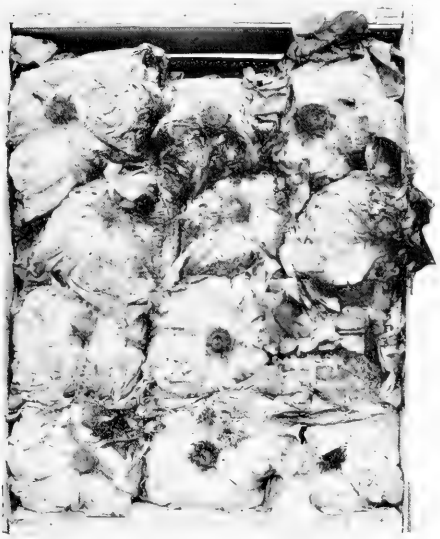

Fig. 59. Lettuce Soft Rot. This rot causes great loss in the handling of head lettuce.

The decay is a soft, slimy rot which makes rapid progress in cars where conditions are not the best. Decays of similar nature have been found in the field, having been reported from Louisiana, New York, and Michigan. Whether these field troubles are due to the same organism and whether they are the same as the rot occurring in shipments are points as yet not determined.

This form of rot is a serious problem to lettuce shippers. Lettuce should be handled under refrigeration and greatest care must be taken to provide ventilation. Cars must not be filled too full. The tight stowing of boxes and hampers leads to wide differences in temperature between the bottom and top of the car, and correspondingly great losses in the top tiers. The hamper is a more costly container than the box and lettuce is more subject to rot in it. It does not lend itself readily to a method of stowing which provides ventilation channels.

In the field, the disease may be associated with the burning of the tips of the leaves, such as comes about from inequalities in the water supply, sun-scorch, etc. Levin,[35] of the Michigan Experiment Station, checked an outbreak of soft rot by spraying with weak formaldehyde. [1-400.] Shading with cheesecloth might be of value in preventing the tips of leaves from burning. The disease is to be expected to be more severe in years of high temperature and scanty rainfall.

Sclerotinia Rot (Cf. Fig. 41) and the Gray Mold (Botrytis) as found on lettuce present the usual signs shown by these parasites on vegetables in general. These are diseases common on lettuce in greenhouses and should be eliminated by proper greenhouse practices.

The Anthracnose does not lead to rotting or decay but is merely disfiguring. Affected leaves show shot-hole perforations and the stems, rusty depressions. The causal fungus is spread in the greenhouse by watering with the hose and the disease is controlled by sub-irrigation or by the use of an overhead sprinkling system. Bordeaux is also of value as a controlling spray.

[35]Lettuce:

Rogers, S. S., 1917. Lettuce growing in California.* Cal. Sta. Circ. 160: 16 pp. Summary of California crop practices; richly illustrated. Short account of diseases.

Stevens, F. L., 1911. A Serious Lettuce Disease. N. C. Sta. Bul. 217: 7-21.* Discusses the disease caused by *Sclerotinia libertiana* and its control.

Burger, O. F., 1913. Lettuce Drop. Fla. Sta. Bul. 116: 27-32. Popular account of the disease caused by *S. libertiana*

Brown, N. A., 1915. A Bacterial Disease of Lettuce. Journ. Agr. Res. 4: 475-478; 25 cents. Technical description of an organism isolated from plants from Louisiana which produces a soft slimy rot on the heads.

Levin, E., 1917. Control of Lettuce Rot. Phytopathology 7: 392-393.

[36]Onion Diseases

Soft Rots:

Soft Rot, white or yellow, slimy, with strong putrefactive odor; rot proceeding from neck into a centre scale. Bacterial Soft Rot.

Gray Mold accompanied by soft rot and water-soaked condition of scales, beginning at the neck; black, scale-like sclerotia present. Botrytis Neck Rot.

Sooty Blemishes:

Smutty or sooty black powder formed in long rifts in leaves. Disfiguring, no rot caused. Onion Smut.

Smutty, purple-black powder formed in ridges between outer scales, or in masses in outer portions. Sterigmatocystis Mold.

Black or olive-green fungous masses on outer scales, forming concentric rings or fan-like blotches; on white onions. Onion Smudge.

Rots

Onion Soft Rot

Little is known of this type of trouble although it is often the cause of important losses in transportation. The large pile of ill-smelling, rotted onions is a common sight in railroad yards. The bacteria commonly invade the onions from the tops and advance down one of the interior scales, leaving the outer ones intact. (Fig. 60.) The rotted onions are soft and mushy and gradually the entire bulb is involved. While investigation has not been made, it is likely that the germs enter the plants in wounds made in the topping process, hence the disease is to be expected to be most serious in years when the onions are not fully matured at harvest time. Both the Spanish onions and the ordinary commercial onions show this type of rotting.

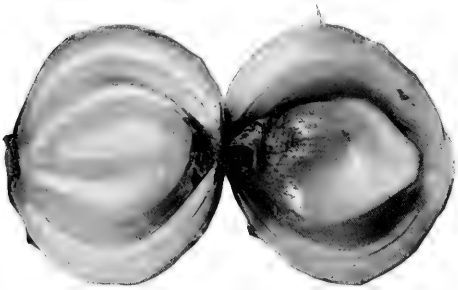

Fig. 60. Onion Soft Rot. The onion scales soften with an ill-smelling rot.

Neck Rot.[37] *(Botrytis allii)*

This is a soft rot of the onion in which the bulb softens but does not become mushy or slimy as in the bacterial rots. In this rot the decay usually advances from the outer scales inward. On rotted onions the fungus fruits as a gray mold. On the necks or at the bases the resting bodies form black, lumpy, fungous masses, called sclerotia. (Fig. 61.)

This disease is common in onion fields. It causes great shrinkage of onions in storage. In cool, well ventilated storage houses, the losses

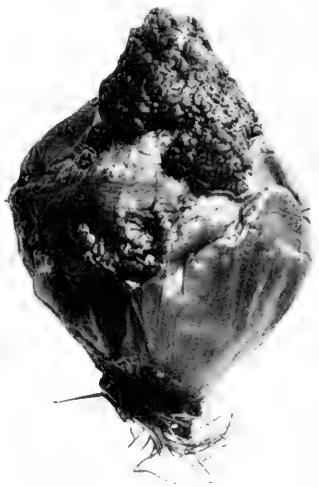

Fig. No. 61. Neck Rot of onion. (Photo by M. T. Munn.)

are greatly reduced. In seasons when onions do not mature, loss is greatest. Injury in topping is in many cases responsible for the trouble.

Blemishes

The characters of these diseases are shown by the figures. They are not factors in causing decay. Onions seriously affected with these diseases are not of highest quality. Onion smut *(Urocystis cepulae)* is more serious as a seedling disease. It is the chief cause of poor stands and yellowed, weakly plants. It is controlled by using

[36]Onion Culture and Diseases:

Halligan, C. P., 1914. Onion culture on muck lands. Mich. Sta. Spec. Bul. 67: 1-18.

Sayre, C. B., 1916. Commercial onion growing. Purdue Sta. Circ. 57: 1-27.

Stewart, F. C. A bacterial rot of onions. New York (Geneva) Sta. Bul. 164: 109-212.

Whetzel, H. H. Onion blight. New York (Cornell) Sta. Bul. 218: 140-161.

Chittenden, F. H. Insects injurious to the onion crop. Dept. Agr. Yearbook 1912: 319-334. Sep. No. 594, 5 cents.

[37]Onion Neck Rot:

Munn, M. T., 1917. Neck Rot disease of onions. New York (Geneva) Sta. Bul. 437: 363-455.

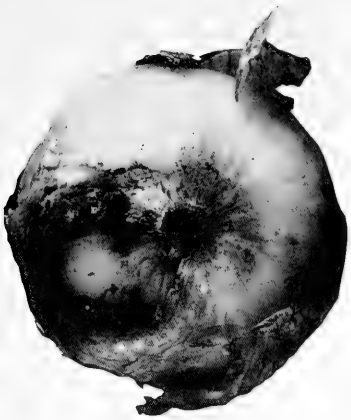

Fig. 62. Sterigmatocystis Mold of onion.

a liquid fertilizer attachment on the onion drill and dropping a few drops of weak formaldehyde about the onion seed when planted. For the other diseases no control measures have been suggested.

Fig. 63. Onion Smudge.

Bermuda and Texas onions show a considerable amount of loss from the blemish caused by the growth of the Sterigmatocystis mold. (Fig 62.) This fungus causes a death of the outer scales and a purplish-black sooty deposit in the ridges. It is called "smut" by the trade.

Similarly the disfiguring sooty growth of the Onion Smudge fungus *(Vermicularia circinans)* (Fig. 63) is confused with smut by the trade. Smudge is a disease contracted in the field. Its chief damage is done to the white onions.

Potato Diseases[38]

Rots:

- Sunken, lead-colored or pinkish pits distributed over tubers. Flesh brown when skin is scraped away. Heart sound at first. Rot progresses into a wet or dry rot depending on conditions. Rotted tubers dotted with gray-white fungous masses. Late Blight Rot.
- Soft, black rot of the flesh, beginning at stem end and typically forming canals lined with bacterial slime. Black Leg.
- Sunken, withered, bluish areas on surface of tuber. Rot, typically, dry and powdery at surface, cheesy within. Fungus fruiting bodies pink or salmon color. Various Fusarium Rots. "Powdery Dry Rot."
- Potatoes soft, leaky. Frost Injury (page 50). Leak. (California shipments.)
- Potatoes rotting with slimy, stringy bubbling rot; putrifactive odor. Bacterial Wet Rot.
- Potatoes soft at end. Jelly End Rot. (Fusarium.)

Flesh Discolorations:

- Vascular ring at stem end of tuber brown or black. Fusarium Wilt.
- Heart of tuber coal black, sometimes hollow. Black Heart.
- Heart of tubers cleft, browned. Hollow Heart.
- Fibers of tubers black, making the flesh netted or blue-gray; potatoes shrunken or withered. Chilling Injury.
- Fibers of tubers, from vascular system outward, black; flesh netted. Potatoes sound, disease found in field. Net Necrosis.
- Flesh showing rusty flecks. Internal Brown Spot.
- Flesh shriveled, blackened, of salty taste. Salt Injury.

Blemishes—Scabbiness:

- Scab spots usually large (¼-inch or sometimes covering whole potato). Skin corky in certain portions, or entirely involved due to merging of scab spots. Spots with radiating border, corky texture. Common Scab.
- Scab spots small; appearing as oval, bulging spots, border a fringe of rifted epidermis; brown-black within and of powdery texture. Powdery Scab.
- Scab spots deeply pitted. Deep Scab.

Scurfiness:

- Brown to black lumps, scattered on surface, resembling dirt; will not wash off. Purple-black when wet. Black Scurf. (Rhizoctonia.)

Late Blight and Rot of Tubers.[39] *(Phytophthora infestans)*

This disease is the most important disease of potatoes. Periodically great epidemics of the disease occur. In such years the handling of shipments of potatoes from the northern states is a very uncertain thing. Carloads will start in seemingly good condition and arrive completely rotted. Many large shippers are refusing to buy potatoes during blight years.

The cause of this decay is a fungous parasite which produces sunken, lead-colored or pinkish pits or spots, scattered on the tuber. (Fig. 64.) The flesh is seen to be brown when the skin is scraped away. (Fig. 65.) The center of the potato is sound at first but becomes brown or black as the disease progresses. Under moist conditions the tubers become soft and slimy due to secondary action of bacteria. Under dry conditions the affected tubers wizen into a hard, dry

mass. The fungus fruits on diseased tubers by producing grayish-white tufts of fungous threads.

This disease also produces a blighting of the top, whole fields being killed as if by frost. The disease on the tuber results from spores washed from blighted tops.

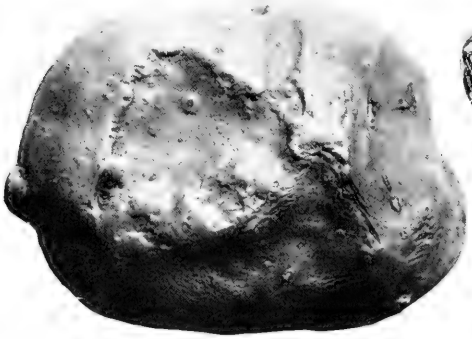

Fig. No. 64. Late Blight of potatoes.

This disease can be controlled by spraying the tops four or five times with Bordeaux mixture. In the northern states when July is wet and cool late blight may be expected and all potatoes should be sprayed.

Fig. 65. The Effect of Late Blight on flesh of the potato.

Black Leg. *(Bacillus atrosepticus)*

This is a soft, black rot which begins at the stem end of the tuber. Canals are rotted into the flesh. The flesh bordering these canals turns black. The rotted portions become covered with a creamy, bacterial growth. Plants from tubers

[8]Potato Culture, etc.:

GILBERT, A. W., 1915. The Potato. MacMillan, $1.75. Discussion of potato culture in all its phases. The section on potato diseases is contributed by Dr. M. F. Barrus, and is probably best popular account of potato troubles.

GRUBB, E. S., and GUILFORD, W. S., 1912. The Potato. Doubleday, Page & Co., $2.00.

WAID, C. W., 1917. Suggestions for growing potatoes. Mich. Extension Bul. 7: 6 pp.* Brief popular account of best Michigan cultural practices, containing directions for seed treatment and spraying.

MILWARD, J. G., 1917. Potato growing in Wisconsin. Wis. Sta. Bul. 280: 26 pages.* Excellent summary of best Wisconsin practices.

GILMORE, J. W., 1917. Potatoes in California. Cal. Sta. Circ. 161: 8 pp.*

MORE, C. T., and DORLAND, C. R., 1916. Commercial handling, grading and marketing of potatoes. Farmers' Bul. 753: 1-40.

Handbooks of Potato Diseases:

ORTON, W. A., 1913. Potato tuber diseases. Farmers' Bul. 544: 1-16.*

TIMPAU, C. E., 1914. Potato Diseases. Idaho Sta. Bul. 79: 1-28.*

COONS, G. H., 1914. The potato diseases of Michigan. Mich. Spec. Bul. 66: 26 pp. This bulletin gives a popular account of the diseases of the potato: Late Blight, Early Blight, Scab, Rhizoctonia, Dry Rot, Wet Rot, and Dry Scab. These are discussed under the topics: signs, losses and control measures. Dangerous diseases as yet not reported for Michigan are described. The discussion of Late Blight, Scab, Rhizoctonia, Wet Rot, and Dry Rot will be of interest to potato shippers.

ORTON, C. R., 1916. Potato diseases. Penn. Sta. Bul. 140: 1-37.* Illustrated handbook of potato diseases containing also a discussion of injuries to the tubers caused by weather, soil, chemicals, insects, and rodents.

COOK, M. T., 1915. Potato diseases in New Jersey. N. J. Sta. Bul. 53: 3-23.* Brief popular account with directions for control.

STAKMAN, E. C., and TOLAAS, A. G., 1912. Potato diseases. Minn. Extension Bul. 35: 1-16. The object of this paper is to describe the various potato diseases occurring in the state in order that they may be recognized and appropriately treated.

JONES, L. R., 1914. Control of potato diseases in Wisconsin. Wis. Sta. Circ. 52: 16 pp. Clean seed, clean soil, clean crop.

HAWKINS, L. A., 1916. The disease of potatoes known as Leak. Journ. Agr. Res. 6: 627-640; 15 cents. The fungi, *Rhizopus nigricans* and *Pythium deBaryanum* entering the potato through wounds, cause excessive rotting of California potatoes in transit. Pythium is a soil fungus and "infection apparently takes place in the field by some of this infected soil getting into wounds made in digging." Advises more care in harvesting, handling, and sorting.

ORTON, W. A., 1909. The decay of potatoes due to *Rhizopus nigricans*. Science 29: 916 (Abstract).

ORTON, W. A., 1909. Potato diseases in San Joaquin County, California. Bur. Plant Ind. Circ. 23: 1-14; 5 cents. "Leak" in storage or transit is found due to *Rhizopus nigricans*.

[9]Late Blight:

JONES, L. R., GIDDINGS, N. J., and LUTMAN, B. F., 1912. Investigations of the potato fungus, *Phytophthora infestans*. Vt. Sta. Bul. 168: 1-100. Also printed as Bur. Plant Ind. Bul. 245: 1-100. Monograph of the most important plant disease. Extensive bibliography.

BARRUS, M. F., 1913. Late Blight and Rot of potatoes. Cornell Sta. Circ. 19: 77-83. Popular account of this disease.

[10]Fusarium Wilt:

MANNS, T. F., 1911. The Fusarium Blight (Wilt) and Dry Rot of the Potato. Ohio Sta. Bul. 229: 299-336.* Discusses disease in field and as a storage rot.

ORTON, W. A. Powdery Dry Rot of the potato. Bur. Plant Ind. Circ. 110: 13-15; 10 cents. It has caused heavy losses in several western states from Minnesota to Washington—"Leaving their point of origin in apparently good order they arrived at their destination badly decayed, were rejected by the purchasers and had to be consigned to the dump. The cause of this rapid deterioration was the Powdery Dry Rot."

WILCOX, E. M., LINK, G. K. K., and POOL, V. W., 1913. A Dry Rot of the Irish potato tuber. Neb. Sta. Res. Bul. 1: 88 pages.* Discusses Powdery Dry Rot of potatoes as a Nebraska disease.

CARPENTER, C. W., 1916. Some potato tuber rots caused by species of Fusarium. Journ. Agr. Res. 5: 183-209; 10 cents. Reports field observations and laboratory experiments with five Fusaria capable of causing rots of potatoes. Discusses Jelly End Rot of California potatoes in which *F. radicicola* and *F. trichothecioides* are associated.

PRATT, O. A., 1916. A western Field Rot of the Irish potato tuber caused by *Fusarium radicicola*. Journ. Agr. Res. 6: 297-309; 15 cents. *Fusarium radicicola* is the cause of a field black rot of potato tubers in southern Idaho. This fungus is also capable of causing a Jelly End Rot—Neither the black rot nor Jelly End Rot makes any progress in storage at or below a temperature of 50° F.

PRATT, O. A., 1916. Control of the Powdery Dry Rot of potatoes caused by *Fusarium trichothecioides*. Journ. Agr. Res. 6: 807-831; 15 cents.

which are carrying this germ, rot from the attack of the causal organism upon the growing stems. The attacked parts turn coal-black, whence the name, Black Leg.

The disease is sometimes a factor in causing rot of tubers in transit.

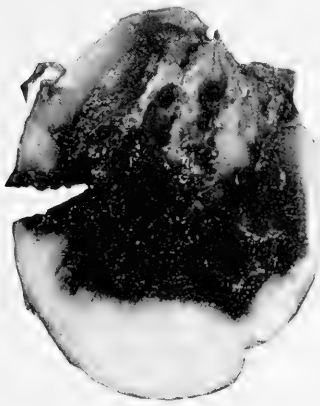

Fig. 66. Black Leg. Note the glistening mass of bacterial slime.

Fusarium Diseases of Potatoes[40]

The accompanying pictures illustrate various forms of attack on potatoes by the parasitic fungi which belong to the group called Fusarium. There are many species and they present much in common. The parasites of this group are native in many soils. They have been found in soils that have never borne a potato crop. Many are able to produce rotting of the flesh if the potatoes are held under humid, warm conditions.

Fusarium Wilt. (Fig. 67.) *(Fusarium oxysporum)*

One type of Fusarium attacks the plant and produces a wilting of the tops. This parasite lives in the water tubes of the plant and is seen in the tubers as a brown ring at the cut stem end. Such tubers are unsafe for planting. The cutting off of a ½-inch slice at the butt end is recommended against this disease. Under warm, humid conditions this fungus can produce a jelly-end rot or a dry rot of the tuber.

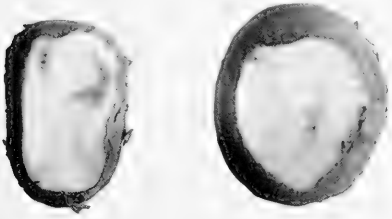

Fig. 67. Fusarium Wilt. Note blackening of water tubes at the stem end of the tuber.

Fusarium Powdery Dry Rot. (Fig. 68.) *(Fusarium trichothecioides*, etc.)

Another type of Fusarium is one which does not attack the growing plant but is primarily a wound parasite, entering bruised or wounded tubers. The rot produced shows up on the tuber as a sunken, withered area—often bluish. The flesh becomes dry and powdery at the surface, cheesy within. (Fig. 69.) The fungous growth is pink or salmon color. Carelessly handled tubers, or those dug when the skin is tender, often rot badly enroute to market and shrink enormously unless storage conditions are dry and cool. The great loss in early potatoes shipped from the south arises in this way. Disinfection of tubers with formaldehyde before storage has proved to be an effective protection for seed tubers.

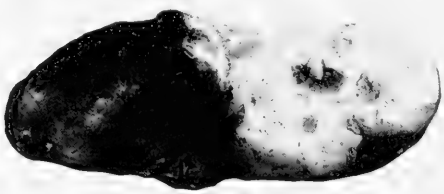

Fig. 68. Jelly End Rot caused by Fusarium.

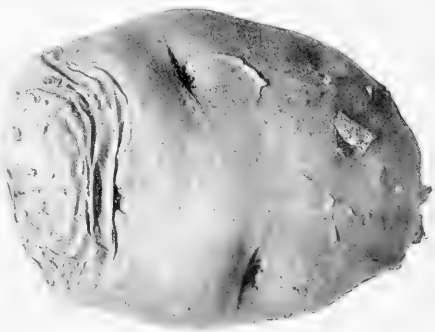

Fig. 69. Powdery Dry Rot, caused by Fusarium sp.

Black Scurf or Rhizoctonia.[41] *(Corticium vagum solani)*

This disease causes a serious blemish on the tubers. The fungus produces lumps of purple-brown threads which cling to the tuber, resembling dirt. (Fig. 70.) These lumps do not wash off, but are deep purple-black when the tuber is wet. The fungus produces rot of growing

Fig. 70. Rhizoctonia or "Black Scurf" of potato.

sprouts under wet conditions and causes cankers on the stems. The "giant" plants which make a rank growth and set 20 to 30 unmarketable potatoes are a result of the attack of this fungus. The disease is controlled by seed treatment with corrosive sublimate (one-half hour soaking in a 1-1000 solution), but not so completely by formaldehyde. Since the control of Black Scurf is necessary, the use of corrosive sublimate is recommended.

Potato Scab.[42] *(Actinomyces chromogenus)*

Scab is a serious, widespread disease of potatoes. (Fig. 71.) It causes a large percentage of the culls in the market and when present in shipments brings otherwise high-grade potatoes down to inferior grades. This disease causes from 10 to 15 per cent loss of the potato crop due to such depreciation. It is readily controlled by seed treatment (formaldehyde or corrosive sublimate) and the use of soils made slightly acid by turning under green crops. Lime, fresh stable manure, etc., tend to increase scab. On many kinds of soil their application should not be made immediately preceding the potato crop. Common scab should be distinguished from Powdery Scab, which is as yet not widespread in this country.[43]

Many scab spots become depressed and pitted due to the action of soil mites, insects, etc. These animals often attack sound tubers. All conspicuously scabby tubers should be discarded, and only smooth, clean stock used for seed purposes.

Fig. 71. Common Scab. With the establishment of the U. S. grades this sort of potato will no longer be shipped.

[41]Rhizoctonia:

Duggar, B. M., and Stewart, F. C., 1901. The sterile fungus Rhizoctonia as a cause of plant diseases in America. New York (Geneva) Sta. Bul. 186: 1-30. Discusses Rhizoctonia injury to many plants.

Morse, W. J., and Shapovalov, M., 1914. The Rhizoctonia Disease of potatoes. Me. Sta. Bul. 230: 194-216.* Richly illustrated.

Peltier, G. L., 1916. Parasitic Rhizoctonias in America. Ill. Sta. Bul. 189: 283-390. Technical discussion of Rhizoctonia as a parasite on great numbers of plants. Extensive Bibliography.

Gloyer, W. O., 1913. The efficiency of formaldehyde in the treatment of seed potatoes for Rhizoctonia. New York (Geneva) Sta. Bul. 370: 417-431. Recommends corrosive sublimate to replace formaldehyde in seed treatment.

[42]Scab:

Lutman, B. F., and Cunningham, G. C., 1914. Potato Scab. Vt. Sta. Bul. 184: 1-64. Complete account of potato scab giving evidence for classifying causal organism among higher bacteria, demonstrating occurrence of the germ in nearly all types of soils. Advises tuber disinfection since it prevents introduction of strains already parasitic. "The most hopeful method of attack on the organism in the soil is to change the neutrality, or slight alkalinity of the latter to weak acidity."

[43]Powdery Scab of Potatoes:

Morse, W. J., 1914. Powdery Scab of potatoes. Me. Sta. Bul. 227: 89-104.*

Melhus, I. E., Rosenbaum, J., and Schultz, E. S., 1916. *Spongospora subterranea* and *Phoma tuberosa* on the Irish potato. Journ. Agr. Res. 7: 213-253; 20 cents. Complete account of Powdery Scab and of the Dry Rot which follows in affected potatoes.

Silver Scurf:

Melhus, I. E., 1913. Silver Scurf, a disease of the potato. Bur. Plant Ind. Circ. 127: 15-24; 10 cents.

Schultz, E. S., 1916. Silver Scurf of the Irish potato caused by *Spondylocladium atrovirens*. Journ. Agr. Res. 6: 339-350; 20 cents. "Under favorable moisture and temperature conditions potatoes may become infected throughout the entire storage season." "——the tubers should be stored at lowest temperature permissible."

Black Heart.[44]

Cars of potatoes moved under conditions when heating is necessary, sometimes show after arrival in market a high percentage of the tubers with black centers. (Fig. 72.) The blackened portion shows a radiating, more or less star-shaped outline. It involves the center watery "heart" of the tuber. Affected tubers may become hollow. This disease is caused by overheating of the cars. The same effects have been produced in controlled experiments at the University

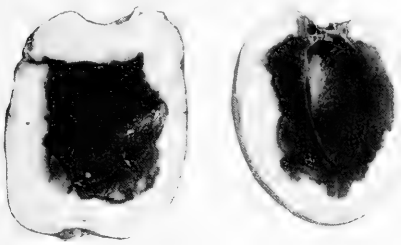

Fig. 72. Black Heart produced by overheating in the car

of Wisconsin by heating potatoes in an oven at 100° F. The disease sometimes arises in the pit, presumably from heating or poor ventilation. The control in cases of carload shipments is obvious

Hollow Heart

Hollow Heart or Cleft Heart is a trouble common on large tubers in years favorable to crop production. (Fig. 73.) It seems to be associated with sudden surges of growth, presumably caused by rains at the time when the plants are "making" potatoes. Close planting in varieties such as the Russet Rural, which is known to produce excessively large tubers, is to be recommended.

Internal Brown Spot.

The entire crop from a field or neighborhood may show small, rusty flecks in the flesh. This disease is associated with irregularities in the water supply and is commonly a dry weather trouble. Affected tubers do not rot and the tubers from affected seed do not reproduce the disease. In years when good seed stock is available, the use of tubers with flesh discolorations of any sort is to be discouraged.

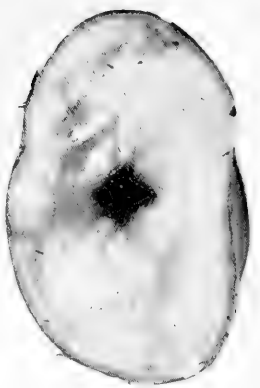

Fig. 73. Hollow Heart.

Net Necrosis and Chilling Injury

Another type of discoloration within the flesh needs to be sharply diagnosed. This is Net Necrosis, a peculiar condition in which almost every fibre in the tuber blackens. This condition is found in tubers in the field and has generally been considered a type of physiological breakdown. Net Necrosis is chiefly important in shipments because it might be confused with the discoloration of the fibers which arises as a result of chilling injury. Often in cars shipped in midwinter, or when field freezing has occurred, although no freezing effect is noticeable, many of the tubers show slight softening and shrinking of the flesh along with discoloration of the fibers. (Fig. 74.)

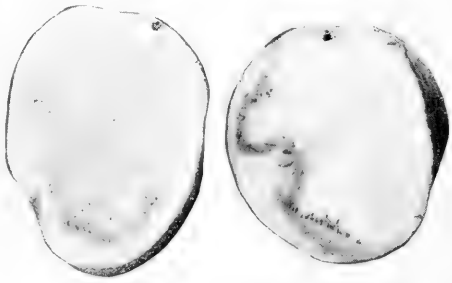

Fig. 74. Frost Necrosis, brought about by chilling.

[44]Black Heart:

Bartholemew, E. T., 1913. Black Heart of Potatoes. Phytopathology 3: 180-182. Carload shipments developed blackened hearts. Trouble found to be due to shipments becoming overheated in transit. "——black heart may be produced in potatoes that have been stored during the winter by keeping them for a certain period of time in a temperature of about 100° F." A technical discussion of the experiments summarized in above paper and a further extension of them is printed in Centralbl. f. Bakt. II, 43: 609-638, 1915.

Stewart, F. C., and Mix, A. J., 1917. Black Heart and the aeration of potatoes in storage. New York (Geneva) Sta. Bul. 436: 321-362.

Salt Injury

It sometimes happens that potatoes next to the floor of cars are found shriveled and the flesh blackened by what appears to be some form of rot. (Fig. 75.) If a section is cut through the potato the blackening will often be found to extend from ¼ to ½-inch or more into the flesh. This injury usually occurs only upon one side of the potato and is found in the potatoes upon the car floor and nowhere else. This is due to the action of the salt on the floor, although the presence of this salt may not be evident due to the mixing with the dirt from the potatoes. Cars that have carried hides, etc., are almost sure to produce such injury unless they are carefully cleaned before loading. As many as fifteen bushels have been discarded from such cars. The injury to the potato is due to the extraction of water from the cells, followed by blackening and death of the tissue. Potatoes should be loaded only into cars that have been thoroughly cleaned.

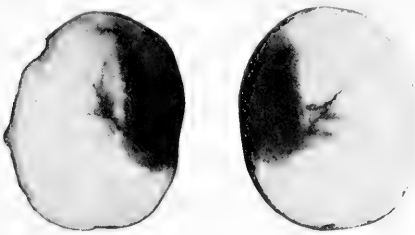

Fig. 75. Injury to potatoes by salt on floor of the car.

Control of Potato Diseases

The diseases of potatoes are numerous and their control is a national necessity and a national problem.

For the most part, clean seed of vigorous, high-yielding strains in clean ground, along with a proper spraying practice must be depended upon. The obtaining of vigorous, high-yielding stock can come only from selection in the field to eliminate weak hills. Every grower should have his own seed plot. Seed should be treated as directed and fields should be sprayed. The following is a brief program for handling tubers. For complete discussion of potato diseases and their control, the reader should send for the bulletins of his nearest Experiment Station and get in touch with the various extension forces of the Agricultural Colleges and the Department of Agriculture.

1. Obtain seed by selection from high-yielding hills. (Select the best one-quarter acre in the field. Pull out all weak, spindling plants. Pull out or stake all "off" varieties. Dig by hand and reject all low-yielding hills.)

2. Soak uncut seed one-half hour in a corrosive sublimate solution made by using four ounces of corrosive sublimate in 30 gallons of water. The solution may be used for four batches, then should be made up fresh. This material is deadly poisonous, and should be used with great care.

3. Cut by hand and reject all wounded, bruised, rotted, scabby, imperfect stock.

4. Cut off ½ to 1-inch slice from the butt end. Throw this away. If the flesh of the potato is discolored, reject the whole potato.

5. Plant on ground following clover or other legume.

6. Spray for "bugs" with Paris Green or Lead Arsenate.

7. Spray four or five times at 10-day intervals with Bordeaux mixture in order to keep tops green and to insure against Late Blight.

Fig. 76. Rhizopus Rot of sweet potato.

Sweet Potato Diseases[45]

Rots:

Soft, watery, and stringy rot; with sweetish odor; potato usually enveloped with mold. Attack begins at a wound or broken end. Rhizopus Soft Rot.

Dry Rot:

White, spongy or punky decay of tuber, beginning as small depressions, tuber not shrinking. Blue Mold Rot.

Skin blackened in more or less circular spots, slightly sunken; flesh beneath greenish; fungus fruiting bodies projecting as bristle-like spines 1-16-inch long; cooked potatoes bitter. Black Rot.

Hard Rot:

Skin becoming black; flesh black, difficult to break; rot progresses slowly from broken ends. Java Black Rot.

Blemish:

Skins stained brown or black—rusting, so-called; skin sound; flesh not affected. Scurf.

Rhizopus Soft Rot. *(Rhizopus nigricans)*

This is the common decay affecting sweet potatoes in storage or transit. (Fig. 76.) The decay begins commonly on the ends of the potato and in a few days under conditions of high temperature and high humidity the entire potato is destroyed. Sometimes the rot starts at the center of the potato and girdles it with a rotted area. This is called Ring-rot or Collar-rot. The fungus causing this disease is found everywhere in nature. It gains entrance into the tuber at wounds or bruises. The sweet potato in general is a carelessly handled product, packed by ignorant help. It is extremely subject to this decay. "A farmer would never think of handling apples, oranges or any of the fruits in the way that sweet potatoes are handled, and yet a barrel of good sweet potatoes will bring as much on the market and often more, than a barrel of good apples, and sweet potatoes bruise often more readily than apples. It is likely that if sweet potatoes were handled with the same care and intelligence as apples little difficulty would be experienced in keeping them in storage." *

Another decay caused by an organism which enters through wounds and bruises is the Blue Mold Rot. The Blue Mold is common everywhere. The decay produced by its attack takes a different turn from that produced by Rhizopus. The potato has a spongy or chalky texture. It is commonly found as small depressions around the wound or at origins of the small rootlets.

Other Diseases

The characteristics of these diseases are indicated by the key. These rots are to be looked upon as slowly progressing diseases which are contracted in seed bed and field and which play an important role in cutting down yields. As storage rots a month or two is usually required. where conditions of high humidity and temperature favor, for the rots to make conspicuous spots, or to injure the potato seriously. At the time of digging (as with sweet potato Black Rot for example) it is likely "that many potatoes are infected, the point of infection being so small as to be invisible to the naked eye." * This infection advances in storage, becoming increasingly important as the season progresses.

The control of sweet potato diseases which cause damage in the field is based largely on sanitary measures which go to (1) secure clean seed potatoes from which to get healthy plants for setting, and (2) general clean-up measures to do away with the wholesale infection which takes place in the hot bed. Numerous bulletins are now available from the experiment stations in the various sweet potato sections. These should be studied and their recommendations should become a part of the field practice.

*Harter, L. L., Farmers' Bul. 714: p. 22.

[45]Sweet Potato—General:

Stuckey, H. P., 1914. Sweet potatoes. Ga. Sta. Bul. 107: 83-112.*

Thompson, H. C., 1913. Storing and marketing sweet potatoes. Farmers' Bul. 548: 3-15.*

Handbooks of Sweet Potato Diseases:

Harter, L. L., 1916. Sweet potato diseases. Farmers' Bul. 714: 1-26.*

McClintock, J. A., 1917. Sweet potato diseases. Va. Truck Exp. Sta. Bul. 22: 455-486.* Discusses diseases common in the Norfolk trucking district and gives the result of tests of various control measures.

Taubenhaus, J. J., and Manns, T. F., 1915. The diseases of the sweet potato and their control. Del. Sta. Bul. 109: 3-55.* Discusses the many types of sweet potato diseases and gives control measures. Illustrated; extensive bibliography.

Rot:

Harter, L. L., and Field, E. C., 1913. A Dry Rot of sweet potato caused by *Diaporthe batatis*. Bur. Plant Ind. Bul. 281: 9-38; 10 cents. Discusses a somewhat important storage rot found in southern and eastern potato districts. The potatoes decay with a shriveling rot which begins at the stem end.

Foot rot:

Harter, L. L., 1913. Foot Rot; a new disease of the sweet potato. Phytopathology 3: 243-245.* Also in more extensive form, Journ. Agr. Res. 1: 251-274; 25 cents.

Various Diseases:

Taubenhaus, J. J., 1914. Recent studies of some new or little known diseases of the sweet potato. Phytopathology 4: 305-320. Discusses charcoal rot, soft and ring rot, stem wilt, and a new leaf spot.

Tomato[46]

The tomato is a staple crop but one which frequently gives much trouble in transportation. As a field or greenhouse crop it is subject to several important diseases and in transportation it is found to lack much in carrying quality. Fruit that is entirely firm and not colored is shipped in individual wrappers from California without great loss. It is evident, therefore, that, with care in handling and in selection of fruit for shipment, tomatoes may be safely transported. The popular containers for such shipments are small baskets which fit snugly into a stout, wooden crate. In some sections crates with sloping sides are used but the ordinary 24-quart berry crate is preferable as a container for the small baskets.

Tomato Diseases

Fruit Sound:
- Quality poor; small; acid. — Septoria Leaf Spot.
- Fruit distorted, cracked and callused. — "Cat Face."
- Fruit showing small corky scabs. — Canker.

Fruit more or less decayed. Blossom end blackened:
- Dry, sunken, black rot of flesh; does not increase rapidly, no mold present at start. — Blossom End Rot.
- Similar appearing rot which progresses more rapidly than the above rot; black mold present. — Black Rot.

Spots not restricted to blossom end:
- Fruit with soft sunken spots; decay, soft and watery soon involving one-half or entire fruit; fungus fruiting in concentric yellow heaps. — Anthracnose.
- Fruit showing black, sunken spots, dotted with pycnidia. — Phoma Rot.
- Fruit showing brown spots with zonate black rings. — Buckeye Rot.

Soft rots involving whole fruit:
- Fruits covered with white or pinkish mold. — Fusarium Rot.
- Fruits soft, decaying with a bubbling, wet, or slimy rot. — Bacterial Rot.
- Fruits soft; wet rot; fruit covered with filmy or cheesy white mold. — Oidium Rot.

Fruit showing mechanical injury. Yellow spots (on green fruit) with spongy tissue beneath; more numerous near calyx end. — Hail Injury.

Fruit infested with greenish or brownish worm which enters mostly at calyx end. — Tomato Fruit Worm.

Septoria Leaf Spot.[47] *(Septoria lycopersici)*

The Septoria Leaf Spot is, according to plant pathologists, the most serious disease of the tomato because of its effect in shortening the crop and in its effect on the quality of the fruit. Fruit from plants whose leaves are weakened is small, watery, and acid. This disease does not produce any decay in shipment. Its control is of interest to all concerned in the tomato crop because of the enormous crop shortage which comes about when the disease is not checked. Spraying with Bordeaux mixture along with the sanitary practices of rotation and trash destruction give efficient protection.

Blossom End Rot[48]

This disease is not caused by parasitic fungi or bacteria. It seems rather to be a physiological breakdown of the tissues caused chiefly from irregularities in the water supply. In the greenhouse, its control is readily brought about by holding the water supply moderate in amount. In the field, this disease is largely associated with drought conditions. Little can be recommended other than the selection of well-drained locations and abundance of cultivation. Certain varieties are very prone to show this trouble. Others, such as the Bonny Best, are not seriously affected.

Black Rot. *(Alternaria sp.)*

This form of trouble is commonly confused with Blossom End Rot (cf. Fig. 78) and in some cases the causal fungus *(Alternaria sp.)* invades Blossom End Rot lesions. This fungus is one of many organisms which is able, not only to tolerate the high malic acid content of the tomato, but to use it for food as well. In this disease the rotted spot is covered with the black, velvety growth of the invading fungus. (Fig. 79.) Occasionally invasion takes place at wounds or at cracks, such

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[46]Tomato—General:

Thompson, H. C., 1915. Tomato growing in the South. Farmers' Bul. 642: 1-13.* Complete guide for tomato growing in the South.

Stuckey, H. P., 1915. Tomatoes. Ga. Sta. Bul. 112: 211-248.* Handbook of tomato culture with rather full discussions of experiments on Blossom End Rot. Fungous diseases and insect pests are briefly discussed and control measures outlined.

Tomato Diseases:

Edgerton, C. W., and Moreland, C. C., 1913. Diseases of the tomato in Louisiana. La. Sta. Bul. 142: 1-23.* General handbook of Southern field diseases of this crop.

Rogers, S. S., 1913. The culture of tomatoes in California; with special reference to their diseases. Cal. Sta. Bul. 239: 591-617.

Rolfs, P. H., 1913. Tomato diseases. Fla. Sta. Bul. 117: 37-48. A discussion of diseases important in Florida fields.

[47]Levin, E., 1915. The Leaf Spot Disease of tomato. Mich. Sta. Tech. Bul. 25: 6-51.* A technical discussion of the most serious disease of tomato with recommendations for control based upon the life history of the organism. While *Septoria lycopersici* does not produce a rotting of the fruit, it is responsible for crop shortages and fruit of inferior quality.

Coons, G. H., and Levin, E., 1917. The Leaf Spot Disease of Tomato. Mich. Sta. Spec. Bul. 81: 1-14.* Popular account based upon above.

[48]Brooks, Chas., 1914. Blossom End Rot of tomatoes. Phytopathology 4: 345-374. Disease not due primarily to bacteria or fungi. Either excessive watering, or a check in water supply, may produce the disease.

Fig. 77. A field of tomatoes ruined by Septoria Leaf Spot.

Fig. 78. Blossom End Rot of tomato.

as often occur following heavy rains. It is needless to say that cracked fruit should not be shipped. As a rot it progresses more rapidly than Blossom End Rot and if found in shipments represents a field infection.

Anthracnose *(Colletotrichum phomoides)*

Fruit affected with this fungus rots quickly. In short, this disease behaves like the other Anthracnoses. The spot may show up at first as a small, whitish dot, but within five days to a week the greater part of the tomato is covered. (Fig. 80.) Attack is made upon green as well as ripe fruit. The control of this disease has not been fully worked out. It is evident that spraying will be beneficial.

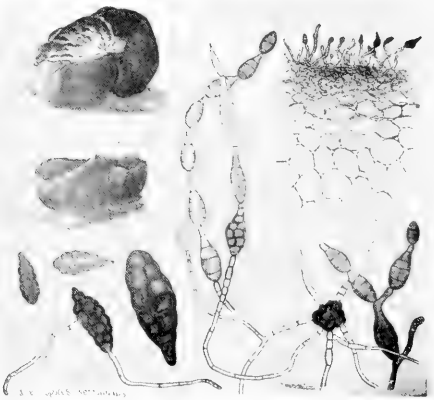

Fig. 79. Black Rot of tomato caused by Alternaria. (After Longyear.)

Phoma Rot[49] *(Phoma destructiva)*

This is the common disease found in Southern tomatoes shipped to distant markets. Each year many carloads are reported as lost through this rot. Investigation has shown that the causal organism is found in the fields and produces there a serious leaf blighting and wilting of the stems.

[49] Jamieson, Clara O., 1915. *Phoma destructiva*, the cause of a fruit rot of the tomato. Journ. Agr. Res. 4: 1-20; 25 cents. This fungus was found an actual wound parasite, causing great loss in Florida fields.

Infected fruit rots in transit with sunken black spots. (Fig. 81.) Control measures have not been fully worked out. It is evident that spraying will be beneficial. The necessity of rigid sorting is obvious.

Fig. 80. Anthracnose of tomato.

Of somewhat similar character is the Buckeye Rot[50] which has just been described. This rot is due to a species of Phytophthora—a fungus of the type known to produce "leaky" decay. The disease has been found in the field and while it is potentially a serious trouble, little is known of its destructiveness.

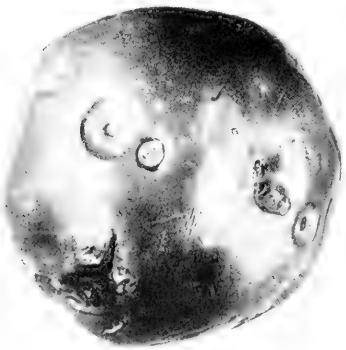

Fig. 81. Phoma Rot of tomatoes.

Tomato "Canker"

This disease, as yet undescribed, was discovered causing great damage in southern Illinois fields in 1917. It was also noticed in western Tennessee and in Michigan the same season.

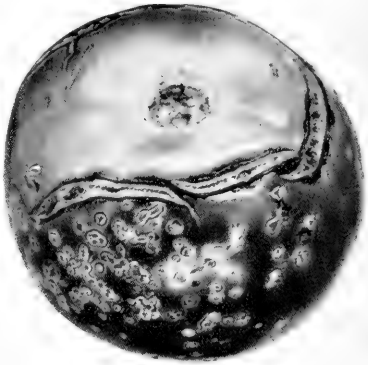

Fig. 82. Tomato Canker.

It is more commonly seen on the green fruit as white raised spots, with the epidermis rifted somewhat similar to apple scab spots. (Fig. 82.) The spots are often very numerous, and conspicuous, resulting in disfigured fruit for the market. As high as five per cent of the crop has been seen affected in some fields.

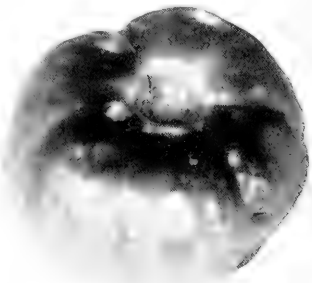

Fig. 83. Hail Injury of tomato.

Experimental evidence shows the disease is caused by an apparently undescribed bacterial organism, and that it is disseminated by insects.

[50] Sherbakoff, C. D. Buckeye Rot of tomato fruit. Phytopathology 7: 119-129. A Phytophthora rot of the fruit producing a gray or dark brown tomato rot, which causes considerable injury to fruit in the field and in transit.

Fig. 85. Corn Ear Worm

Hail Injury

Tomatoes are sometimes damaged in the field by severe hail storms and the effect upon the fruit is severe enough to be of importance in transportation. Tomatoes showing this type of injury should be classed as culls and are unsafe to pack with sound stock. The spots are more numerous near the calyx end, are bright yellow on the green fruit (Fig. 83) and the wound extends for some distance beneath the surface. The tissue underneath is white and corky. Although no shrinkage is usually evident on the surface hollow spaces are found beneath the injured tissue. Close sorting is necessary to eliminate fruit of this kind.

Tomato Fruit Worm (Corn Ear Worm)

This pest is often met with in shipments of tomatoes from the South where it destroys as much as one-third of the crop in some seasons. (Fig. 84.) This is the common worm found in sweet corn (Fig. 85)—its favorite food plant—and in cotton bolls. When crates in which infested tomatoes have been packed arrive at destination, the greenish worms may be found crawling over the packages, or over the walls of the car, and the tomatoes from which they emerged are "leaky."

Fig. 84 Tomato Fruit Worm.

The damage to shipments is often considerable, due to this "leaky" condition and the soiling of the crates.*

"Cat Face"

The condition illustrated in Figure 86 is typical of much of the fruit shipped from Southern fields during some seasons. The cause of this trouble is not well understood, but is assigned to seasonal variations, especially prolonged dry weather. Such fruit should be classed as culls and packed only in crates so labeled. Much of the fruit that arrives at destination in a leaky condition is due to tomatoes of this sort. A few crates containing baskets like those shown in the illustration may ruin the sale of a good car of fruit. Buyers at the loading stations often refuse to buy during periods when this trouble is very evident. Careful sorting and grading will eliminate this trouble.

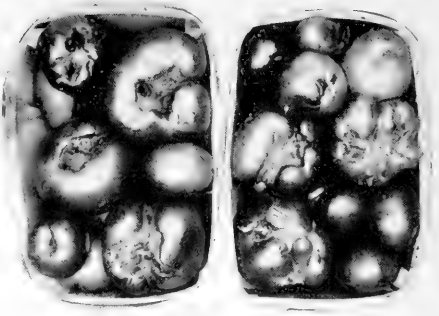

Fig. 86. Cat Face tomato.

Frost Injury

The problem a national one. This is an economic problem of much importance in the transportation of perishables, especially potatoes. It concerns the grower, the shipper, the carrier, and ultimately the consumer. It is a problem in which the responsibility lies with the grower when field-frosted potatoes, apples, etc., are met with. The presence of field-frosted stock in shipments during some seasons is serious enough to take away all profit from the handling of the commodity. The shipper is directly concerned since commerce in frozen perishables is an unprofitable business at the best. The carrier has generally paid the claims on all frosted stock for it has commonly been difficult to place the responsibility elsewhere. Finally the great economic loss due to frozen perishables, especially in a season like that of 1917, falls as a burden on the consumer, who must pay the price of a curtailed supply and freight charges on worthless stock.

The loss is enormous. Cars arriving at destination during the fall and winter months often show from two to twenty per cent loss from frost injury received either in the field or in transit. During the fall of 1917 it was difficult, on account of the high percentage of field-frozen stock, to find a car of sound potatoes from the northern and western potato states. Potatoes are commonly allowed to remain in the ground as late as possible in the fall that the skins may become tough. This practice, if carried too far, in a season when very early cold periods occur, leads to freezing in the ground.

How to recognize frozen potatoes. Frosted potatoes when thawed become soft and leaky, and badly stained sacks are usually a good indication of the presence of such damaged potatoes. If the skin remains unbroken, the flesh retains its white color for several days, but soon blackens if exposed to the air and to the

*The eggs are laid upon the leaves or fruit and after hatching the young larvae feed for some time upon the tips of the tender leaves. In most cases they enter the fruit under the lobes of the calyx and for this reason it is often difficult to detect their presence when the tomatoes are picked while green. The mature larvae leave the fruit and pupate in burrows in the soil.

Spraying with lead arsenate two pounds to 50 gallons of water, applied just before blossoming time and repeated as many times as necessary through the season is recommended. The last spraying should be made about 10 days before harvesting begins, using paris green, one pound to 100 gallons water. This is an important spray and is usually necessary for successful control. Paris green washes off more readily than arsenate of lead and for this reason is recommended for the final spray. Sweet corn is the favorite food plant of the insect, and by planting it around the tomato field before the plants are set the parent moths can be lured to lay their eggs there. It is desirable to have corn in silk and tassel from fruit setting time until harvesting is over, but mature ears should be gathered before the worms escape. Wormy tomatoes should be destroyed.

Bishopp, F. C., 1917. The Bollworm or Corn Earworm.* Farmers' Bul. 872: 15 pp.

INJURIOUS INSECTS AND THEIR CONTROL

No attempt has been made to consider insect pests or the blemishes they cause. The following bibliography will be helpful to those interested. In this particular case of the tomato fruit worm, the insect is responsible for a specific loss in what is apparently sound fruit at time of packing.

Slingerland, M. V., and Crosby, C. R., 1915. Fruit Insects MacMillan Co. $2.00.

Sanderson, E. D., 1913. Insect Pests of Farm, Garden, and Orchard. John Wiley. $3.00.

O'Kane, W. C., 1912. Injurious Insects. MacMillan Co. $2.00.

Various State Handbooks:

Nearly every state has a publication covering the important insects on important crops. Occasional bulletins on important insect pests are referred to under various crops considered in this bulletin.

Bureau of Entomology Publications:

The bulletins from this Bureau cover nearly all injurious species. No attempt is made to list the publications available. The reader should consult the two Index publications given below.

1916 Index to papers on insects injurious to citrus and other sub-tropical fruits. Bureau of Entomology 99:

1916 Index to papers on insects affecting vegetables. Bureau of Entomology 109:

action of decay organisms. Frost-injury is not easily confused with any disease by anyone who has seen typical specimens.

Careful examination will fix responsibility. Opposed to field frost, which is within the responsibility of consignor, is the freezing in transit for which the carrier, by mishandling, or the shipper by too great carelessness in protecting the perishable, may be responsible. The statement has often been made that it is impossible to determine at destination whether freezing occurred previous to loading or while in transit. This is not true. The examination of individual specimens outside the car may not lead to any safe conclusion. However, inspection of the contents with reference to the distribution of the frozen product in the containers and the location of these in the car, offer means of solving the difficulty. For example, field-frosted potatoes are found scattered throughout the sacks without any special reference to exposed portions of the car. On the other hand, shipments frozen in transit show the greatest damage in certain portions of the car—near the doorways, the ice-bunkers, and the floor. The extent of damage may vary from only slight loss to complete destruction of contents, but the location of containers holding the frozen product and the distribution in the container itself leaves little chance for controversy. The records of outside temperatures when compared with the movement of car are usually sufficient to place responsibility at the proper point.

Everyone must co-operate. The problem of elimination of losses in transit begins with the grower who must guard against freezing of his goods in the field and who must cull worthless from transportable stock; it demands that shippers properly prepare their cars to withstand extreme temperatures through which they are likely to pass; and finally the carriers must handle shipments efficiently.

The shipment must be protected. The installation of false floors, lining with heavy paper, the use of straw, etc., and the use of portable heaters are necessary protective measures that must be adopted by shippers if the losses due to the freezing of perishables are to be minimized. An "ounce of prevention" means a saving to everyone.

Take no chances on the weather. In self protection, as well as conservation, the carriers find it necessary early in the season to place an embargo on all shipments of perishables moving under "Carriers' Protective Service" loaded in other than refrigerator cars. But shippers handling their goods at their own risk take chances and fail to protect shipments of perishables during hazardous weather periods. The unexpected usually happens. By careful sorting and the use of the protective measures already referred to, a great reduction in the present enormous loss due to frozen perishables can be accomplished to the benefit of everyone concerned.

PART III. THE GENERAL PRINCIPLES OF SUCCESSFUL SHIPPING

Cultural Practices in Relation to a Sound Product[51]

The bulk of this bulletin is devoted to a discussion of particular diseased conditions. Many of the serious losses arise from unsafe handling and preparation. This has been considered in another section. Many of the diseases arise from specific pests which must be combatted by specific treatments. But there is a class of ills which come about from general unthriftiness of the plants, and there are diseases which become serious because of improper agricultural practices. In order that the grower may combat these untoward conditions and obtain a large and prevailingly sound product, the following general points in agriculture must be noted. These are grouped in more or less logical order, and the statements made are meant merely to be suggestive.

Soil

The soil. The first essential to crop growing is the proper soil. Too many crop failures are registered because the farmer puts a crop on a soil totally unsuited for it. The choice of soil must be carefully made. In general, intensive root or vegetable crops need a rich, productive soil. For early crops the soil must warm up quickly and must be rich enough to force the plant to rapid growth. Such soils are those which have sunny exposure and are well drained. The latter factor, drainage, cannot receive too much attention. The drainage of nearly all soils needs improvement. Certain sandy soils seem to have good natural drainage, but with loamy or clay soils drainage means a great deal in evenness of water supply, in aeration of the soil and in earliness of crops. Drainage in the seed bed and in the field is second only to crop rotation as an important general crop practice to prevent plant disease depredations.

The farmer must study his soil and learn its capabilities. Soils that are acid must be corrected, soils that lack humus must be enriched by proper green crops. Each farm is an experiment station and happy is the farmer who can make his work a series of profitable tests.

Soil Fertility

Improve the fertility. With a knowledge of the soil on a farm there comes to the farmer a knowledge of its needs. There are two ways of farming, namely, by conserving methods and by robber methods. Only the former method is profitable. The farmer must not only keep up the fertility of his soil but he must increase it.

By far the best and cheapest fertilizer to use is stable manure. This must be applied liberally. It has a beneficial effect on the physical character of the soil aside from its mere fertilizer value.

For many crops commercial fertilizer is necessary. The fertilizer to use and the quantity depends not only upon the soil but upon the crop to be grown. It seems safe to say that for intensive crops the use of the right commercial fertilizer is highly to be recommended. The grower should make careful tests and satisfy himself as to the returns he is getting from the fertilizer.

Nor must be overlooked the possibilities of increasing soil fertility by turning under green crops, especially the leguminous ones. Carefully planned rotations contain this provision for renewing the soil's nitrogen and humus, and great crops result from such a practice.

Choice of Crops

Crop selection. The crop to be grown perhaps needs little comment. Some men change crops so often as never to become expert. Some, on the other hand, are so conservative that they do not share in the advantages often opened up by a new industry.

The crop grown should be one for which there is a good available market, and one for which the soil is adapted. Certain sections have built up a reputation for growing certain crops. This reputation is an asset in the markets and in such regions it pays to grow the advertised crop.

Much could be said about choice of crops in order that a proper sequence of operations can

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[51] GENERAL WORKS ON HORTICULTURE, FARMING, ETC.

Bailey, L. H., 1914-1917. Standard Encyclopedia of Horticulture. MacMillan Co. 6 Vols. $36.00.

Corbett, L. C., 1913. Garden Farming. 473 pp. Ginn and Co. $2.00. This book is a handbook giving instructions for growing all types of garden crops. It discusses types of containers used in various sections. This book has two chapters devoted especially to the problems of handling perishables. Chap. VI, Transportation of Truck Crops; Chap. VII, Precooling and Cold Storage of Vegetables.

Card, F. W. Bush Fruits. MacMillan Co. 4th reprint. $1.50.

Gilbert, A. W., 1915. The Potato (With section on diseases prepared by M. F. Barrus). MacMillan Co. $1.75.

Rolfs, P. H. Sub-tropical Vegetable Gardening. MacMillan Co. $1.50.

Coit, J. E. Citrus Fruits. MacMillan Co. $2.00.

Fletcher, S. W. Strawberry Growing. MacMillan Co. $1.75.

Kains, M. G. Plant Propagation. Greenhouse and Nursery Practice. Orange Judd Co. $1.50.

Lloyd, J. W., 1914. Productive Vegetable Growing. Lippincott. $1.50.

Sears, F. C., 1914. Productive Orcharding. Lippincott. $1.50.

Wilkinson, 1915. The Apple. Ginn & Co. $2.00.

be maintained. Many greenhouses used for growing seedlings lie idle all the rest of the year. Many farmers are crowded with work in one season and have little to do at the next. Proper choice of crops brings about a balancing of jobs and greater efficiency.

Rotation of Crops

Rotation is crop insurance. The general farmer must plan to change crops on his field each year. With intensive cropping, wherever possible, rotation must be employed. In a very few cases rotation is not practised— for example in celery culture on old established muck areas—but there is no crop but is benefited by change of soil.

As crops are grown year after year diseases become intensified. Those that are harbored by soil or trash naturally become worse as the same field is used without change. Some insects are controlled almost completely by crop rotation.

Putting aside all considerations of soil fertility, crop rotation is necessary if plant diseases and insect pests are to be controlled.

The Seed

Select good seed. The grower cannot give too much attention to the source and quality of his seed. Where possible seeds of disease-resistant and high yielding sorts should be selected. Each grower can do much by selecting from the best yielding and most desirable plants of his field the seed for the next year's planting. Where this cannot be done reliance must be placed upon seed from reputable houses. Where disinfection is necessary the seed should be treated in the recommended fashion in order that diseases may not be introduced.

Seedlings

Give the plant a chance. The grower should grow his own seedlings. Too often serious diseases are brought to a new locality with the seedlings. Seedlings must be given good care. Crowding in the flats must be avoided. Over-watering is injurious since it almost invariably leads to damping-off. Most seedlings are made more stocky by transplanting once or twice. Certain seedlings after growth in hot bed or cold frame need to be "hardened off" so that they will not wilt on being planted in the field. With good, sturdy, healthy seedlings half the battle for a sound product is won.

Planting

Successful planting. The time of planting, the method, depth, etc., must be governed by local conditions and by the needs of the particular crop. In general the success of the planting centers about the preparation of the seed bed. The ground must be in good tilth, the clods broken, and the incorporation of the manure or fertilizer thorough. Then when planting is made cultivation should begin as soon as possible to control weeds.

Cultivation

Work the soil. Cultivation is aimed to keep the soil in good working condition and to destroy weeds. Weeds crowd the growing plant and steal its food and water. No successful agriculture can be carried on where weeds flourish. The farmer must clean up foul ground and must safeguard his fields by good seed. The fight on weeds is one that he has always before him, but profits come from a successful weed control.

Cultivation at the start should be thorough and deep, but as the feeding roots increase it should be more and more shallow. For some crops, such as beans and tomatoes, wet plants must not be worked, for to do so spreads disease.

Marketing

The weak link in agriculture. The preceding discussion deals with the production of the plant. The points of harvesting are considered in the next topic called "Preparation." There is next to consider the problems of marketing. This is a large problem and on its successful solution hinges the success of the venture. A worthy product, properly prepared and sent, with good judgment, to market, usually brings satisfactory results. By a study of the market requirements, and by study of market fluctuations the grower must learn to ship properly to the right place. What is given under preparation has great applicability here in insuring a favorable reception for the goods at the market.

In growing the crop, clean plants in clean soil assure safety. In shipment, sound plants, properly handled, arrive on the market in good condition. Integrity of product is an essential to successful agriculture.

The Preparation of Fruits and Vegetables for Safe Transportation

Waste can be eliminated. Some of the important causes for damage to shipments of perishable freight may be traced directly to the manner in which it is prepared and delivered to the transportation companies. Improper handling during harvesting, careless loading, stowing, bracing, and stripping, are some of the important factors concerned in the losses met with by shippers of fruits and vegetables. There is much wanton waste of foodstuffs that could be largely eliminated by a little more care in the operations preceding movement by the railroads. Responsibility for these things belongs exclusively to the shipper.

Careful handling pays. It is not enough that fruit and vegetables be well grown, although this is a primary essential, for subsequent handling may detract from the value and quality of the best grown product. The experience of the citrus growers of California has shown the necessity for careful handling of the fruit during harvesting and throughout the operations preceding delivery to the carriers. Their experience should be useful to growers of other crops in various sections of the country for the same principles apply everywhere.

Good loading is the best insurance. To eliminate waste in shipments, not only must plant diseases be controlled, but in addition it is essential that certain common-sense principles be observed in preparing the products for shipment. Experience has shown that the best way to assure the safe arrival of a car loaded with perishable freight is to load and brace it in such a manner that ordinary handling by the transportation company will not disturb the contents. Too often a first-class product, well graded and packed, is loaded in a car in a haphazard manner, poorly stowed and weakly braced, with the result that upon arrival at destination there is much loss from shifting and breaking of the packages. In certain sections of the country losses through shifting and breaking of the packages are practically unknown, while fruits and vegetables forwarded from regions much nearer to the markets arrive in very poor condition. It must be clearly recognized that the responsibility for this sphere of operations belongs to the shipper, but the carriers must assume an active interest in the methods employed. A visit to the railroad yards in a large market center like Chicago will convince anyone of the necessity for a little more co-operation among all those concerned in the production and handling of perishable foodstuffs.

A brief discussion of some of the most important factors (exclusive of disease control) operating toward eliminating losses in transit is here given under appropriate headings.

What Preparation Includes and Its Importance

Harvesting

Wounding and bruising must be avoided. The guiding principle to be observed in the harvesting of perishable products so as to place them upon the market in the best possible condition is the avoidance of bruises and injuries in removing the product from the plant. The fruit should be as nearly mature as possible before picking but should not be mellow, the degree of ripeness depending, of course, largely upon the distance from the final market, and when in this mature, sound condition, nearly all fruits stand up better under long hauls. In removing the fruit from the plant only the minimum pressure necessary, distributed as uniformly as possible over the entire surface, should be employed. In commercial orchards the grower should instruct his pickers in the best methods of removing the fruit from the tree, emphasizing the importance of sound fruit in successful transportation. When it is remembered that a large percentage of the rotting of fruits and vegetables occurs through the invasion of weak parasites that cannot enter through the unbroken skin, but are dependent upon wounds and bruises for the avenues of entrance, the importance of proper harvesting methods is readily appreciated. The enormous losses suffered by the California citrus industry due to careless harvesting and handling of the product, were totally eliminated with the development of practices that did away with such injuries. In picking highly perishable fruits like strawberries, raspberries, etc., much bruising usually occurs through grasping the berries and the pressure exerted in removing from the stems. It is also a common practice to pick a handful of fruit before placing it in the picking container. This practice cannot be condemned too severely, for no amount of refrigeration will overcome the inherent tendency of such bruised fruits to decay, nor is the railroad company liable for any losses that occur through the rotting of fruits due to this cause while in transit. There are many special devices upon the market designed to aid in harvesting the fruit with the least possible injury. Commercial growers should adopt the ones best adapted to conditions in their localities. It is up to the growers and shippers to improve

the conditions under which they prepare and tender their products to the carriers for transportation.

Sorting and Grading

Minimum handling means maximum carrying quality.

In the harvesting of small fruits like strawberries and raspberries, sorting should be done at the time of picking so that it will not be necessary to rehandle the fruit at the packing house. Investigation by the Bureau of Markets has found this to be the limiting factor in the distance over which berries can safely be transported. Sorting and grading during picking is not only commendable because it eliminates excessive handling and bruising, but should also appeal to the practical grower as an economic practice.

A good product makes an enviable reputation.

Sorting and grading not only reduce the losses from transportational troubles but they also build a reputation for the shipper that cannot be established in any other way. (Figs. 87 and 88.) It is a great temptation to the average shipper to pack mediocre fruits and

Fig. 87. Good grade potatoes always in demand.

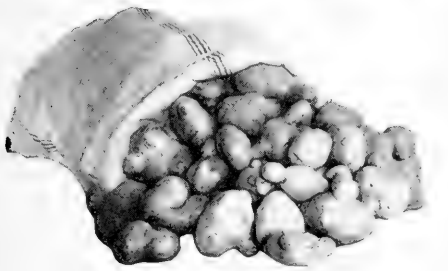


Fig. 88. Poorly graded—always a drag.

vegetables when the market is strong and the price high. It may not at the time of packing seem profitable to discard fruit showing slight decay or bruising but to do so always pays. A few cars in poor condition arriving upon a strong market, will ruin prices quicker than any other factor, and the few dollars that the unwise shipper thought to obtain through adding a few packages of poor produce are more than lost in the prices received for subsequent shipments. The market once demoralized by an inferior product rarely recovers. Good sorting and grading facilitate a uniform pack, and attractiveness is next to quality in regulating demand. Buyers of fruits and vegetables do not look at the fruit on the top of the package, but go deeper to seek the truth, and the product is quickly sold when uniformity is found throughout the entire container. (Fig. 89.)

Fig. 89. The large peaches in the cover were used to face this basket of small low-grade fruit. Such dishonest practices never pay.

Packing and Packages

An attractive package always in demand.

Fruits and vegetables are a class of foodstuffs that command the best prices only when packed in the most attractive way. The package must appeal to the eye, and even if the quality is high the sale is sure to be slow if the product is put up in an unattractive container. A clean, compact, honest and serviceable package is always in demand and commands the highest prices on any market. The success of western grown apples is a striking example of what good grading and packing will do toward establishing a demand for a product. What has been accomplished by western growers can be duplicated by every grower.

Study the tastes of the markets.

The producer of fruits and vegetables should make a special study of the packages best adapted to carry his product to the markets in the most attractive and safe manner. Almost every market has preferences for special styles and the grower should know the peculiarities of the markets to which he consigns his produce.

The container must be serviceable. A container for perishable freight, first of all, should be serviceable and constructed to meet the demands of transportation over long distances. Many thousand dollars worth of perishable freight is wasted annually due to the use of containers unable to hold up under the strain of long hauls. The education of growers and shippers as to the best package in which to ship their products is a type of work worthy of greater consideration by the extension workers of the Agricultural Colleges. A good example of the losses due to weak packages may be seen by examining shipments from certain sections of the country of potatoes packed in flimsy barrels that always arrive at destination badly crushed and broken. Shipments over much longer distances in barrels of better construction arrive in good condition.

Good ventilation retards decay. For vegetables particularly, a prime requirement of a good package is that it shall afford free ventilation. (Fig. 90.) The importance of this factor in the safe transportation of such highly perishable products as lettuce, celery, etc., cannot be overestimated. Rapid refrigeration cannot be accomplished unless the cold air can penetrate freely into the packages. The rots caused by bacteria and fungi develop very rapidly in poorly ventilated packages and no amount of refrigeration will overcome the inherent tendency to decay under these favorable conditions. Two recent reports on large shipments of lettuce packed in closed containers show almost total loss. No fault could be found with the handling of the cars and from our experience with shipments of lettuce in various containers it is plain that the loss of these shipments was largely due to the poor ventilation in the packages. Good ventilation insures maximum refrigeration and minimum decay.

The package must not injure the contents. Another requirement of a good package is that it should minimize bruising and injury to the contents. An illustration of the importance of this is shown in Figures 91, 92, 93. Sharp corners, protruding nails, and splinters, etc., cut and bruise the contents and open an avenue for the entrance of the rot-producing organisms always present upon the surface.

Uniform packages are easy to load. Uniformity in size and design are very desirable features in packages to be used for large shipments of fruits and vegetables. It is much easier to load a car with packages of uniform size, as this permits a definite plan for each load to be followed. A car cannot safely be loaded with packages of various sizes and shapes, nor will good bracing always insure against shifting in loads of this kind.

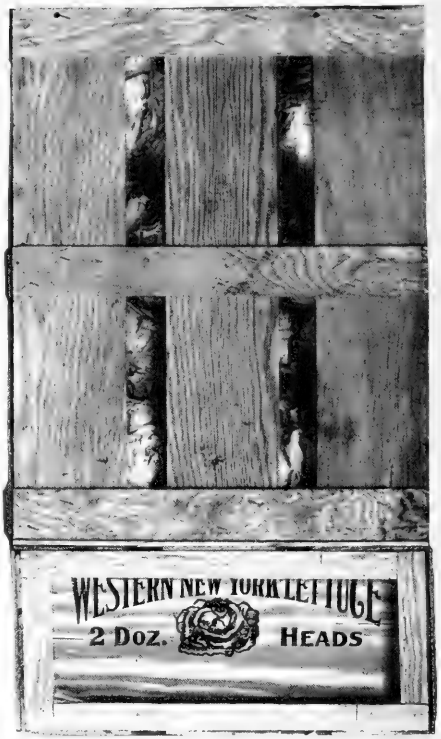


Fig. 90. Lettuce in boxes, equipped to provide ventilation.

Loading

Load for a definite purpose. The plan of the load should aim to secure maximum ventilation, refrigeration and stability. The packages should be spaced widely enough to allow a free circulation of air but not so wide as to permit shifting. False flooring should be installed so as to give maximum circulation of air around and through the packages. This is also very essential when heaters are used to prevent freezing in the winter months. A free circulation of air is necessary to insure rapid refrigeration, therefore, a solid load should be avoided. The height of the load should be such that the top tier of packages is below the line of safe refrigeration and well within the cooler portions of the car. Furthermore, overloading is dangerous because it checks air circulation and

thus defeats the very purpose of the refrigerator car.

Strip each tier of packages. All packages with flat bottoms should be stripped between each tier as illustrated in Figure 94. Stripping hastens refrigeration, helps to secure rigidity and distributes the weight of the load more evenly over the packages. Stripping material usually consists of pieces ¼ by 1½ inches and the length should approximate the width of the car. Two strips are used for each tier of packages, and each tier should be secured with nails to prevent shifting.

Fig. 91. Casaba melons, unprotected in the crate

Fig. 92. Casaba melons, showing rot which arises from bruising.

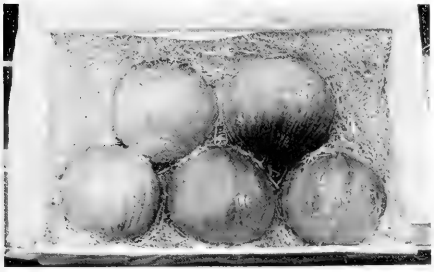


Fig. 93. Casaba melons, packed to avoid bruising

Avoid a solid load. Brace solidly. In general, cars should not be loaded solidly but the space in the doorway should be left for ventilation and the installation of bracing to prevent shifting and breaking of the packages. The proper way to construct and install the gates recommended for use in bracing cars of fruits and vegetables is illustrated in Figures 95 and 96.* Experience has shown that this type of bracing is preferable to all others. It is simple to construct and economical of material and time. It has proved uniformly successful in protecting shipments over the longest and roughest hauls. The use of this bracing eliminates the practice of driving large spikes into the car floors. Annually thousands of dollars' damage results to refrigerator cars through this needless practice. The insulation is damaged and the cars are soon unsafe for the transportation of perishable freight.

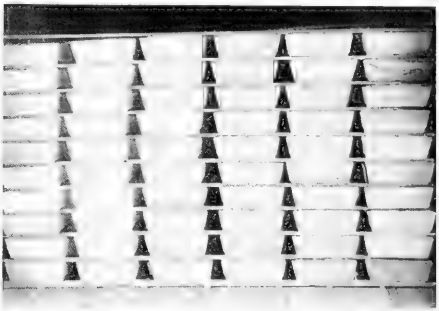


Fig. 94. Crates properly stripped.

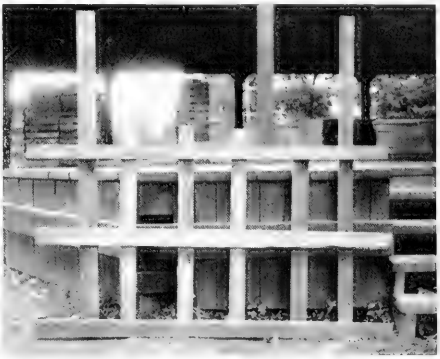


Fig. 95. The gate shown here is easily made and permits efficient bracing.

* The material consists of 2 × 4-inch lumber for cross pieces of the gate; 1 × 4 or 2 × 4-inch lumber for the uprights; 2 × 4-inch lumber for the braces between gates

Fig. 96. A pair of gates in place showing ease with which efficient bracing is accomplished.

In the above bracing it is not necessary to drive one single nail into any part of the car. This bracing should be universally adopted for protecting shipments in refrigerator cars.

As an example of what may be accomplished by study of methods of preparation, stowing, etc., there may be cited the very successful trials of the Western New York "End to end offset" loading system for peaches (Figs. 98 and 99), and the somewhat similar plan for loading Climax baskets (grapes). The directions for this method of loading are as follows:

Loading Climax Baskets

Though the size and the strength of Climax baskets vary, the general idea of end to end loading applied to the various sized containers, greatly reduces damage by breakage in transit.

Using the eight-quart Climax basket for loading in an ordinary refrigerator car, the load is started by placing the baskets lengthwise along one side of the car, distributing any irregular outcome throughout the floor tier. The only place in the load where a basket is crosswise of the car is in the ends of the car next to the

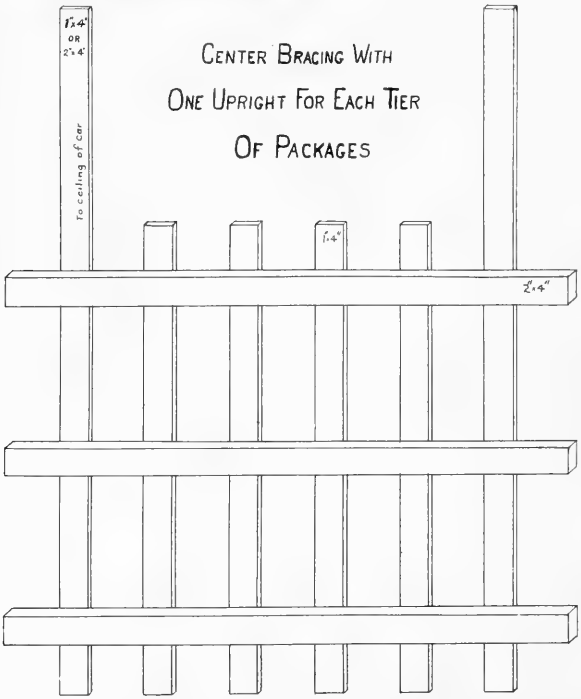


Fig. 97. Diagram to show construction of a gate for bracing.

bunker where a few baskets are needed to fill in space where a basket cannot be placed lengthwise of the car.

When the load approaches the opposite side wall of the car, there is usually about four inches of slack which is taken up by "crisscrossing" or "worming" the baskets.

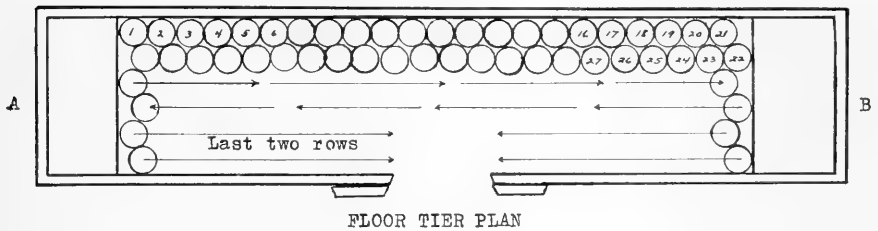
The first, or floor tier of baskets in the "worming" is started in each end of the car worked along toward the doorway oppositely oblique.

The second tier in the "worming" is placed between the handles of the floor or first tier baskets.

Advantages: 1. This load gives a solid load from end to end of the car and nearly all baskets meet the end to end jolting with the longest, strongest way of the baskets.

2. Avoids necessity of bracing and "figuring" out of the finishing of the load in the doorway.

(Directions through the courtesy of E. H. Anderson, Supt. Perishable Freight Investigations, N. Y. C. Lines.)



FLOOR TIER PLAN

Fig. 98. Recommended end to end method of peach loading.

The Western New York "End to End Offset" Loading System

Load According to Direction of Arrows

1. *Place* the *first basket snugly* in one corner of the far side of the car *with the basket handles as shown in small diagram.*

2. Place the first row of baskets along far side of the car, with handles of baskets in same relative position.

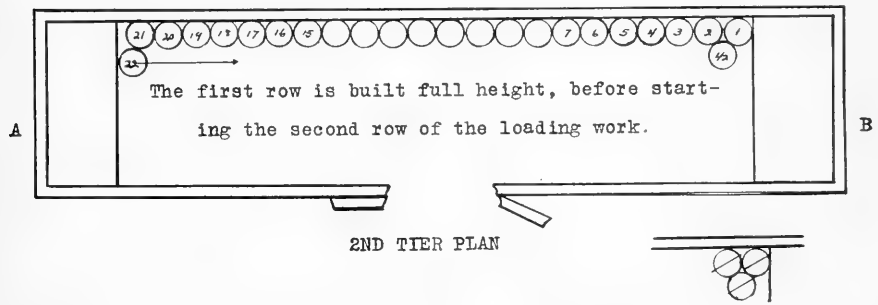
3. Adjust first row of baskets, to obtain the proper offset for the second row. (The number of baskets along the side of car varying with length of car.)

4. The first row of baskets is built to full height of load before starting the second row.

5. Each succeeding row of baskets is put in place as shown by the arrows in the diagram.

6. The last two rows of the load are started from both ends and should come out evenly in doorway, if the loading has been done with care.

(Directions through the courtesy of E. H. Anderson, Supt. Perishable Freight Investigations, N. Y. C. Lines.)



2ND TIER PLAN

Fig. 99. Recommended end to end method of peach loading.

Plant Diseases and the Farmer: A Call to Action.

Farming is a business and must be run on business principles. The farmer must have the point of view that he is a manufacturer. The fields are his factory—the growing plants, the busy machines creating his product.

What a wonderful mechanism is a plant! It is a machine for trapping sunshine. It possesses the wonderful chemical (chlorophyll) that is able to combine the raw materials, carbon dioxide and water, to form the most important thing in America today,—FOOD. Where the factory buys coal for its energy, the plant taps the great free source of all power, the SUN. Where the ordinary factory has to pay a high price for its raw materials, the plant uses stuffs that are as free as the air or as the rain that falls! Again, if one factory doesn't use the steel another can fashion it to its own design,—but the plant uses a raw material that nothing else could utilize.

The point of the whole matter is simply this: The farmer is engaged in a peculiarly fundamental business, he can not be replaced, *his task is the feeding of the world.*

With the consciousness of his importance, the farmer must gain the consciousness of the responsibility that rests upon him. We will not tolerate a factory with slipping belts, broken gears, or idle floor space. Modern business demands EFFICIENCY.

A diseased plant is a crippled machine; a field with half a stand is an idle floor space. The field is the farmer's work shop and every patriotic impulse, every dictate of good business judgment demands that the fields be made efficient servants of the nation.

And what may be said of the wanton wastes of the market induced by faulty handling, either in production or in movement? The theme of this bulletin has been the story of these losses. The bulletin has sought to tell in a practical, workable, understandable way, the facts about the great leak in American agriculture. The pressing problem is *"How to stop the leaks."* The crying need is *Action!*

The Plant Pathologist is the doctor for sick crops. He is the efficiency expert who seeks to speed up the idle, sickly plants in the field, and who seeks to eliminate idle soils and useless wastes.

The great gains in agriculture will not come so much by the invention of new systems of culture, or by the discovery of "miracle" varieties, as by a greater conservation of the crop we already produce.

Food Saved Is Food Made—Help Save It.

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