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AGRICULTURAL EXPERIMENT STATION  
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**REPORT OF THE PLANT PATHOLOGIST**  
**AND**  
**SUPERINTENDENT OF SOUTHERN CALIFORNIA STATIONS**  
**JULY 1, 1906 TO JUNE 30, 1909**

By RALPH E. SMITH.

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REPORT OF THE PLANT PATHOLOGIST  
AND  
SUPERINTENDENT OF SOUTHERN CALIFORNIA STATIONS.

July 1, 1906 to June 30, 1909.

BY  
RALPH E. SMITH.

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INTRODUCTORY AND GENERAL.

At the beginning of the period covered by this report, July 1st, 1906, the duties of the plant pathologist were increased by his appointment to the additional position of Superintendent of the Southern California Pathological Laboratory and Experiment Stations. By this action the Forestry Station at Santa Monica and the Citrus Experiment Station at Riverside were placed in charge of this Division, as well as the Laboratory of Plant Pathology at Whittier.

The Forestry Station is a local sub-station which has for many years been under the control of the University, as one of the several substations which were formerly conducted by the Agricultural Experiment Station.

The Citrus Experiment Station constitutes a branch of the work founded under the legislative act of 1905, in connection with the Southern California Pathological Laboratory. The idea of this consolidation of the three local branches was to handle all the sub-station work in southern California under one management. Shortly before this time the old sub-station located near Pomona was given up and the land reverted to the original owner, the work being carried on to better advantage by the newly created stations.

With the development of the Division of Plant Pathology during the six years of its existence the demand for plant disease investigation has more than kept pace. The present report extends from July 1st, '06 to June 30th, '09, covering a period composed of the second year of one biennial legislative period and the whole of another. The work of this time has therefore been divided into two quite distinct

portions. The year '06-'07, being the second year of the period from July, '05 to July, '07, was occupied by this Division largely in the continuation of several special investigations, founded on appropriations of the legislature of 1905, which have already been reported on up to July, '06, in our last report. (Bulletin No. 184, Report of the Plant Pathologist to July 1, 1906.) These were the Pear Blight work, established by a special appropriation of \$10,000 for this purpose, the Walnut Blight investigation, also provided for by the State with a \$4,000 appropriation, the Beet Blight investigation, supported by a private subscription of \$1,000 raised by the Spreckels Sugar Company, and the Lemon Rot investigation, carried on under a fund of \$1,000 contributed by the lemon interests of southern California.

During the first year covered by the present report the activities of the Division were largely confined to these special undertakings by force of circumstances. Funds in the amounts specified were fairly liberal to support the work, half of each amount being available for the year '06-'07, but it was impossible to pay much attention to other work.

During the period of these special appropriations from 1905 to 1907 it became very evident that such a method of financial support for the investigation of plant diseases is far from ideal. The result has been that while it was possible to give a large amount of attention to these problems during the period covered by the appropriations, it was impossible to lay out the work and develop the Division on a permanent basis or put it into good shape for continuous, satisfactory work on whatever problems might arise. At the end of the fiscal year '06-'07 this Division had at its disposal a considerable number of well-trained assistants who had become experienced in work in California and who would have been of great and increasing value for continued work in the investigation of different plant diseases or other lines of agricultural experimentation. As a result, however, of the discontinuance of these special investigations on pear blight, etc., at the end of the biennial period, no funds were available for keeping up this working force and they were lost to the Station. Moreover, it is extremely difficult to secure competent help for these limited periods of special work with no guarantee of regular continuance. It is certain that, with each succeeding legislature, demands will be made for appropriations to support work of the nature carried on by this Division in one part of the State or another. Yet under the conditions described it is impossible to maintain an efficient organization for meeting these varying demands at short notice.

A most satisfactory remedy for this condition was found for the southern part of the State in the establishment of the Southern California Pathological Laboratory. This institution, founded by the legislature of 1905 and now established in full working order, is maintained by regular appropriations like other State institutions, and may thus be administered efficiently and economically to carry on continuous work on the most important problems which present themselves, with no embarrassing limitations or violent fluctuations in the available funds. The Laboratory has been housed in a permanent building at Whittier, is well equipped for its purpose, has a permanent, well-organized working force and is thus able to cover this field with increasing satisfaction and with much economy to the State, as compared with the system of irregular appropriations for specific investigations or for seeking cures for certain troubles.

Previous to the meeting of the legislature of 1907 a considerable variety of undertakings was urged upon the Division with the object of seeking special appropriations for their support. This included the continuation of the pear blight work, work on the peach blight, a disease which had suddenly assumed very serious proportions, demands for local laboratories in a number of sections, suggested by the establishment of the Southern California Laboratory, and a variety of other projects. So numerous and varied were these suggestions that much confusion would have resulted had they all been presented to the legislature in the form of special appropriation bills, and the carrying out in such a form of the work desired would have been most unwieldy. It was therefore thought best to combine all these projects into one bill, asking for an appropriation to cover general work in plant pathology outside of southern California along the same lines as had proven so successful in that section. It was proposed that the office of State Plant Pathologist be created for the plant pathologist of the Experiment Station and that the laboratory at Berkeley be designated the State Laboratory of Plant Pathology, thus putting all the work of this sort in the State upon a uniform basis. This bill passed the legislature but failed to receive the Governor's signature. As it represented all the special lines of work which had been going on during the previous period, as well as the demands which had been made on the Division for the following two years, the whole work was seriously crippled and very much limited during the period from July 1st, 1907 to June 30th, 1909. Such work as has been possible during that time has been only such as could be provided for by the general Experiment Station or University funds, with the exception of that done in southern California.

Some activity has also been going on with funds derived from the Adams Fund, a national grant made for the purpose of agricultural investigation.

The bringing about of the arrangement, found so successful in southern California, for the remainder of the State was provided by the legislature of 1909 by the passage of the following Act:

“An act providing for the investigation of the nature and means of control of destructive diseases of cultivated plants in those portions of the state not benefited by the Southern California Pathological Laboratory, and making an appropriation therefor.

“The people of the State of California, represented in senate and assembly, do enact as follows:

“Section 1. The regents and president of the University of California are hereby directed to maintain in connection with the agricultural experiment work of the university in those portions of the state not benefited by the Southern California Pathological Laboratory a scientific station or laboratory with the necessary equipment for the investigation of the nature and means of control of injurious and destructive diseases of cultivated trees, plants and crops.

“Section 2. They are directed to make or cause to be made investigations of such troubles as pear blight, peach blight, olive knot, apricot failures, pear scab, apple diseases, root rot, root knot, diseases of tomatoes, potatoes, asparagus, onions and other vegetables, and such other plant diseases as may be called to their attention. They shall also furnish information and practical demonstrations to the growers of these crops as to the best means of control for such diseases.

“Section 3. The sum of fifteen thousand dollars is hereby appropriated out of any money in the state treasury not otherwise appropriated to be expended by the regents of the University of California in carrying out the purposes of this act and the state controller is hereby authorized and directed to draw his warrant for the same, payable to the regents of the University of California, and the treasurer of the state is hereby directed to pay such warrant.”

Under this law it will be possible to commence systematic investigations and demonstrations on the most serious plant disease problems in northern California, and this work is now being actively organized. The law is intended to provide for permanent work similar to that in southern California, and it is hoped that the results of this work may be such as to warrant continued financial support of the State in the future, thus maintaining at the University, in reality as well as in name, the headquarters of the division of plant pathology.

In connection with this work the establishment of the University Farm at Davis has considerable promise. It is expected that opportunities will develop at the Farm for field work and practical operations of various sorts on a larger scale than can be handled at Berkeley, a very necessary feature in work of this kind.

A very gratifying feature of the development of work in plant pathology in California is the increasing tendency to affiliate the work

with that of the various Divisions of the United States Department of Agriculture. The rapid development of the Federal Department has resulted during recent years in a great increase in its activities in California. It has been the aim of this Division to so conduct its work as to operate completely in harmony with the agents of the Department and avoid as much as possible any duplication of work or misunderstanding. It is believed that the best results may be secured by segregation of the various workers on different problems or different phases of the same problem, rather than an attempt at combined work upon the same subject. So long as a clear understanding exists as to the plans and undertakings of the Station and the Department, there is no obstacle to harmonious work, and the field is broad enough for the utilization of every possible agency which can be brought into action. It is particularly undesirable, however, that representatives of the State Station and those of the United States Department should be working in the same field along more or less similar lines without such an understanding and a complete mutual knowledge of what is being undertaken.

The correspondence of the Division is continually growing, involving a great variety of questions regarding all sorts of troubles with plants, which leads to a continual broadening of the experience of those connected with the work. The practice of personal inspection on the part of the plant pathologist and his assistants, requiring a large amount of traveling to various parts of the State, is considered highly desirable for work of this sort. Though much time is consumed in this way, it is impossible otherwise to keep in touch with agricultural conditions in a State of the size and peculiarities of California. The establishment of the Southern California Laboratory has been of great advantage in this respect, furnishing a local headquarters for the work in one of the most important sections of the State.

The publications issued by this Division during the period covered by this report include Bulletin 184, Report of the Plant Pathologist to July 1, 1906; Bulletin 190, The Brown Rot of the Lemon; Bulletin 191, California Peach Blight; Bulletin 196, Eucalyptus in California; Bulletin 200, Gum Disease of Citrus Trees in California; and Circular 35, The Southern California Pathological Laboratory and Citrus Experiment Station. Numerous communications on subjects connected with the work have appeared in the horticultural press from members of the staff, as well as contributions to the programs of Farmers' Institutes, Fruit Growers' Conventions, Farmers' Clubs, and other meetings of a similar nature.

Changes in the staff of the Division have been too frequent, mostly on account of the demands of the special appropriations covering the year 1906-7 and the discontinuance of these appropriations after that time. Messrs. R. L. Adams, S. S. Rogers and F. L. Yeaw joined the pear blight work during the year mentioned. The two former have since entered the employ of the Spreckels Sugar Company, in charge of a private experiment station established by that company. Mr. Yeaw reëntered the service of this Division in December, 1907. Mr. A. M. West resigned his position as Assistant Plant Pathologist in the Southern California Laboratory on November 1st, 1906. Mr. B. J. Jones, who was connected with the pear blight work during the whole biennial period and who had charge of the field work during the most of the time, left the Division on the conclusion of this work. Mr. C. O. Smith was transferred from Berkeley to the Whittier Laboratory in December, 1906. Mr. E. B. Babcock, formerly a member of our staff, returned to the work in July, 1907. He was stationed in southern California for a time and afterwards engaged in teaching at the University, being appointed Assistant Professor of Plant Pathology on July 1st, 1908. July 1st, 1909, Mr. Babcock was transferred from plant pathology to another department of the University. The vacancy in teaching thus created has been filled by the appointment, as Assistant Professor of Plant Pathology, of Mr. William T. Horne, Chief of the Department of Plant Pathology in the Agricultural Experiment Station of Cuba. Mr. T. F. Hunt, who had been employed in the work on pear blight and beet blight, was assigned to the Citrus Experiment Station at Riverside in September, 1906. On July 1st, 1909, he was transferred to the position of chief field assistant in the northern California work. Mr. O. Butler, a graduate student in plant pathology, was employed in research work in the Southern California Laboratory from August, 1907, to January, 1909. Mr. H. J. Ramsey, who has been stationed at the Southern California Laboratory, at Whittier, as chief assistant during the whole period of this report, was advanced in title to Assistant Professor of Plant Pathology on July 1st, 1909. Miss E. H. Smith has had charge of office and laboratory work at Berkeley as heretofore. Mr. H. J. Quayle, Assistant Professor of Entomology in the University, was assigned to the southern Laboratory for entomological work, commencing July 1st, 1908. Mr. J. W. Mills, for many years in charge of university sub-station work in southern California, was assigned to the Citrus Experiment Station at Riverside upon the beginning of the work there in June, 1906. Mr. Mills continued in local charge of the development of the Station grounds until July 1st, 1908, when

he resigned to engage in private enterprise. Mr. J. H. Norton, Chemist at the Arkansas Station, was appointed Assistant Professor of Fertilization on July 1st, 1908, and assigned to work in southern California on problems of soil fertilization and management, particularly with reference to the citrus industry. On July 1st, 1909, Mr. Norton's title was changed to that of Assistant Professor of Agricultural Chemistry. Mr. N. D. Ingham, formerly employed in the pear blight work of this Division, was assigned to the Santa Monica Forestry Station in April, 1906, and still continues in charge of that work. Mr. W. B. Parker, a University student, was employed during the summer of 1908 in the olive knot investigation. Dr. J. Eliot Coit, of the Arizona Experiment Station, was appointed Assistant Professor of Pomology from July 1st, 1909, and assigned to citrus work in southern California.

#### REPORT ON WORK OF THE DIVISION.

The principal subjects considered in this report are as follows:

Plant Pathology at the University, Development of the Whittier Laboratory, Development of the Riverside Station, Condition of the Forestry Station, Pear Blight, Walnut Blight and Culture, Lemon Rot, Sugar-Beet Blight, Peach Blight, Rose Diseases, Apricot Diseases, Olive Knot, Onion Mildew, Brown Rot of Stone Fruits, Celery Blight, Apple Mildew, Tomato Diseases, Technical Investigations in Plant Pathology, Work in Entomology at the Southern California Laboratory, Citrus Culture and Diseases (Disease Investigation, Soil and Fertilizer Work, Pomological Work), Variety Introduction and Testing of Pecans, Peaches and Tomatoes, Eucalyptus Investigations, Work in Imperial Valley, Pasadena City Farm.

#### PLANT PATHOLOGY AT THE UNIVERSITY.

While the headquarters of this Division are naturally at the University in Berkeley, it has not yet been possible to develop the work there in a satisfactory degree. The funds available for this work have been so much more abundant in connection with the Southern California Laboratory than those for the remainder of the State that the former institution has come to be the principal field of the work of this Division. The teaching of plant pathology at the University has never received the attention which the subject deserves. Courses have been given in a somewhat desultory manner since 1904 by the writer and Messrs. C. O. Smith and Babeock. Commencing in 1908 the work received more systematic attention than before through the

appointment of Mr. Babcock as assistant professor of plant pathology. The department, however, has never been sufficiently equipped or housed to give extended or specialized instruction in this subject. In the field of investigation the work has also suffered in a similar manner. Following the early work of the writer from 1903 to 1905, carried on with practically no equipment or assistance, the following two years were devoted, as mentioned elsewhere in this report, to certain special investigations on a considerable scale, but without the means for general development of the department at the University. Some progress was made, however, during this period in the development of laboratory equipment and other facilities. During the past two years there has been very little more accomplished in this direction. Investigations have been carried on by Miss Smith in the laboratory and Mr. Yeaw in the field, and some problems have also been taken up by Mr. Babcock, but the development and activity of the department outside of southern California during this time has been very limited.

Conditions for the future, both in regard to investigation, experimental work and teaching at the University are much more promising. Professor Horne has been called for the purpose of assisting in building up the teaching department, and the facilities and equipment for this purpose are rapidly improving. It seems safe to predict that the teaching of plant pathology at the University will from now on receive very satisfactory consideration.

The situation in regard to investigation and experimentation, together with field work on plant diseases, in the northern part of the State is entirely changed and very much improved by the action of the legislature in passing the bill referred to on page eight. This work will be centered at the University and to some extent at the Davis Farm and can now be carried on upon a systematic and permanent basis. In general, therefore, it may be said that the Division is at last finding itself in a position to make its headquarters at the University where they properly belong and administer its work in a logical manner all over the State.

#### DEVELOPMENT OF THE WHITTIER LABORATORY.

The establishment of the Whittier and Riverside branches of the Station work has been described in Circular 35 of this Station. Since this publication the work of development at Whittier has gone on satisfactorily both in the laboratory building and the adjacent grounds. The laboratory is now well equipped for the work of investigation in plant pathology, entomology, and to some extent in chemistry. An

appropriation of \$1500 was made by the last legislature for the further equipment of this laboratory, and with this money we intend to supply several urgent needs. A considerable part of the appropriation will be expended in the purchase of books, with the idea of obtaining a working library composed of the most necessary works needed by those engaged in the laboratory investigations. The remainder of the appropriation will be used in the purchase of a few more microscopes,

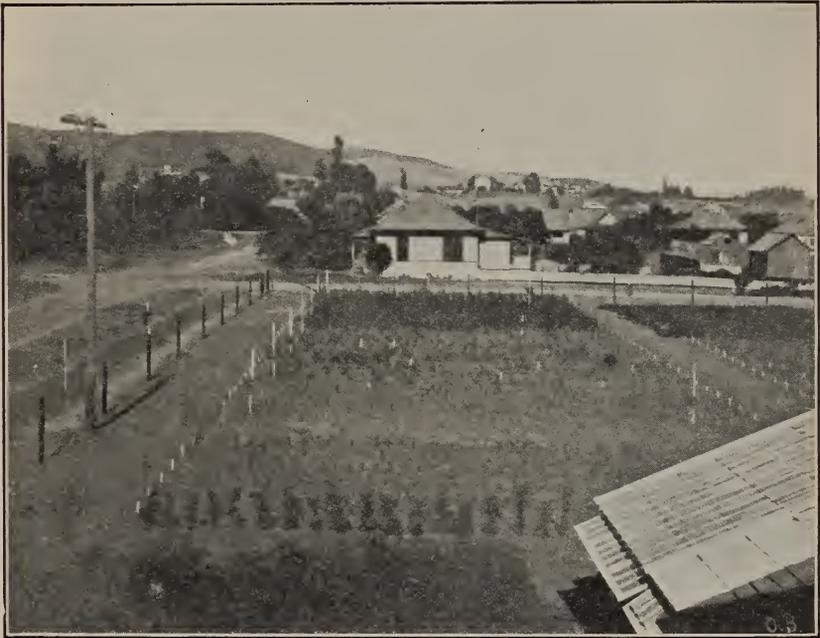


Fig. 1.—Experimental Garden at Whittier Laboratory. May, 1908.

a high-class photographic lens, and other necessary equipment. In connection with the library a good beginning has been made toward collecting as complete a set as possible of the publications of the various state experiment stations and the United States Department of Agriculture. The library receives regularly all the current publications of these institutions, and a fairly complete set of back numbers is being collected. These bulletins have all been catalogued and systematically arranged.

During the last two seasons most of the available field space at the laboratory has been utilized in growing walnuts. Considerable plantings have been made of various species and selections for the purpose of forming grafting stock for trees of improved quality to be grown and distributed by the Station for practical trial by walnut

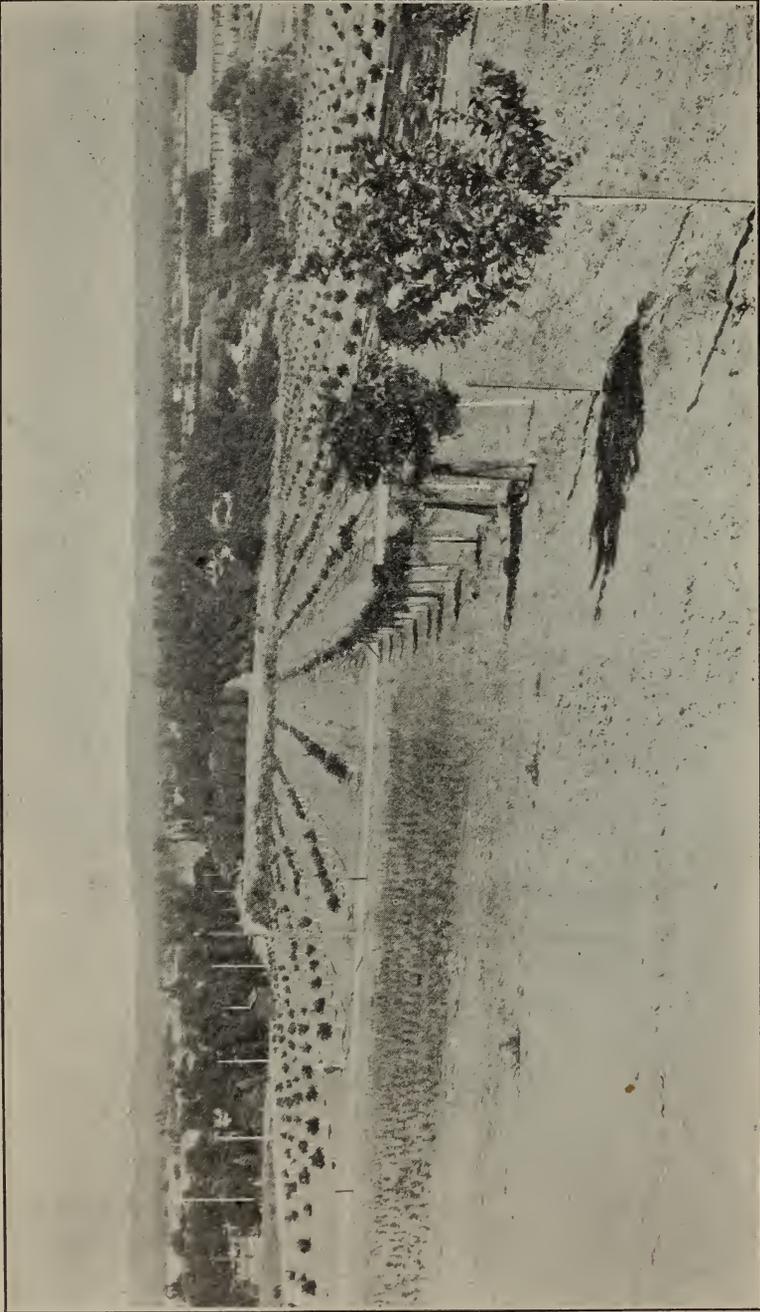


Fig. 2.—View at Citrus Experiment Station: Nursery planting in left foreground, young trees in fertilizer experiment plots directly in front, leased grove of older trees in distance. May, 1908.

growers in various sections. Considerable space has also been devoted to tomatoes in connection with the work on this vegetable. A limited number of specimen trees have been planted in the space available, representing the most important varieties of citrus and other fruits. A grove of walnut and other nut trees planted on the near-by grounds of the Whittier State School is developing well and will soon afford an interesting and valuable feature.

During the past year the development and equipment of the laboratory has been considerably advanced by the addition of Professor Quayle's work in entomology. Two rooms on the second floor of the building have been devoted to this purpose and equipped as an office and laboratory for the entomologist. A portion of the greenhouse has also been set aside for an insectary and used by Professor Quayle in his work. A considerable amount of apparatus has been added to the laboratory equipment for entomological purposes.

In the same connection may be mentioned the equipment of a small but quite complete chemical laboratory in one of the larger rooms on the second floor of the building. This room has been fitted with benches, shelves, cupboards, hood, etc., and equipment is now being installed for chemical work.

#### DEVELOPMENT OF THE RIVERSIDE STATION.

Work on the grounds at Riverside is proceeding well and the plantings thus far are developing very satisfactorily. The nature of the work undertaken at this Station precludes the possibility of the rapid development and progress made at the Whittier Laboratory, but every effort is being put forth to develop this Station. The plantings of young citrus trees made in the spring of 1907 for fertilizer and other experiments, as described in Circular 35 and elsewhere in this report, are making an excellent development. The citrus seed-bed stock started in 1907 has been planted out in nursery form and budded to various selected stock; a considerable planting of eucalyptus trees of various species has been made on the mountainside back of the Station; improvements in the irrigation facilities have been made from time to time, and much other work of a general nature has been done in developing and beautifying these grounds. The lines of investigation centered at this Station have been particularly those connected with field problems in citrus culture, matters having to do with studies of soil nature and treatment and pomological work. It is for such purposes that the orchard and nursery plantings on the place have been made. In connection with Professor Norton's work further development of field and cultural work is being laid

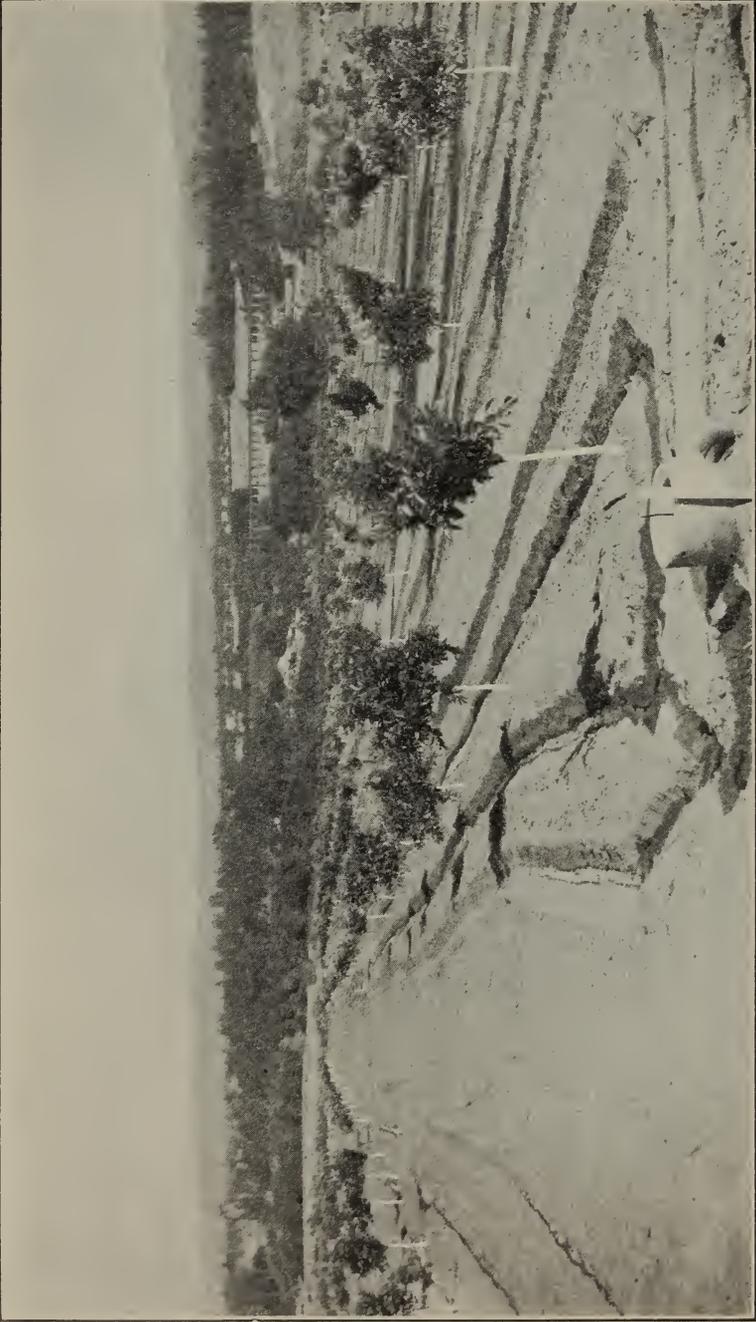


Fig. 3.—Corner of one plot in fertilizer experiment planting, showing irrigation water outlet. May, 1908.

out and a system of pot cultures is also being installed on a considerable scale. Much of the work of this Station is necessarily carried on in the commercial groves of the vicinity and elsewhere rather than on the Station grounds proper.

An effort was made during the meeting of the last legislature to obtain an appropriation for erecting a laboratory and office building on the Station grounds, but owing to the fact that this land is not owned by the State but held on a twenty years' lease, no appropriation for a building was granted. Some effort was also made to obtain an appropriation for the purchase of the land by the State, but this met with little support on account of the high value of the property, due to its favorable location.

#### CONDITION OF THE FORESTRY STATION.

At the time when the Santa Monica Station was turned over to this Division all the buildings of the Station had been lost by fire, and the new ones, for which plans had been prepared, had not yet been begun. The erection of these buildings was therefore the chief activity of the Station during the first year covered by this report. Two dwelling houses, a stable, tank house, lath house, green house and office were erected, so that the Station is now excellently equipped as to buildings. Much improvement in the grounds has been made by Mr. Ingham by cleaning up dead trees, underbrush and other relics of the disastrous fire which destroyed the former buildings, as well as by new plantings, road making, etc. In point of natural beauty and picturesqueness of location, the Forestry Station may be called the choicest of the University's possessions. The valuable collection of growing eucalyptus trees on the Station grounds, representing over seventy species, as well as many other trees and shrubs, was not seriously injured by the fire, and this unique collection represents the most valuable feature of the Station.

The work of the Forestry Station in previous years has consisted largely in the growing and public distribution of eucalyptus trees of various species in order to promote their trial and planting throughout the State. Since all the promising species can now be obtained of nurserymen, and with the limited funds devoted to the work of this Station, it has seemed unwise to continue this tree distribution during the period covered by this report. On the Station grounds, therefore, little has been attempted except in the way of keeping up the property and using the collection of trees growing there for purposes of study and observation.

It is evident that in the field of forestry proper this Station can

be put to no important use under present conditions. Extensive work in forestry is being done in southern California by the United States Forest Service to much better advantage than could be done by the State Experiment Station. The equipment at Santa Monica presents, moreover, no particular advantage for such a purpose. The Station's greatest field of usefulness is rather in the direction of silviculture, in the study of planting and growing of trees as a commercial crop, for which some of the various species of eucalyptus are of great value



Fig. 4—Santa Monica Forestry Station.

in California. The work of the Forestry Station under the present management has, therefore, resolved itself almost entirely into a study of specific subjects, beginning with that of eucalyptus-growing in California, based largely on field observations all over the State where the trees are grown. This work has been done by Mr. Ingham, making the Station at Santa Monica his headquarters, and utilizing the collection of trees there as stated above. It is desirable that this collection should be duplicated in other places to provide against its loss or partial destruction from any cause, and for this reason trees of all the species represented are being grown with the idea of finding opportunities for planting duplicate collections on public grounds in California.

#### PEAR BLIGHT WORK.

This work, which has been carried on in co-operation with the United States Department of Agriculture, was reported on at length for the first year in our last report. The detailed history and character of the undertaking may be obtained from that publication. The second year's experience in the work, the period from July, 1906 to July, 1907, was in most respects similar to that of the first year already

reported on. The work consisted in general of an effort on the part of a considerable force of field experts to encourage the eradication of pear blight, according to the methods established by Mr. M. B. Waite of the Federal Department of Agriculture. The working force in the field consisted of Messrs. Waite and Scott of the United States Department of Agriculture, with several assistants, six representatives of this Division of the State Experiment Station and a number of men working under various County Boards of Horticulture. The plan of work was largely that mentioned on page 232 of the last report. This consisted in distributing the available men in a somewhat permanent manner among the various pear-growing districts, allowing the men in each district to render all possible assistance to the growers in that part of the State. No effort was made on the part of the Experiment Station to enforce compulsory eradication. The latter undertaking was left to the discretion of the County Boards of Horticulture, the Station men endeavoring to give all assistance of any sort which was desired by the growers in enabling them to suppress the disease. This work was continued through the winter and up to July, 1907, at which time the appropriation period ended and, no new funds being forthcoming, the work was obliged to lapse.

The general results of this two years' work on pear blight by the Station, coöperated in by the United States Department of Agriculture and the State and County Boards of Horticulture, have been by no means meagre or unsatisfactory. With the appropriation of \$10,000 made by the legislature of 1905, a force of men, varying from six to twelve, was kept in the field for two years in continual earnest work; every pear grower in those sections of the State which are largely interested in this crop was visited many times and thoroughly instructed in the best known methods of handling the disease; 750,000 pear trees were carefully inspected several times; numerous meetings and demonstrations were held to promote the objects of the work; and in general it can fairly be said that to the extent of practical possibility everything was done to suppress this destructive disease. Full credit should be given to the other agencies mentioned outside of the Experiment Station for their part in the undertaking. It is difficult to see what further could be done under present conditions and in the light of present knowledge, but the work has emphasized the necessity of changed methods and increased knowledge in certain respects. Along such lines appears to be the greatest hope for the future of the pear industry in California. After the amount of work done in the field by the agents of the Experiment Station and Department of Agriculture it does not appear to the writer probable that further work of



Fig. 5.—Bartlett pear tree on ordinary root, showing mass of suckers.

this sort on a large scale could be of much profit. Our pear growers have had every opportunity to become thoroughly informed as to the methods of control advocated and to put them into practice. So far as these methods are applicable to existing conditions there should be no further necessity for their demonstration. Pear blight, however, has by no means been eradicated from California, nor is it likely to be. The future of the industry is therefore still problematical, although a considerable number of individual growers are handling blight successfully.

One of the most valuable results obtained from the work done thus far has been the experience gained as to the behavior of the disease under California conditions. Of these peculiarities there are two which seem of particular importance, since they are the factors which have most largely prevented complete control of pear blight in California; these are: first, the very large amount of infection of twigs and green shoots which occurs with no relation to the blossoms; second, the large number of trees which become infected in the body near the ground or in the butt under ground. In the latter case the blight runs down into the roots and often girdles and kills trees which, in the tops, appear perfectly healthy, or only slightly affected with the disease. So far as the usual form of the disease is concerned, occurring in the top of the tree with the infection mostly through the blossoms, our growers have learned to handle it with considerable success by the usual methods where the work is done carefully.

The one most discouraging and baffling feature of the disease has been that mentioned, where large numbers of trees in an orchard apparently free from blight would suddenly be found affected in the butts and thus beyond redemption by the methods of handling blight in the tops. Could this difficulty be overcome we believe that pear growing would again flourish on a sound basis, though requiring more care and attention than at present.

During the years 1907-09 our chief activity in regard to pear blight has been along the line suggested in the last paragraph, carried on under the provisions of the Adams Act. This work has consisted mostly in an effort to determine the method by which infection takes place in cases where the green twigs and shoots contract the disease so abundantly, and also to investigate the possibility of growing trees in such a way as to avoid the butt blight mentioned above. It has been found that the latter form of the disease is a result of the other peculiarity mentioned, the infection of the butts taking place through green sprouts or suckers, sometimes when the latter amount to no more than a bud with only one or two leaves formed in



Fig. 6—Bartlett top—worked on LeConte. Neighboring trees on ordinary root are four years older but considerably smaller.

the rough bark near the butt. Infection of this sort appears to be brought about in a similar manner to that in blossom infection, mainly by insects. Our investigations have shown that a great variety of insects which feed on the green shoots may carry the blight organism and thus produce infection. There is no apparent means of preventing this form of the disease beyond that which has already been in use, namely, the removal of sprouts from the body of the tree, and this has not proven very satisfactory on account of the continual crop of suckers produced by many trees, some of which become infected while still very small. There is also some infection through wounds made by cutting off the suckers.

The most promise is in the direction of growing trees upon a stock more or less immune, or one which is not disposed to produce sprouts, thus avoiding the infection of the trees by blight in the trunk or roots. It is well known that different varieties of trees vary in their susceptibility to blight. None are entirely immune under all conditions, but some are much more so than others.

The whole consideration of pear blight in California rests primarily upon the fact that the word "pear" in this State means ordinarily the Bartlett pear. This variety is so preëminently satisfactory that while it is one of the most susceptible to blight and other varieties much less affected are to be found, yet the giving up of the Bartlett pear would mean practically the giving up of the pear industry. The development of a new variety as satisfactory as the Bartlett, but fairly resistant to the blight, would be a most uncertain undertaking. Our chief thought has, therefore, been as to the possibilities of growing the Bartlett under some system by which the tree could be rendered less susceptible to destruction. The ordinary French seedling root upon which pear trees are commonly grown has two vital defects in relation to blight. It is very free to sucker and it is very susceptible to the disease. These suckers become infected, the blight runs down into the butt and roots, and the tree is killed while the top is still in good condition. The Bartlett pear tree trunk also suckers rather freely and blights readily. It therefore seems that it would be of great practical advantage if the Bartlett could be grown on a trunk and root somewhat resistant to blight and not given to sending up suckers. With a Bartlett top worked on this combination an orchard could certainly be kept free from serious injury much more readily than with the present style of tree.

The extensive experience gained in our work on pear blight has shown among the trees now growing in the State one suggestion of particular value. This is the growing of the Bartlett upon rooted

cuttings of the LeConte. The latter variety while by no means blight-proof, is much less easily affected than the Bartlett. It roots readily from cuttings and produces a trunk decidedly free from suckers. Trees of this combination existing in the State have shown a most vigorous growth, considerably exceeding that of the Bartlett on the ordinary root. It should be clearly understood that there is no idea that the Bartlett top would gain any immunity from blight from growing on the LeConte. The sole object is simply to grow the root and trunk free from the disease and confine the blight to the top of the tree, where it can be more readily seen and handled, and where its effects are less disastrous. As to the growth of the Bartlett on the LeConte, what experience we can gather goes to show that the tree thus grown, while unusually thrifty and vigorous, is very slow in coming into bearing. This has been learned particularly from Mr. Richard Burton, of Vacaville, who has old trees of this sort and whose experience forms the basis of most of what is said upon this subject. It has therefore been suggested that the trees be double worked, with some other variety between the LeConte root and the Bartlett top, in order to promote early bearing. The Hardy suggests itself as one possibility for this purpose, as it succeeds well in California and has shown itself to be quite free from blight. For the purpose of a thorough investigation and demonstration along these lines pear trees are being grown by this Division, trying out various combinations as to root and trunk, along the lines suggested. The results already obtained give considerable promise of success. Our main object will be to demonstrate the possibility of growing a nursery tree with a Bartlett top which can be planted in the orchard and kept free from blight simply by keeping the disease out of the top.

The seasons of 1908 and 1909 have been most remarkable in the absence of pear blight throughout the affected districts. The disease has disappeared in an astonishing manner where for the last few years it has been most abundant. This freedom from blight is evidently a climatic effect and is encouraging in showing the possibility of occasional years of little blight when a tree may have an opportunity for recovery, but should not be taken as indicating a permanent cessation of pear blight.

#### WALNUT BLIGHT AND CULTURE.

A large amount of work on walnut blight has been carried on in southern California at the Whittier Laboratory, and still continues. The appropriation of \$4,000 made by the 1905 legislature was expended in an investigation of the nature of the disease and the pos-

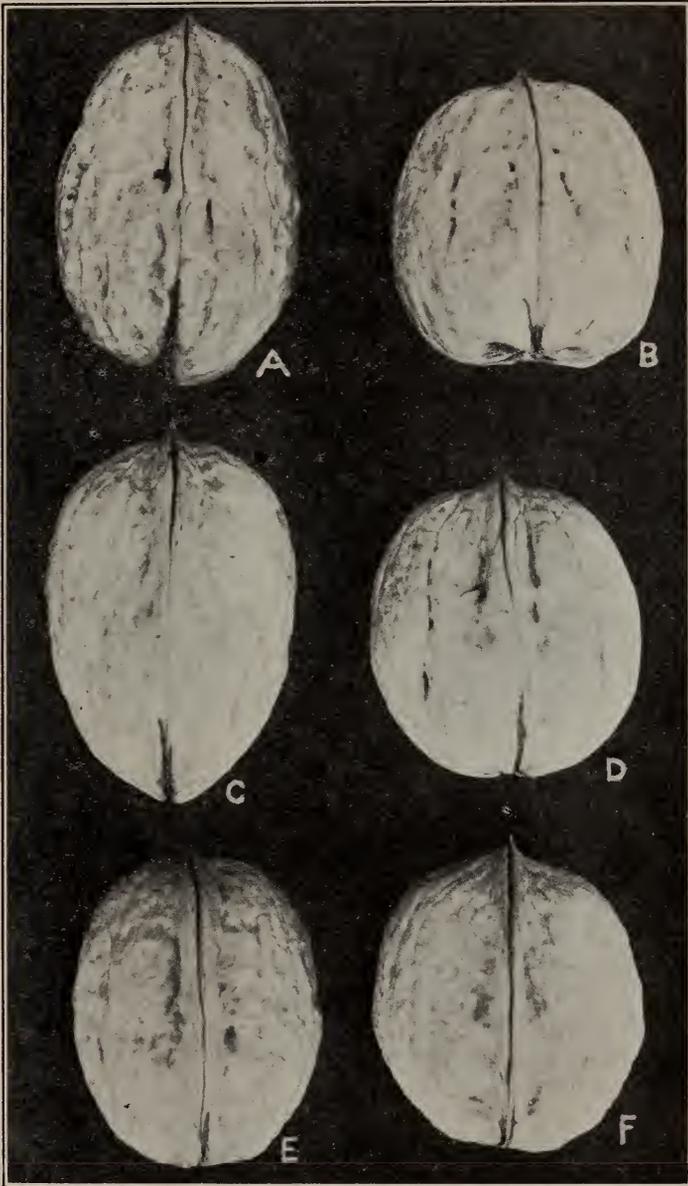


Fig. 7.—Specimens of blight-immune walnuts. A Franquette, B Mayette, C Eureka, D San Jose (Wiltz' Mayette Seedling), E Hale, F Placentia (not immune).  
Natural size.

sibility of its control by spraying the trees with different substances. This investigation has been made one of the chief features of the work of the Southern Laboratory since its establishment. From the experience previously gained, the idea of finding a remedy for the disease in the form of any application to the tree has been given up as impractical, and the chief effort is now being made along the lines of improved cultural practice, thus increasing the production of the trees.

The greatest possibilities in this direction seem to lie in soil fertilization, and extensive experiments along such lines are being carried on by this Division. Some of these are now in their third season and ought to show results in the crop of 1909. It is already very evident that in spite of the disease the production of most of the present orchards could be greatly increased by fertilizing the soil, if the most economical method in this respect was determined. In regard to irrigation, also, as affecting the condition of the trees, considerable benefit is being demonstrated by the determination of the best practice in this regard.

The ultimate solution of the blight problem appears to be in the growing of walnuts immune to the blight, desirable types of which are already in existence. Much work is being done at the Whittier Laboratory in this direction. This involves the growing of grafted rather than seedling trees and thus opportunity is given for choice regarding both the root and the top of the tree. Each is of great importance. Extensive plantings have been made at the Laboratory of nuts of various kinds and sources for the production of root stocks. These represent several species of walnuts and also hybrids between different species. Experience has already shown that in the native California black walnut we have a more hardy root than that of the English walnut, one that is more capable of flourishing under unfavorable conditions and one with a much wider range of soil. The native walnut varies, however, in individual trees almost as much as the cultivated species, so that there is room for careful selection and discrimination in growing a root stock. The California walnut is also divided more or less distinctly into two separate species. It may be classed as the southern California and northern California types. The tree which grows wild in the southern part of the State has its favorite habitat upon dry, somewhat elevated hillsides with occasional trees in the valleys at the foot of these hills. It is distinctly a hillside rather than a valley tree, however. The tree itself has quite a shrubby rather than a tree-like form and, even in large specimens grown on good soil with abundant

water, the tendency is still towards abundant branching rather than the formation of a tall, clean trunk. The nut of this type is a very small one. According to the latest arrangement by Professor W. L. Jepson, the southern California walnut is to be regarded as *Juglans californica* Wats. It grows quite abundantly in the Puente hills southeast of Whittier and in the Santa Monica, Newhall and other mountains of that vicinity, extending north at least to the Ojai valley back of Ventura. This species is also found to some extent in the lower parts of the San Bernardino range.

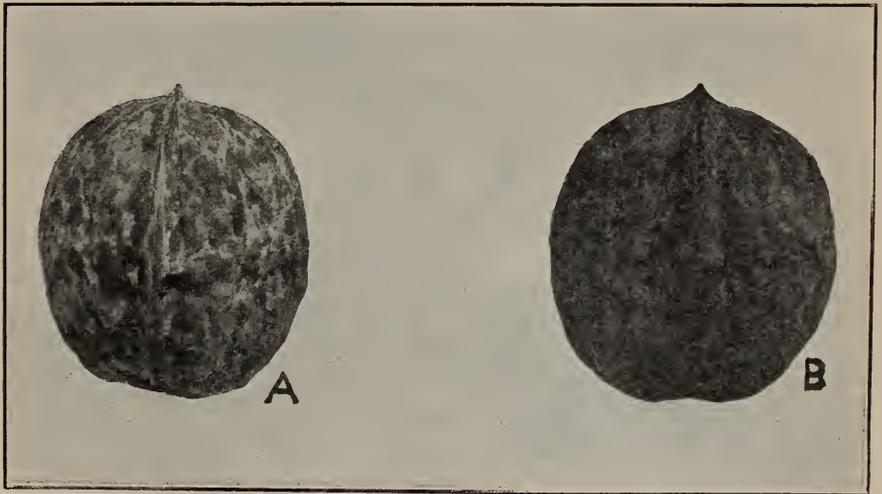


Fig. 8.—Two blight-immune walnuts: A Concord, B Chase. Natural size.

The northern California nut averages fully twice as large, and the tree has typically a tall regular form approaching that of the eastern black walnut. This is classed by Dr. Jepson as *Juglans hindsii* Jepson. The origin of the northern California walnut is much in doubt. While this tree is one of the commonest grown for shade and ornament about many of the towns in central and northern California, yet there are only a very few places where there is any indication of the tree having been indigenous. Considerable attention has been given to this interesting question and we have found but three locations where the walnut trees go back beyond the knowledge of any white person. These are: 1, near Walnut Creek, Contra Costa County; 2, Walnut Grove, Sacramento County; 3, a point in the mountains of Napa County, northeast of Napa City, near the top of the west slope of the so-called "Wooden Valley." In each of these

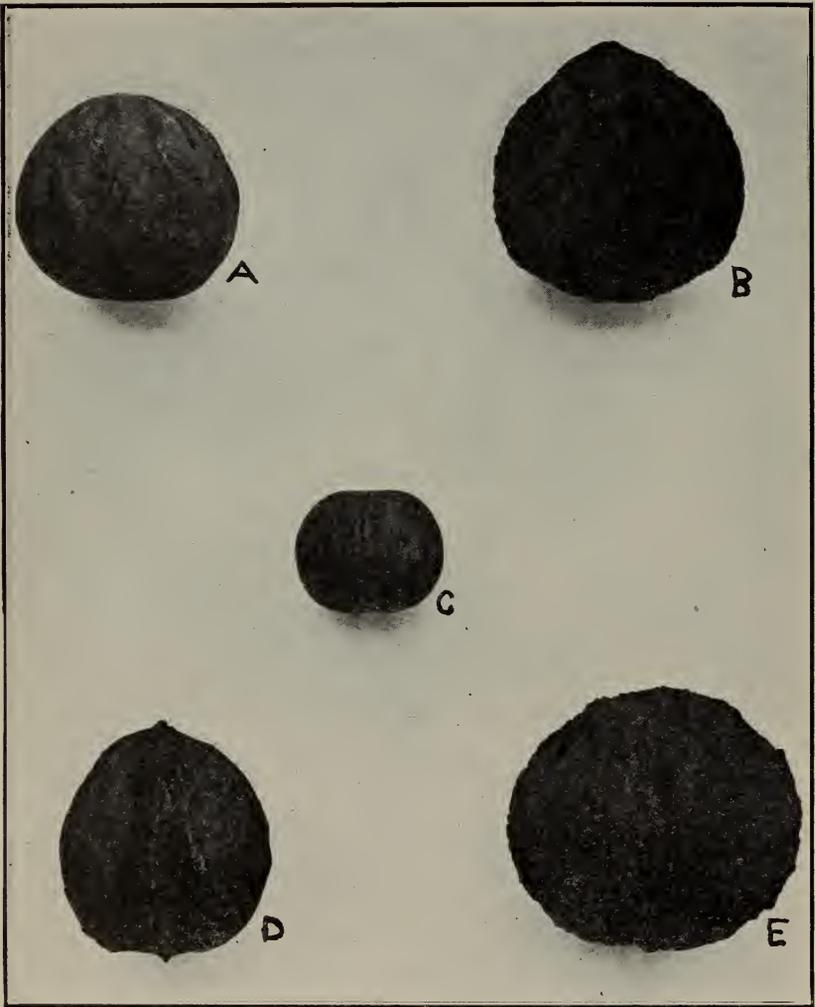


Fig. 9.—Walnuts used for root-stocks. A Northern California Black (*Juglans hindsii*), B Eastern or American Black (*J. nigra*), C Southern California Black (*J. californica*), D Hybrid English X *californica*, E Hybrid, *nigra* X *californica*.

places, and at no other which we can find, there were large old black walnut trees growing at the time of the first white settlement. These primeval trees do not appear to have been indigenous to the localities where they are found, but the question of their origin is an extremely obscure one. Morphological and field studies are being made by Mr. Ramsey upon this subject. The northern tree shows a decided preference for a moist valley soil in the vicinity of streams rather than that of the south for growing on dry hillsides.

Both the northern and southern California walnuts have been found satisfactory as a root stock for the English, but we have as



Fig. 10.—Top-grafted walnut trees, March, 1908.

yet no sufficient comparison between them to judge finally as to which is the better. Such comparisons are now being made by this Division by grafting English walnuts on various roots and planting them in various soils. The possibility of using for roots some of the not uncommon hybrids between the California black, American black and English walnuts is also receiving much attention, on account of the extremely vigorous growth of these trees. Selected walnuts from all over the State as well as from other parts of the country have been planted at Whittier, and a very interesting nursery is in process of development.

The selection of a strain or variety of English walnut possessing immunity to the blight as well as desirable commercial qualities is receiving much attention. Immunity to this disease is not obtained

entirely by actual resistance, but in many cases by simply escaping the worst infection period: *i.e.*, the moist weather of early spring. Most of the immune trees are such as come out rather late in the spring, thus escaping rather than resisting the blight. Several of the ordinary French walnuts, such as the Franquette and Mayette, have this quality of lateness in an extreme degree, but this involves



Fig. 11.—Same trees as in figure 9; July, 1908.

the question of the time of harvest in the fall, an extremely late crop not being desirable in California. The most promising trees found thus far are local seedlings of foreign varieties which develop somewhat later than our ordinary seedlings, but not so late as the French varieties mentioned. A number have been found which seem to justify their planting as blight-immune. Among these we may mention varieties which have received the names Eureka, Concord, Chase, and San Jose, as well as the Franquette and Mayette mentioned

above. All of these and many other varieties are being grown by this Division and their value carefully tested for various portions of the State. We are now in a position to supply scions of all the important walnut varieties, as well as a limited number of nursery trees of some.



Fig. 12.—English walnut grafted on California black.

One very imperative phase of this matter has been the question as to the fate of the present existing plantings, consisting of many thousand acres of fine, large, thrifty trees, very satisfactory in every way except for the occasional loss of a considerable part of the crop through their susceptibility to the disease. Many of these orchards are extremely profitable, even under present conditions, and it is

evident that by increased attention to soil fertilization their productiveness can be maintained in a very satisfactory degree in spite of the disease.

One means of handling large trees which are extremely susceptible to blight is by top grafting them to the more immune kinds. The methods of doing this have received the consideration of this Division, and much work has been done along this line. During 1908 and 1909 a considerable number of large trees were top grafted, both by the Station and by individual growers, with decided success. Experience elsewhere, particularly in the central part of the State, where many large native walnuts have been grafted to the English variety, has shown that with reasonable success a new top equal to the original one can be put on a large tree in four years. In orchard work the most rational practice appears to be the picking out and working over of the trees most susceptible to blight each year until finally the whole orchard has been changed. In this way there is no marked loss from cutting off the trees in any one season.

Another method of working over an old orchard consists in inter-setting with nursery trees of the California black walnut. It is more practical to plant the young trees rather than the nuts in the orchard. The object of this method is to grow the black walnut trees up to three or four years old and then graft them in the top to the desired variety. If the ground is closely shaded by old trees they should be thinned enough to give the young black walnuts a chance to grow. This thinning can be done in most of our older orchards without any disadvantage, as in most of them the trees are already too thick. The young grafted trees will come into bearing early, and it is possible by this plan to have a new orchard well started by the time it is necessary to cut out the old trees. The advantage of a tree having the black walnut trunk as well as root is a very considerable one, owing to the susceptibility of the English walnut trunk to sunburn.

The publication of a bulletin on walnut blight and walnut culture in general is contemplated for the present year.

#### LEMON ROT INVESTIGATION.

The investigation of the form of lemon decay known as "Brown Rot", which was begun in July 1905, was practically completed during the year 1906-7 and reported on in full in Bulletin No. 190. Successful means of preventing the great losses which had occurred from this trouble were found and a detailed account of the whole subject may be found in the bulletin mentioned. This work has led to fur-

ther investigations upon lemon decay and other phases of the lemon business at the Whittier Laboratory.

#### SUGAR-BEET BLIGHT INVESTIGATION.

The blight or curly top of the sugar-beet has been a subject of investigation in this Division for some time, as mentioned in our last report. This work has been in coöperation with the Spreckels Sugar Company and other beet growers of the State, continuing during the period from the spring of 1905 to the fall of 1906. In 1907 the company mentioned took two of our assistants into its own employ and has since then continued the field work through them.

Some investigations of a technical nature are being carried on in relation to the nature of this disease at the Whittier Laboratory. From the work thus far it appears to be well established that the trouble is largely influenced by meteorological factors varying from one season to another.

#### PEACH BLIGHT INVESTIGATION.

Active work on this subject was completed in the winter of 1906-7 and a bulletin on the subject (Bulletin No. 191) published in September, 1907. Work during the year mentioned consisted mostly in extensive field work and demonstrations, having for their object a general application of the method of treatment found successful in previous years. This work came to a very successful conclusion, as described in the bulletin mentioned.

#### ROSE DISEASE INVESTIGATION.

Owing to the delay in publication of a bulletin on this subject, which was promised in our last report, it has been possible to gather other data to supplement that previously obtained. During the past two seasons a thorough survey has been made of the various varieties of roses growing in most of the important nurseries in the State, as well as on private grounds, in order to determine the relative degree of susceptibility of the various varieties to the usual rose diseases.

Further work on the treatment of the rose mildew has also been carried out on a considerable scale during the past season.

#### APRICOT DISEASE INVESTIGATION.

Work on this subject has been carried on for some time in connection with the peach blight work and has received special attention during the years 1907-09. The main object has been to determine



Fig. 13.—Apricot buds killed by peach blight fungus, *Coryneum beyerinkii*.

the nature of the trouble with apricots which so reduced the crop in the State for several years previous to 1908 and to determine the extent to which the apricot is being affected by the peach blight fungus, *Coryneum beyerinkii*.

We are convinced that the death of the fruit buds of the apricot previous to blooming which has been so prevalent in many localities, may be due to the fungus just mentioned, and that a spotting of the leaves and fruit at an early stage is also caused by *Coryneum*. This spot is quite characteristic, usually less than a millimeter in diameter, red, with light centre. It is distinct in appearance from any other apricot spot which has come under our observation, but might

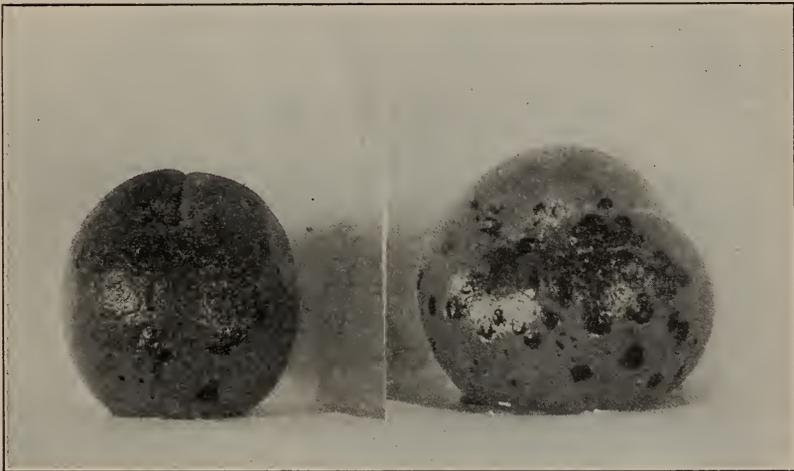


Fig. 14.—Black spot of apricot fruit, caused by *Cladosporium*.

easily be confused with a seemingly physiological effect which is very general. This is a reddish dot, smaller even than the *Coryneum* spot and less definite in outline, which at its minimum is nearly always present, and might almost be called a normal condition of the fruit. Its cause is not yet understood, but it does not appear to be a parasitic disease. It is quite possible that this is the “apricot scab” which is claimed to have been prevalent in the State many years before the *Coryneum* blighting of the buds began. This can only be determined by observation of the fruit during “off years” for *Coryneum* blight for a number of seasons. Such was the year just past, and so far as the writer has been able to observe there has been comparatively little spotting of the fruit in most sections. What has



Fig. 15.—Apricot "Seab" and "Shot hole."

come under our observation may be classed under three heads: *Coryneum* spotting (very slight), the physiological effect (rather more than the *Coryneum*), and a black spot of apricot, which has been rather prevalent in some sections.

The black spot was first sent us for identification by Mr. Earl Morris, Entomologist for Santa Clara County. It is caused by a fungus, *Cladosporium carpophilum*, described by von Thümen and since reported by Arthur, Smith, and others as damaging peaches and plums. The fungus forms a thin, black coating in spots about 2-3 mm. in diameter when isolated, which causes the fruit to dry and crack, especially when the spots are confluent. It attacks the fruit later in the season, and is in every way distinct from the *Coryneum* spot.

The uncertainty of the apricot crop during recent seasons and its susceptibility to climatic conditions has rendered difficult the determination of the actual causes of these troubles. From experience thus far it appears that the *Coryneum* treatment recommended for peaches, in Bulletin No. 191, consisting of two sprayings with Bordeaux mixture, one in November and the other in February, will prove as effective with apricots as with peaches.

#### OLIVE KNOT INVESTIGATION.

The knot or Tuberculosis of the Olive has been known in the State for several years, but until a comparatively recent period did not seem to assume a very serious aspect. Bulletin No. 120 of this Station was published several years ago on the subject, describing the disease quite fully. In some sections the trouble has now developed to such an extent as to make its control seem quite necessary for the future of the industry, so many trees having become badly affected. On this account coöperative arrangements were made during 1908 with olive growers in certain sections where the disease is most troublesome and investigations started in an effort to obtain further information concerning this trouble. It seemed particularly desirable to learn the method and source of infection in the olive knot disease concerning which we have hitherto had no information. This work was carried on during the summer of 1908 by Professor Babcock and Mr. W. B. Parker and will continue to receive attention. It is highly probable that a definite mode of infection will be found which may give an important clue to possible means of control.

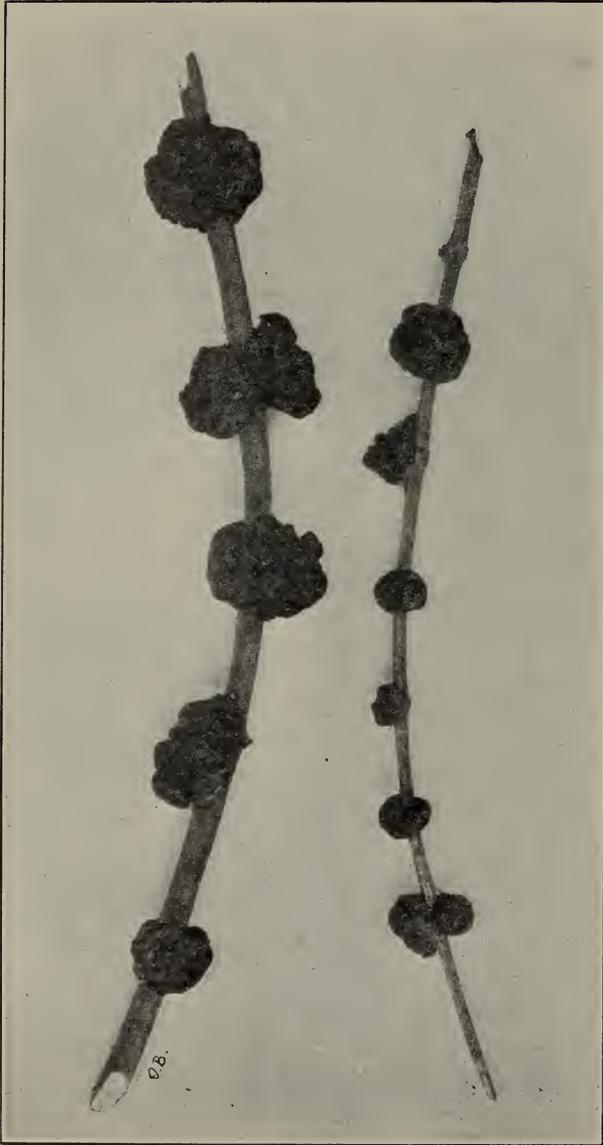


Fig. 16.—Olive knot.

## ONION MILDEW INVESTIGATION.

The growing of onions for seed is a large industry in California. In connection with this business much trouble has been experienced for a number of years on account of the attacks of a fungous disease, the Downy Mildew of the Onion (*Peronospora schleideniana*). This fungus makes its attack on the leaves and seed stalks of the plant during moist weather, causing large losses in the crop. Its occurrence varies from year to year on account of climatic conditions, and for this reason we have never been able to secure satisfactory demonstrations as to the possibility of controlling the trouble by spraying. During the season of 1908 spraying experiments were arranged by this Division more extensively than ever before with the hope of finding a practical treatment for controlling the trouble. The season was not a favorable one for the disease, however, so that the results secured have not been satisfactory.



Fig. 17.—Brown rot of plum. (*Sclerotina*.)

## BROWN ROT OF STONE FRUITS INVESTIGATION.

What has been said of the preceding subject applies equally well to the present one. This fungus (*Sclerotinia fructigena*), which causes a very destructive decay of peaches, plums, apricots, etc., when conditions are favorable, varies in its occurrence in this State with the character of the season as to moisture. The trouble has never become general over the State, but in seasons with late spring rains has been very troublesome in the San Francisco Bay region on early

peaches, apricots and certain varieties of plums. During 1908 arrangements were made for careful spraying demonstrations at a number of points in the affected region, and the Division was prepared to give the matter thorough attention. On account of the dry season, however, there was practically no occurrence of the trouble. It appears probable that in seasons with late rain a spraying with any standard fungicide not injurious to the foliage, directly following each rain after the crop is set, would control this trouble quite effectively. In the case of brief showers followed by drying weather, the brown rot is not likely to develop and spraying is not necessary.



Fig. 18.—Celery field, Smeltzer, Cal.

#### CELERY BLIGHT INVESTIGATION.

Another important work is that which has been begun in coöperation with the celery growers of the extensive Orange County district. In the peat lands of this section, located between Santa Ana and the coast in the vicinity of Smeltzer, a very large celery growing industry has developed, the crop being grown particularly for shipping during the winter after the eastern celery has had its season. During the summer of 1907 nearly 6,000 acres of celery were planted in this district. Great losses in the crop were experienced in the winter of

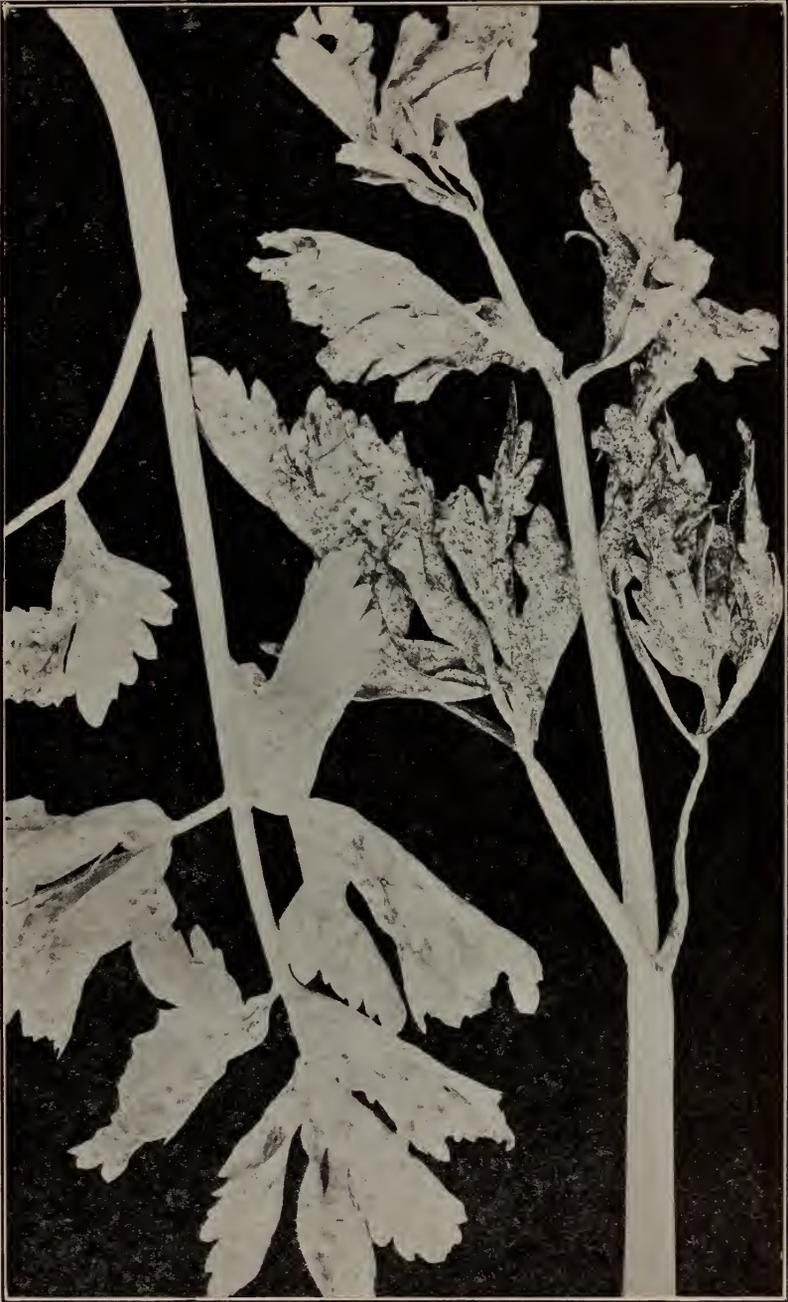


Fig. 19.—Celery blight, caused by *Septoria petroselini* var *apii*.

1908 from a fungous disease causing a blight of the leaves of the celery plants and heavy decay during shipment. (*Septoria petroselinii*, var. *apii*). These losses were estimated as causing a shrinkage of 1,950 carloads in shipment and had a most disastrous effect upon the quality of the celery on arrival in the eastern markets and the financial returns from the crop. The whole money loss of the season caused by this fungous disease was conservatively estimated at \$550,000.00.

Spraying the plants in the field with Bordeaux mixture was tried by a few during this time with decidedly beneficial results, even though not begun until the disease had already appeared.

As a result of this experience and with the knowledge of the successful control of this disease in other sections by such spraying, the Orange County Celery Growers' Association, which comprises practically all the celery growers of that section, made plans for a general spraying campaign during the season of 1908-09. Copper sulphate and lime were purchased in large quantities by the Association and practically every grower sprayed his fields faithfully and to the best of his ability throughout the season. The acreage planted was much less than that of the year before, amounting to only about 2,700 acres. The spraying thus carried on by the various growers naturally varied a great deal in regard to thoroughness and other details, but resulted in general in a most striking demonstration of the value of such work. In unsprayed fields the blight was as bad or worse than ever before, but as a result of the spraying done by the members of the Association the crop was carried through in excellent condition, put on the market in the best of shape, and the financial returns were exceptionally good. The Division of Plant Pathology was able to be of considerable assistance in the matter by occasional inspections and the giving of advice and instructions in regard to the spraying operations. There is still a large field for work in this direction in perfecting the methods of preparing and applying the spray to fit the particular needs of the celery growers, and also in demonstrating the most economical and effective practice in regard to time, frequency and other details of spraying. This work will be carried on by the Division during the coming season on a somewhat more extensive basis than heretofore, in coöperation with the Celery Growers Association, the California Vegetable Union, and the Golden West Celery and Produce Company.



Fig. 20.—Apple mildew.

## APPLE MILDEW INVESTIGATION.

The powdery mildew, one of the worst troubles affecting apples in California, has become abundant in all parts of the State where apples are grown. The Division has been carrying on spraying investigations in coöperation with growers in an effort to determine the best method of control for this disease. Results thus far indicate the best success from treatment with sulphur- or sulphide-containing sprays in the spring and early summer.

## TOMATO DISEASES.

The investigation of tomato diseases has received considerable attention ever since the beginning of the southern California work. One of the most important branches of tomato growing in that section has come to be the crop which is matured late in the fall for eastern shipment. This enterprise has proven extremely successful, except for one drawback. This is the prevalence of the common potato-blight fungus (*Phytophthora infestans*), attacking the tomato vines in seasons when rain occurs early in the fall. During the fall of 1907 the whole acreage of tomatoes was completely ruined in this manner before active shipments had begun, making the crop a total loss. Demonstrations by the Laboratory at that time, however, showed the possibility of entirely controlling this disease by means of spraying the vines with Bordeaux mixture following the rain. Preparations were made by this Division and by the growers to carry out such spraying on a large scale during the season of 1908, should weather conditions make it necessary. The season was not such, however, as to favor the extensive development of the blight, so that extensive spraying was not required. Such spraying, however, like all other work of the same sort, is of the nature of insurance and should be prepared for each year, whether conditions make it necessary or not.

The method of procedure in regard to the spraying operation itself is a very simple one, consisting in spraying the vines thoroughly with Bordeaux mixture, made by mixing together blue stone (copper sulphate) and lime water, using 5 pounds of the former and 5 pounds of unslaked lime to 50 gallons of water. The blue stone is dissolved and the lime slaked in separate portions of water, and the two then diluted and mixed together, running them through a strainer. The chief problem involved is much the same as that with the celery disease; namely, that of getting a large acreage properly sprayed at the proper time. It is to this phase of the matter in each instance

that this Division is paying particular attention, working through the coöperative associations into which the growers of these crops are united.

Considerable work of an experimental nature has been carried on at the Whittier Laboratory on the subject of the prevention of damping off of tomato plants in the seed bed by chemical soil treatment. This trouble causes severe loss almost every season, both in tomato and other plants. Our results thus far have not been especially promising. The experiments have been mainly in the treatment of soil with dilute solution of formaldehyde and sulphuric acid.

The best results in growing plants have been obtained by careful attention to proper watering and soil preparation, obtaining as thrifty and vigorous a growth as possible without oversaturation of the soil with water.

#### TECHNICAL INVESTIGATIONS IN PLANT PATHOLOGY.

In addition to these more practical lines of work having immediate field application, the very favorable resources of the Whittier Laboratory are also being made use of for various lines of technical research in connection with the work of this Division. Opportunities are offered for the work of graduate students at the Laboratory in special investigations. Work of this nature which has been going on includes an investigation of various species of *Fusarium*, supposed to be the cause of diseases of various plants; also the study of several of the so-called physiological plant diseases, based particularly on the "Curly Top" of the sugar-beet and the aster "Yellows."

#### WORK IN ENTOMOLOGY AT THE SOUTHERN CALIFORNIA LABORATORY.

The work and usefulness of the Whittier Laboratory has been greatly broadened during the past year by the commencement of investigations in entomology by Professor Quayle. The problems of insect control in Southern California have received an unusual amount of attention from a purely economic standpoint, but until recently there has been very little careful investigation made concerning destructive insects of this portion of the State from a biological standpoint. Among the important problems in entomology those concerning citrus insects are much the most prominent, particularly in the case of certain scale insects. Mr. Quayle has therefore devoted his principal attention to the commencement of a thorough study of the biology of the most important insect enemies of citrus trees. Chief among these are the four scale insects which are most prominent, the

so-called black, purple, red, yellow, and soft brown scales (*Saissetia oleae* Bern., *Lepidosaphes beckii* Newm., *Chrysomphalus aurantii* Mask., *Chrysomphalus aurantii* var. *citrinus* Coq., and *Coccus hesperidum* Linn.)

Each of these species has received careful study in the field, laboratory and insectary to determine exactly its life habits and the whole course of its development. Other citrus insects which are also receiving attention are the mealy bug (*Pseudococcus citri* Risso.) and the cottony cushion scale (*Icerya purchasi* Mask). It is our intention to continue and extend these studies in the future and also to build up collections of southern California insects, and in other ways to make the Whittier Laboratory a center of entomological research in southern California.

#### CITRUS CULTURE AND DISEASES.

One of the most important undertakings of this Division is the study of citrus culture, this work being prominent both at the Whittier Laboratory and at the Riverside Station. The whole subject of citrus culture demands more and more attention from scientific investigation as the industry grows older, and the station founded at Riverside especially to meet this demand has possibilities of a most useful development, while at the same time its responsibilities to the industry are great.

The commencement of this citrus work under the direction of the Division of Plant Pathology should by no means be looked upon as an indication of a narrow scope or limited field in the future of the work, or that it is expected that its many phases will be covered in a superficial manner by work from a single standpoint. It is rather the intention to make these Stations centers of research on problems relating to citrus culture, developing facilities and special departments as rapidly and efficiently as possible.

*Disease Investigations.*—The study of diseases or failures of citrus trees in California is a most complicated problem. This is due to the fact that the chief troubles are not of parasitic origin, but are due to abnormal physiological conditions brought about by the artificial environment under which the trees are grown. The exact nature of these troubles is in most cases extremely difficult of determination, while a demonstration of a remedy or corrective for the same is even more difficult. The case is very different from those where fungus or similar diseases occur. In fact, it is not entirely a question of health and disease with the citrus crop, but rather one of commercial perfection and its opposite; in other words, the per-

fection of desirable commercial qualities is by no means the same as natural development or natural health. The fact is that the work of the plant pathologist in California with citrus fruits is not limited to the study of actual disease and the means of avoiding it. He is rather called upon to advance commercial perfection and learn how to overcome conditions which are undesirable from this standpoint, whether they be ones of actual disease or not. For this reason it is natural that problems of soil fertilization and other cultural considerations should be closely associated with the work of the pathologist, since they cannot be sharply segregated.

A thorough study of what may be called the actual diseases of citrus trees in this State is being carried on in Southern California, both in the field and laboratory. As a result of this work thus far it may be said in general in regard to citrus diseases that almost nothing has been found which may be ascribed to the effects of any parasite. If we except decay of the fruit and a very few minor cases, the above statement may be made an absolute one. It is a fact beyond question that the most serious troubles with citrus trees in California are the effects of unfavorable natural conditions and not those of fungi, bacteria or other parasites. Some of these effects are at present most obscure, and difficult or impossible to account for in any satisfactory manner. Yet the study of the various diseases and of the nature of the tree itself has been sufficient to show that the above statement is true.

The citrus disease investigation is being conducted in the field by various members of the staff, while a large amount of more technical work is being done at the Whittier Laboratory in the preparation and microscopic study of affected tissues.

The particular diseases or troubles under consideration at present may be named as follows: Gum disease of the lemon, scaly bark of the orange, Florida die-back (*Exanthema*) of the orange, puffing, splitting, brown spot and staining of the orange, and pitting of the lemon. These are all serious troubles affecting very materially the production of groves and the financial returns from the fruit. The results of investigations on the first three subjects mentioned have been reported in Bulletin 200, "Gum Disease of the Citrus Trees in California." In this work the nature of these diseases was quite fully established and practical means of control demonstrated.

The so-called "brown spot" of the orange is a subject which received considerable attention during the past year. This is a peculiarly obscure problem, and no positive results have been obtained as to the nature of the trouble or methods for its control. The disease



Fig. 21.—Orange scaly bark.

shows itself in the form of dark-brown sunken spots of considerable size on the surface of the orange. These spots are not visible while the fruit is on the tree or when freshly picked, but develop within two or three weeks after picking, thus appearing mostly after the fruit has reached the eastern markets. The spot affects the most fancy, smoothest fruit worst and occurs abundantly only in certain sections. We feel safe in saying that it is not caused by any insect, fungus, bacterium or other living parasite and is not the effect of fumigation, spraying, ordinary frost or any such thing. The spot itself is simply a portion of the rind which weakens prematurely and becomes dead, dry and dark colored. Some influence must act upon the fruit at some time previous to the beginning of the picking season which causes the rind to be injured or weakened in these spots. It seems most likely that this influence is connected with some climatic condition peculiar to the region in which the trouble occurs. A large amount of negative information was obtained during the past season which is not without value in simplifying and more clearly defining the problem. The work will be renewed next season in a further effort to discover the real nature of this spotting.

In addition to these more specific diseases, investigation is needed in many cases of failures or troubles with trees which are occurring abundantly. This work commonly involves soil studies and chemical investigations of various sorts, and herein is illustrated the close correlation of such investigations with plant pathology proper in citrus work.

*Soil and Fertilizer Work.*—The work on citrus culture in general which has thus far received the most attention is that relating to the fertilization of the soil. This is one of the most important and at the same time most complicated problems which face the California citrus grower. The attention of the Experiment Station for many years has been directed to a considerable extent in this direction, yet as the industry advances the demand for information becomes more and more specific, and the problems more and more obscure. If the general vigor and growth of the trees were the only question involved, or even their quantitative product, present knowledge would be fairly sufficient. With the problem complicated by the relation of fertilization to certain definite qualities of the fruit, desirable and undesirable, likewise questions affecting the physical quality of the soil and its treatment, the mere matter of fertility becomes almost of secondary importance. A large amount of investigation of the matter from many different standpoints will be needed to make the Citrus Experiment Station a practical success, measured by the de-

mands awaiting it. As a fundamental basis of the work upon fertilization, it has seemed desirable to determine more definitely than is now known the specific effects of the various fertilizing elements upon citrus fruit. For this purpose a ten-acre planting of young trees has been started, as described in Circular 35, made up of twenty small plots, upon which the application of the various single elements and combinations has been begun. This should show more definitely than is known at present the results of such applications. Similar experiments have also been begun to a limited extent upon trees of mature size in an orchard adjoining the Station grounds, which has been leased for this purpose.

Other fertilizer experiments have also been begun for the purpose of testing the effects of certain materials and also in regard to different amounts of complete fertilizer as affecting the comparative amount of the fruit. A series of coöperative fertilizer experiments, which was begun by the Experiment Station several years ago under the direction of Professor Stubenrauch and carried on by Mr. J. W. Mills, has been continued by the Citrus Station. In the majority of cases, however, these experiments were not continued long enough by the various growers in whose groves they were being carried on to give any definite results. Only a very few are being kept up at present, and the uncertain nature of the results even in these is sufficient to show the extreme difficulty of conducting satisfactory fertilizer demonstrations in the ordinary grove, although coöperative experiments of a simple nature adapted to commercial practice can be arranged with growers in various sections. This has been done already to some extent by the Citrus Station since its establishment, carrying out demonstrations on the improvement of unfertilized groves by the use of complete fertilizers in different amounts, the application of specific elements in certain cases and other similar undertakings.

The work of the Station concerning soil nature and treatment has been greatly broadened during the past year by the appointment of Professor Norton to our staff. His work has been commenced along the line of seeking more accurate information and data in connection with soil treatment than is now available. The principal problem upon which his investigations have been begun is that connected with the addition of humus to the soil. Careful studies have been started concerning the various cover crops on the basis of measurement of tonnage produced, chemical analysis and the question of nitrogen fixation, the latter in connection with pot experiments. Other important problems relating to soil improvement, fertilizer, etc., will be

taken up and this work laid out on a permanent and thorough basis. Professor Norton will also be able to devote some attention to crops other than citrus in connection with his soil studies and chemical work.

*Pomological Work.*—A beginning has been made at the Riverside Station of considerable work of a pomological nature in relation to citrus fruit. This includes particularly the improvement of varieties by bud selection and the testing of various citrus species for root stocks. A considerable nursery has been started in which are growing orange and lemon trees which have been selected from trees showing various peculiar characteristics of a desirable kind, and also a large amount of root stock of various species.

The addition of Professor Coit to our staff will give greater breadth and strength to work along pomological lines.

#### VARIETY INTRODUCTION AND TESTING OF PECANS, PEACHES AND TOMATOES.

The facilities available at Whittier and Riverside for growing trees and plants has made possible a beginning of the introduction and testing of various cultures of certain sorts.

*Pecans.*—The growing importance of pecan culture in the southern states has awakened considerable interest in the possibility of the production of these nuts in California. The subject was brought to the attention of this Station through its work with walnuts, and, being of a similar nature, has been given some attention. Pecan trees are growing in various parts of California and thrive well. Their production is a matter of much variation in different sections and with different trees. In general, however, the interior valleys of the State where the summers are hot and the winters fairly cold seem better adapted to pecan culture than the coast regions. Many trees in the State fail to produce, or ripen their nuts very irregularly, on account of the mild climate and lack of definition of the seasons.

Of the many improved varieties of pecans which are now being grown in Texas, Florida, Georgia, Louisiana, Mississippi, etc., very few have been tested in California, and none for a long enough time or generally enough to demonstrate their adaptability to this State. During the winter of 1908 trees were obtained by this Division of about thirty of the leading varieties from various nurseries in the southern states. These were planted on the grounds of the Whittier Laboratory and are all growing well at present. A large number of pecan

nuts were also planted in the nursery, and upon these seedlings the various varieties will be propagated and the trees thus obtained distributed for trial in different parts of the State. In the spring of 1908 trees of a few varieties obtained from nurseries were also planted at a few different points in the State for the same purpose of demonstration.



Fig. 22.—Pecans: Large variety is Frotscher, the others seedlings, showing variation in size and shape.

*Peaches.*—Another somewhat similar project has been begun with peaches adapted to growth in southern California. In this section of the State the production of the usual commercial varieties has been quite uncertain, owing to the mildness of the winter climate. The success in Florida and other southern regions of many varieties of the Honey and other Chinese peaches has suggested the possibility of developing varieties from such a source of value in southern California. For this purpose buds of a large number of varieties were obtained from Florida in 1906 and trees from these are now being grown for testing and distribution.

*Tomatoes.*—In certain sections of southern California a valuable industry exists in growing tomatoes for shipment during the late

fall and early winter. These are planted in the field in July and set a large amount of fruit during the latter part of the summer, which matures at a time when eastern tomatoes have been killed by frost. For this purpose varieties are desirable of good appearance and shipping quality, and also such as will continue to set fruit well into the winter. The variety most commonly planted at present, the Stone, is quite satisfactory for this purpose, but a number of other kinds are being tested at Whittier with the idea of obtaining the best variety for the exacting requirements of this shipping crop. Most of this work has been done with the assistance of Mr. R. E. Mansell, of the Experiment Station at Berkeley.

#### EUCALYPTUS INVESTIGATIONS.

A very careful study has been made under the direction of this Division by Mr. Ingham, of the Forestry Station, of the present condition, prospects and methods of Eucalyptus culture in California. The growth of these trees of many different species has been studied all over the State and their adaptation determined in the various sections. As a result of this study a bulletin has been prepared, entitled "Eucalyptus in California." This includes a discussion of the growing of Eucalyptus as a crop, the methods of the same, the utilization of the wood and descriptions of the important species. Following the preparation of this bulletin other work has been taken up upon the commercial utilization of Eucalyptus wood for lumber, its qualities, uses, methods of handling, etc. This has been taken up in a practical way by fitting up a small woodworking shop at the Santa Monica Station, where a great variety of samples is being prepared under Mr. Ingham's direction, showing the wood of the various species. These collections have been placed on exhibition and the work is being followed by further investigations along the same line.

Some work has also been done in the study of the extraction of oil from the foliage of various kinds of Eucalyptus. The oils obtained from the different species vary quite widely in their character.

#### WORK IN IMPERIAL VALLEY.

The great Imperial Valley region in the extreme southeastern part of California presents many serious problems in plant pathology as well as other lines of agricultural investigation. The rapid development of agriculture under the extremely unusual natural conditions of that region has been accompanied with many grave problems affecting the prosperity of the industry. As a result of this,

there has been a strong demand for a sub-station or some sort of local institution for agricultural investigation in that part of the State. In response to this demand the following Act was passed by the last legislature:

“An Act Making an Appropriation for the Investigation of Agricultural and Horticultural Problems and Conditions in Imperial County, and Providing for the Establishment in Said County of a Branch Agricultural Experiment Station for the Purpose of Prosecuting said work.

“The people of the State of California, represented in senate and assembly, do enact as follows:

“Section 1. The regents of the University of California are hereby directed to cause to be prosecuted, through the Southern California Pathological Laboratory and branch experiment station, investigations on the conditions and problems attending the culture of crops in the region known as the Imperial county and similar adjacent sections.

“Sec. 2. Such investigations shall be particularly directed toward the solution of various difficulties and problems affecting the growing of crops, which have arisen in said region on account of the unique natural conditions obtaining in that portion of the state.

“Sec. 3. The regents of the University of California are hereby authorized to establish at some suitable point in Imperial county a branch agricultural experiment station for the purpose of carrying on the work herein provided for; provided the necessary land therefor is obtained without cost to the state.

“Sec. 4. The sum of six thousand dollars (\$6,000) is hereby appropriated out of any money in the state treasury not otherwise appropriated to be expended by the regents of the University of California in carrying out the purposes of this act, and the state controller is hereby authorized and directed to draw his warrant for the same payable to the regents of the University of California, and the treasurer of the state is hereby directed to pay such warrant.”

Section 3, concerning the establishment of a station, constitutes a subsequent addition to the original bill and can hardly be complied with on the basis of the appropriation granted for this purpose. The original idea was that of conducting preliminary investigations and observations with these problems rather than establishing a permanent station at once. The work had not yet been organized at the close of the period covered by this report, but will be undertaken along whatever lines seem most suitable.

#### PASADENA CITY FARM.

An informal coöperative arrangement has been made by this Division during the past year with the city of Pasadena in regard to the development of a large tract of land owned by the city and used as a sewer farm. This land comprises over five hundred acres of varied and mostly excellent quality, and supports at present about one hundred acres of English walnuts and large crops of hay, grain,

corn and alfalfa. One of the greatest handicaps of this Division in southern California has been the lack of sufficient land for making plantings on a commercial scale of walnuts, citrus fruits, and various other crops in connection with which work is being done. The arrangement proposed by the city of Pasadena seems to fill this want in an almost ideal manner. The work can be done at practically no extra cost to the Experiment Station and can be made of value to Pasadena and other cities having sewage problems, in addition to the results that may be obtained from the regular lines of agricultural experimentation. Active work has already been begun on this project by planting a number of varieties of our walnuts for trial and grafting over of old trees. A citrus nursery has also been started and during the coming year a large amount of other nursery material will be planted on the farm.

## PLANT DISEASES OF CALIFORNIA.

The following list contains a number of additional diseases to those given in our last report, as well as notes on the occurrence of the more serious troubles during the period covered. In general, the prevalence of plant diseases during the year 1907 was of about an average extent. The more common troubles occurred as extensively as usual, or on the whole rather more so. The year 1908 was marked by a very noteworthy freedom from fungous and bacterial plant diseases of all sorts. This evidently resulted from the dry winter of 1907-8 and the prevalence of dry, windy weather during much of the season all over the State. Thus the relation of climate to the occurrence of parasitic diseases was a most notable feature of the fruit season of 1908 in California. No general rule prevailed in 1909, some diseases being more abundant than usual and others noticeably absent.

## POME FRUITS.

## APPLE.

*Powdery Mildew*.—This disease has proven an exception to the condition above stated, being more prevalent than usual during 1908. It is one of the serious troubles of the apple orchard in this State. Investigations on the control of the disease have been carried on to some extent by this Division, as reported elsewhere. Very prevalent in 1909.

*Blight*.—Attacks of the pear blight bacillus upon the apple occur to a limited extent, although no very serious results have occurred. The disease was prevalent to some extent on apples in 1908, although less in general than in previous years. Not commonly serious in 1909.

*Canker* (*Nectria ditissima*).—This fungous disease has been found in the State, but is not a serious trouble in commercial orchards.

*“Baldwin Spot.”*—Troubles of this nature are becoming serious in California. In some sections the crop has been badly affected by the development of discolored spots or streaks in the interior of the apple from an unknown cause. No evidence is present of any parasitic attack.

## PEAR.

*Scab*.—Pear scab was extremely prevalent in 1907 and injured the quality of the crop greatly. Thorough spraying with Bordeaux mix-

ture, beginning when the buds first unfold and repeated later at intervals, showed excellent results as usual in controlling the disease. In 1908 and 1909 pear scab was almost entirely absent from the State.

*Blight*.—Pear blight prevailed to a considerable extent in 1907 and continued the destruction of many trees which began with the epidemic of 1904. In 1908 and 1909 the occurrence of the disease was very much reduced, and in many sections it disappeared almost entirely. This was due to climatic causes and does not indicate a permanent subsidence of the disease.

*Curly Bark*.—A very common but not serious condition of pear trees may be called by this name. It is shown by areas of bark which are cracked in a peculiar concentric manner, as the name indicates. Its occurrence is a matter of very little concern.

#### LOQUAT.

*Scab*.—The leaves and fruit are affected to considerable extent in the San Francisco Bay region by the fungus *Fusicladium eriobotryae*. Also found at Santa Barbara and Whittier in 1909.

#### STONE FRUITS.

##### APRICOT.

*Dead Flower Buds*.—A large acreage was badly affected in 1907 by a killing of the flower buds before opening, apparently by the peach blight fungus, *Coryneum*. Much less prevalent in the spring of 1908; more abundant in 1909.

*Fruit Scab* (*Cladosporium carpophilum*).—So far as known, this is the first record of *Cladosporium* spot on apricots. It is rather troublesome in some districts.

*Fruit spot* and shot-hole of leaf (*Coryneum*).—Quite serious on unsprayed trees.

##### ALMOND.

*Shot-hole Fungus* (*Cercospora circumscissa*).—This is of rather frequent occurrence, causing spotting of the leaves and twigs.

##### CHERRY.

*Brown Rot* (*Sclerotinia*).—Fruit and twigs of the cherry affected with the brown rot fungus were seen in the spring of 1908.

*Gummosis*.—Quite abundant in wet winters.

##### PEACH.

*Leaf Curl* and *California Blight*.—Were decidedly scarce in 1908. Both occurred to greater extent in the previous year. Leaf curl was very abundant in 1909; blight not very abundant.

*Crown Gall*.—Our most prevalent disease of stone fruit trees.

*Root Rot (Toadstool or Oak Fungus)*.—Causing extensive losses in deciduous fruit orchards located on cleared oak land.

#### SMALL FRUITS.

##### LOGANBERRY.

*Rust (Puccinia peckiana)*.—Common.

*Leaf Spot (Septoria rubi)*.—Common.

*Root Knot*.—Not uncommon.

#### SUBTROPICAL FRUITS.

##### ORANGE.

*Scaly Bark*.—This trouble consists in a rough breaking out of the bark on the trunk and branches of oranges, starting in a small area and greatly enlarging. It is a form of gum disease and cannot be connected with any parasite. The trouble is an old one in the State and is quite like that described in the Annual Report of the Florida Experiment Station for 1907.

*Mal di gomma*.—The typical form of this disease, as described from Florida and elsewhere as a rotting of the roots, is not of common occurrence in California, although a few bad cases have been seen.

*Exanthema*.—The disease described in Florida under this name occurs in southern California to a limited extent and almost entirely on one type of soil. This is the coarse, gravelly, very porous material, occurring close to the mountains in some sections. The trouble appears to be due to irregular nutrition, owing to the very loose nature of the soil. A few cases have been seen on heavier soils where excessive amounts of organic nitrogen have been applied. Experience appears to have demonstrated some benefit in this disease by spraying the trees with Bordeaux mixture. How this comes about is difficult to explain, except on the basis of an increased assimilation as an effect of the presence of the spray upon the leaves.

*Splitting*.—Considerable losses are experienced some years by a splitting of oranges before maturity. This affects particularly the Navels. It is evidently influenced by climatic conditions and is not the effect of a parasite. The trouble was very prevalent in the crop of 1907-08; much less abundant in 1908-09.

*Brown Spot and Staining*.—These troubles occurred to a serious extent during the winter of 1908. They are characterized by the

dying and discoloration of the surface of the rind in certain spots or areas, causing the disfiguration of the fruit. They were less abundant in 1909, except in certain sections.

*Navel Rot (Alternaria citri).*—This fungus causes considerable loss each year in Navel oranges by infection at the navel opening and the production of a black, dry rot. The fungus is not very active in its development, but spoils much fruit in wet winters. Affected fruit becomes prematurely ripe before the decay is visible externally.

*Damping Off.*—Much loss is caused in citrus seed beds by the killing of young plants by “damping off” fungi. This is caused most commonly by two parasites, one a species of *Fusarium* and the other *Rhizoctonia*. The development of these fungi is particularly favored by moisture and they can be controlled to a very large extent by judicious watering of the seed bed. In most cases the water is applied too frequently and abundantly and the spread of the fungus thus favored. This trouble was very abundant during the spring of 1909, when much cloudy weather occurred.

*Anthraxnose or “Tear Stain” (Colletotrichum).*—This fungus seems to have been present in California for some time, but previous to 1909 has attracted no attention as affecting the fruit seriously, occurring only occasionally as a saprophyte on unhealthy leaves and twigs. During the past season, however, it has been quite abundant on oranges and extremely so on lemons and grapefruit in the coast sections.

#### LEMON.

*Brown Rot (Pythiacystis citrophthora).*—Less prevalent than usual in 1908 and 1909.

*Cottony Mould Rot (Sclerotinia).*—Not uncommon in curing houses.

*Gray Mould (Botrytis).*—Occurs occasionally in storage and sometimes causes considerable loss under cold storage conditions at low temperatures. Causes a brownish, soft rot of the rind, more or less covered with a considerable growth of loose gray mould.

*Anthraxnose or “Tear Stain” (Colletotrichum).*—Quite common in coast sections in 1909, causing spots on the rind of the fruit. Infection apparently favored by attacks of red spider.

#### OLIVE.

*Tuberculosis.*—This bacterial disease is on the increase in certain sections and has become a matter of serious importance in those regions.

*Leaf Spot (Cycloconium oleaginum)*.—Apparently rather common.

*Dry Rot* of fruit.—Cause unknown. Prevalent in 1908.

#### GUAVA.

*Russeting*.—An effect on the fruit in San Diego County.

### VEGETABLES AND FIELD CROPS.

#### ASPARAGUS.

*Rust*.—Continues to some extent each year. Damage by floods in the principal asparagus regions have somewhat overshadowed the effects of the rust. Much less abundant in 1908 and 1909.

#### SUGAR BEET.

*Rust (Uromyces)*.—The rust was extremely abundant during the winter of 1907-08 on sugar beets growing during the rainy season. It did not persist after the rains ceased.

*Curly Top*.—This disease, also called blight, occurred very little in 1907, but came on in some sections during the summer of 1908.

*Downy Mildew (Peronospora schachtii)*.—Found in Los Angeles and Orange counties in the spring of 1909.

*Root Rot (Rhizoctonia)*.—Caused considerable loss in young seedlings in 1908 and 1909.

#### CELERY.

*Leaf Blight*.—This disease occurred disastrously in the large Orange County celery districts during the season of 1907-08. Great losses were experienced both in the field and in shipment. The disease was fully as prevalent during 1908-09, but was largely controlled in Orange County by spraying, as described on page 42.

*Stem Rot (Sclerotinia)*.—Found in 1909. Not serious.

*Root Rot (Fusarium)*.—Occurred only in extremely wet ground. Fungus possibly saprophytic.

#### POTATO.

*Early Blight (Alternaria)*.—Found in Berkeley and reported elsewhere. Not serious.

*Late Blight (Phytophthora)*.—Occurs every year to a considerable extent on winter potatoes grown during the rainy season and on the summer crop in foggy sections along the coast.

*Stem Rot (Fusarium)*.—Considerably abundant each year.

## TOMATO.

*Winter Blight* (*Phytophthora infestans*).—Entirely ruined the late crop of shipping tomatoes in southern California in October, 1907. Less abundant in 1908.

*Stem Rot* (*Sclerotinia*) and *Nematode Root Rot*.—Observed on greenhouse plants in southern California.

*Blossom End Rot*.—Very prevalent in 1908. The origin of the disease appears to be connected with soil moisture conditions.

*Summer Blight* or *Wilt* (*Fusarium*).—Almost entirely absent from southern California in 1908, but quite abundant in the northern portion of the State. Apparently connected with *Fusarium* damping off in the seed bed. Soil in the field does not carry infection from year to year.

## EGG PLANT.

*Stem Blight* (*Fusarium*).—A dry rot of the stem often starting above ground in infection through a wound. This plant grows to be two years old in California and infection by this disease is more common during the winter.

## SWEET POTATO.

*Black Rot* (*Ceratocystis*).—Found in 1908 in Orange County for the first time in California.

*Soft Rot* (*Rhizopus*).—Quite common.

## SWEET CORN.

*Bacterial Disease* (*Bacterium stewarti*).—An apparently typical case of this disease was found in southern California in 1909.

## TURNIP.

*Black Rot* (*Bacterium campestre*).—A probable case found in 1909.

## WATERMELON.

*Wilt* (*Fusarium*).—Abundant in old fields and growing worse.

## GRAINS AND FORAGE CROPS.

## ALFALFA.

*Downy Mildew* (*Peronospora trifoliorum*).—Found on one volunteer plant in 1909.

*Alfalfa Crown Gall* (*Urophlyctis alfalfae*).—This unusual disease was found in the State for the first time during 1909, and, so far as we know, has not been observed heretofore in this country. It has been collected in wet regions in Yolo and Stanislaus counties, and doubtless occurs elsewhere.



Fig. 23.—Crowngall of alfalfa.

## NUT, FOREST AND SHADE TREES.

## MADRONE.

*Leaf Spot (Sphaerella arbuticola)*.—Quite abundant and disfiguring.

## SYCAMORE.

*Sycamore Blight (Gloeosporium nervisequum)*.—Very prevalent in 1909.

PALM (*Washingtonia*).

*Leaf Spot (Auerswaldia sp.)*.—Noticeable in parts of southern California.

## WALNUT.

*Bacteriosis*.—Very prevalent in 1907. Less abundant in 1908 in most sections. Quite common in 1909.

BLUE GUM (*Eucalyptus*).

*Leaf Spot (Hendersonia sp.)*.—Observed in several cases on young leaves.

## FLORAL AND ORNAMENTAL.

## CARNATION.

*Leaf Spot (Heterosporium)*.—Rather common.  
(*Septoria*).—Occasionally found.

## OLEANDER.

*Leaf Spot (Macrosporium nerium)*.—From Fresno.

## SUNFLOWER.

*Damping Off and Stem Rot (Botrytis)*.—Observed in one case.

## ROSE.

*Mildew, Rust and Black Spot*.—All unusually abundant during the spring of 1909.

# STATION PUBLICATIONS AVAILABLE FOR DISTRIBUTION.

## REPORTS.

1896. Report of the Viticultural Work during the seasons 1887-93, with data regarding the Vintages of 1894-95.
1897. Resistant Vines, their Selection, Adaptation, and Grafting. Appendix to Viticultural Report for 1896.
1900. Report of the Agricultural Experiment Station for the year 1897-98.
1902. Report of the Agricultural Experiment Station for 1898-1901.
1903. Report of the Agricultural Experiment Station for 1901-03.
1904. Twenty-second Report of the Agricultural Experiment Station for 1903-04.

## BULLETINS.

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| <p><i>Reprint.</i> Endurance of Drought in Soils of the Arid Region.</p> <p>No. 128. Nature, Value and Utilization of Alkali Lands, and Tolerance of Alkali. (Revised and Reprint, 1905.)</p> <p>133. Tolerance of Alkali by Various Cultures.</p> <p>140. Lands of the Colorado Delta in Salton Basin, and Supplement.</p> <p>142. Grasshoppers in California.</p> <p>147. Culture Work of the Sub-stations.</p> <p>149. California Sugar Industry.</p> <p>150. The Value of Oak Leaves for Forage.</p> <p>151. Arsenical Insecticides.</p> <p>153. Spraying with Distillates.</p> <p>154. Sulfur Sprays for Red Spider.</p> <p>156. Fowl Cholera.</p> <p>159. Contribution to the Study of Fermentation.</p> <p>160. The Hop Aphid.</p> <p>161. Tuberculosis in Fowls. (Reprint.)</p> <p>162. Commercial Fertilizers. (Dec. 1, 1904.)</p> <p>163. Pear Scab.</p> <p>165. Asparagus and Asparagus Rust in California.</p> <p>167. Manufacture of Dry Wines in Hot Countries.</p> <p>168. Observations on Some Vine Diseases in Sonoma County.</p> <p>169. Tolerance of the Sugar Beet for Alkali.</p> <p>170. Studies in Grasshopper Control.</p> <p>171. Commercial Fertilizers. (June 30, 1905.)</p> <p>172. Further Experience in Asparagus Rust Control.</p> <p>174. A New Wine-cooling Machine.</p> | <p>176. Sugar Beets in the San Joaquin Valley.</p> <p>177. A New Method of Making Dry Red Wine.</p> <p>178. Mosquito Control.</p> <p>179. Commercial Fertilizers. (June, 1906.)</p> <p>180. Resistant Vineyards.</p> <p>181. The Selection of Seed-Wheat.</p> <p>182. Analysis of Paris Green and Lead Arsenate. Proposed Insecticide Law.</p> <p>183. The California Tussock-moth.</p> <p>184. Report of the Plant Pathologist to July 1, 1906.</p> <p>185. Report of Progress in Cereal Investigations.</p> <p>186. The Oidium of the Vine.</p> <p>187. Commercial Fertilizers. (January, 1907.)</p> <p>188. Lining of Ditches and Reservoirs to Prevent Seepage and Losses.</p> <p>189. Commercial Fertilizers. (June, 1907.)</p> <p>190. The Brown Rot of the Lemon.</p> <p>191. California Peach Blight.</p> <p>192. Insects Injurious to the Vine in California.</p> <p>193. The Best Wine Grapes for California; Pruning Young Vines; Pruning the Sultanina.</p> <p>194. Commercial Fertilizers. (Dec., 1907.)</p> <p>195. The California Grape Root-worm.</p> <p>197. Grape Culture in California; Improved Methods of Wine Making; Yeasts from California Grapes.</p> <p>198. The Grape Leaf-Hopper.</p> <p>199. The Bovine Tuberculosis.</p> |
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## CIRCULARS.

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| <p>No. 1. Texas Fever.</p> <p>2. Blackleg.</p> <p>3. Hog Cholera.</p> <p>4. Anthrax</p> <p>5. Contagious Abortion in Cows.</p> <p>7. Remedies for Insects.</p> <p>9. Asparagus Rust.</p> <p>10. Reading Course in Economic Entomology. (Revision.)</p> <p>11. Fumigation Practice.</p> <p>12. Silk Culture.</p> <p>15. Recent Problems in Agriculture. What a University Farm is For.</p> <p>17. Why Agriculture Should be Taught in the Public Schools.</p> <p>18. Caterpillars on Oaks.</p> <p>19. Disinfection of Stables.</p> <p>21. The Advancement of Agricultural Education.</p> <p>24. Olive Pickling.</p> <p>26. Selection and Preparation of Vine Cuttings.</p> | <p>27. Marly Subsoils and the Chlorosis or Yellowing of Citrus Trees.</p> <p>28. A Preliminary Progress Report of Cereal Investigations, 1905-07.</p> <p>29. Preliminary Announcement concerning Instruction in Practical Agriculture upon the University Farm, Davisville, Cal.</p> <p>30. White Fly in California.</p> <p>31. The Agricultural College and Its Relationship to the Scheme of National Education.</p> <p>32. White Fly Eradication.</p> <p>33. Packing Prunes in Cans. Cane Sugar vs. Beet Sugar.</p> <p>34. California State Farmers' Institute at the University Farm.</p> <p>35. Southern California Pathological Laboratory and Citrus Experiment Station.</p> <p>36. Analyses of Fertilizers for Consumers.</p> |
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Copies may be had on application to DIRECTOR OF EXPERIMENT STATION, Berkeley, Cal.