New York State Agricultural Experiment Station

Geneva, N. Y.

FIFTIETH ANNUAL REPORT

FOR THE FISCAL YEAR ENDED JUNE 30, 1931

U. P. HEDRICK

PUBLISHED BY THE STATION

UNDER AUTHORITY OF CORNELL UNIVERSITY

CORNELL UNIVERSITY
NEW YORK STATE AGRICULTURAL EXPERIMENT STATION, GENEVA, N. Y.

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Associate in Research (Bacteriology).

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Assistant in Research (Bacteriology).

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JAMES D. HARLAN, B.S.,
Assistants in Research (Pomology).

CHARLES B. SAYRE, M.S.,
Chief in Research (Vegetable Crops).

WILLIAM T. TAPLEY, M.S.,
Associate in Research (Vegetable Crops).

WALTER D. ENZIE, B.S.,
PARKS V. TRAPHAGEN,
Assistants in Research (Vegetable Crops).

PATRICK H. CORCORAN, *Agriculturist.*
JAMES D. LUCKETT, M.S., *Editor.*
HERMANN O. JAHN, *Florist.*
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JAMES S. LAWSON, Phm.B.,
Museum Preparator.

THE UNIVERSITY OF THE STATE OF NEW YORK

THE STATE DEPARTMENT OF EDUCATION

ALBANY, *January* 2, 1932.

TO THE GOVERNOR AND LEGISLATURE OF THE STATE OF NEW YORK:

SIRS.—Pursuant to law, the Fiftieth Annual Report of the New York State Agricultural Experiment Station, at Geneva, N. Y., is herewith submitted to the Legislature.

Very respectfully yours,

CHESTER S. LORD,
Chancellor of the University.

FRANK P. GRAVES,
President of the University and Commissioner of Education.

CORNELL UNIVERSITY

ITHACA, NEW YORK, *August* 20, 1931.

HON. FRANK P. GRAVES,
Commissioner of Education,
Albany, New York.

DEAR SIR.—In compliance with the statutes, I present herewith the Fiftieth Annual Report of the New York State Agricultural Experiment Station, for the fiscal year ended June 30, 1931.

Respectfully submitted,

LIVINGSTON FARRAND,
President of Cornell University.

ITHACA, NEW YORK, *August* 19, 1931.

To the President of Cornell University:

SIR:—Herewith I respectfully transmit the Fiftieth Annual Report of the New York State Agricultural Experiment Station at Geneva for the fiscal year ended June 30, 1931. This report has been prepared by the Director and Staff of the State Station. It constitutes a comprehensive review and record of the significant work under way and the current progress thereon at this important center.

It is a pleasure to call attention to the statement of the Director that the past year has been one of exceptional progress in the development and service of the Station, and that the Station has now attained the most nearly adequate personnel and facilities, in relation to the demands upon it, that it has yet possessed. The year has marked the substantial culmination of many years of effort to acquire the scientific laboratories and other physical necessities for its work. Funds have been added for special pieces of work germane to the Station's program. These gains are at once reflected in increased productivity, a larger volume of publication, and renewed enthusiasm for the responsibilities imposed.

The record of progress in research, viewed from the standpoint either of range of problems or of advances made and conclusions reached, is impressive. The report merits careful reading by public officials in any way concerned with the affairs of the Station and by farmers who look to it with confidence for assistance with their problems. The further needs of the Station for operating funds, to which the Director makes explicit reference, will also be of interest to those who sincerely desire to see the Station staff enabled to make the most efficient use of the plant which has now been provided.

Respectfully submitted,

A. R. MANN,

Dean.

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FIFTIETH ANNUAL REPORT

OF THE

New York State Agricultural Experiment Station

DEAN A. R. MANN, *College of Agriculture, Cornell University, Ithaca, N. Y.:*

SIR.—I have the honor to present herewith a report of the New York State Agricultural Experiment Station for the fiscal year ended June 30, 1931. The character and progress of the work at this institution for the past year has been quite like that of previous years and this report, in the main, considers the customary items of previous reports. You will find herein, as in past reports, accounts of efforts to which the members of the staff of the Station have given their time and energy. Some of the results set forth are concrete and immediately beneficial to the agriculture of the State; of other efforts, all that can be said is that the problems which the workers seek to solve are still being investigated.

The Year

It is most gratifying to be able to report what seems to be a year of unusual prosperity in all that pertains to the essentials of successful experiment station effort. Let me briefly enumerate: A greater number of bulletins and circulars have been published, than in any previous year, 44 in all; the appropriations for the work of the Station were greater than in any other year, so that the finances of the institution have been more nearly adequate to its needs than for many years; the equipment of the institution is greatly enriched by the building of a new horticultural building and a range of greenhouses suitable to the needs of research work; the Station staff has been increased by seven new members, making a total of 65; lastly, there seems to have been an unusually fine relation of good will and cooperation with the farmers of the State—a gratifying continuation of the relations of past years.

The Station Staff

I am happy to say that there have been few resignations from the Station staff, and no deaths during the past year. Four men, unfortunately one of them a head of a Division, after longer or shorter periods of faithful service, have been called to responsible positions elsewhere. I cannot refrain from saying in this connection that the Station would have been glad to have kept all of these men and all would have stayed gladly had money been available to meet the financial inducements which tempted them to take up other work.

The resignation of Dr. J. J. Willaman, Chief of the Division of Chemistry from April 1, 1929, took effect October 1, 1930.

Frederick Borg, Librarian from July 1, 1929, asked to be relieved of his duties on September 1, 1930.

The resignation of Leslie R. Hawthorn, Assistant in Research in Vegetable Crops, took affect November 30, 1930.

Lastly, Dr. E. E. Clayton, Associate in Research in Botany, severed his connection with the Station on June 1, 1931.

New members of the staff, in order of their appointment for the year, are as follows:

Mr. W. D. Enzie, a member of the faculty of the Oregon State College, was appointed to fill the position made vacant by the resignation of Mr. Hawthorn. Mr. Enzie is a graduate of Oregon State College in 1929, and has served since that time as fellow in horticulture and instructor in horticulture in that College.

Dr. Maurice W. Yale became an Associate in Research in Bacteriology July 1, 1931. Dr. Yale is a graduate of the New York State College of Agriculture, from which institution he has also received an M. S. degree. In June, 1931, he received a Ph.D. degree from Iowa State College.

Mr. Alvin W. Hofer was elected by the Trustees to the position of Assistant in Research in Bacteriology to begin work July 1, 1931. Mr. Hofer is a graduate of the University of Illinois, and in June, 1931, received an M. S. degree from the University of Wisconsin.

Dr. H. S. Cunningham became a member of the Station staff as Associate in Research in Botany on June 1, 1931. Dr. Cunningham is a graduate of the Nova Scotia Agricultural College in 1912, received a B. S. degree from MacDonald College in 1917, an M. S.

in 1924, and a Ph.D. from Cornell in 1928. He has been Plant Pathologist of the Bermuda Government since 1928.

Prof. L. N. Cooley was elected to the position of Associate in Research in Botany, effective July 1, 1931. Prof. Cooley has a B. S. degree from Ohio State University in 1927 and an M. S. from the University of Tennessee in 1930. He was an instructor in botany in the University of Tennessee from 1927 to 1930, Assistant Plant Pathologist at the Ohio Experiment Station during the summers of 1926 to 1929, and a full time assistant at the latter institution since June, 1930.

Dr. Arthur L. Shuck became an Associate in Research July 1, 1931. Dr. Shuck is a graduate of Central College, Missouri, with an M. S. degree from the University of Missouri and a Ph.D. from the University of Illinois in June, 1931.

Mrs. Mabel L. Ruttle-Nebel was elected to the position of Assistant in Research in Botany, to be effective July 1, 1931. Mrs. Ruttle-Nebel has an M. A. degree from the University of Saskatchewan and a Ph.D. degree from Cornell in 1930.

Effective July 1, Mr. Ralph R. Jenkins became Assistant in Research in Vegetable Crops. Mr. Jenkins has been a post-graduate student at Cornell University, and has a B. S. and an M. S. degree from the University of New Hampshire.

Mr. E. C. Smith accepted the position of Assistant in Research in Chemistry, to begin work July 1, 1931. Mr. Smith has an M. S. degree from the University of Illinois.

Changes in Title

It has been a pleasure for the Director to ask for and to have granted the following promotions of men at the Station which involve changes in title:

Dr. D. C. Carpenter, Associate in Research in Chemistry, since 1922, was promoted to Chief of the Division of Chemistry, beginning October 1, 1930. Prof. Leon R. Streeter, Associate in Research, a member of this staff since Feb. 1, 1921, was promoted to be Chief in Research in the Division of Chemistry, beginning October 1, 1930. Dr. Z. I. Kertesz, a member of this staff since July 1, 1929, as Assistant in Research in the Division of Chemistry, was promoted to be Associate in Research beginning October 1,

1930. Miss Marjorie B. Rogers, a stenographer at this Station since July 1, 1928, was promoted to become Station Librarian, to take effect September 1, 1930. Prof. W. F. Walsh, Assistant in Research in this institution since 1915, was promoted to the position of Associate in Research in Chemistry, effective July 1, 1931. Prof. J. C. Marquardt, Assistant in Research in Dairying since 1923, was promoted to become Associate in Research, to be effective July 1, 1931.

New Buildings

It is most gratifying to report that the new horticultural building which the Station has so long needed, provided for by the Legislature of 1930, is now nearly completed and will be ready for use early in the autumn of 1931. The new building dominates all other structures on the Station grounds in size, position, and architecture. It provides ample facilities for three divisions of the Station's organization, *viz.,* Pomology, Botany, and Vegetable Crops. The purchase of equipment is now under way at a cost of $65,000. The expenditure of this sum will make certain that the needs of the men who are to occupy the new building will be satisfactorily met. This institution will be better equipped for scientific research with the occupancy of this laboratory and the new greenhouses now under way than ever before, and the staff should be able to carry on present work to better advantage and to undertake new work of importance that has long waited for room and equipment.

As long ago as 1914, the Director of this Station asked for new greenhouses, calling attention to the fact that "their building could not be long delayed because the present greenhouses through age and decay have reached a condition that will not permit of use much longer." Yet the Station workers have struggled on with these small, antiquated, poorly equipped houses for 17 years. In these 17 years the extra cost of repairs, coal, and labor would easily have built a better range than the old houses were at their best. Meanwhile, every phase of research having to do with plants has suffered by reason of lack of greenhouse space. At last the Station is to have a new range of glass. The Legislature of 1931 appropriated $80,000 for new greenhouses and plans are now being made with the expectation that before the winter of 1931 the houses will be built. It is said that "it is better to travel hopefully than it is

to arrive", but after traveling with more or less hope for 17 years, it is, all at the Station agree, a great source of satisfaction to "arrive."

Special Appropriations

During the past 10 years, nearly every Legislature has called upon the Station to do work asked for by the farmers of the State for which special appropriations have been made. There are now 11 of these special funds:

Long Island Vegetable Research Farm	$11,300
Hudson Valley Horticultural Investigations	15,250
Problems of Production, Storage, and Distribution of Nursery Shrubs and Plants	13,450
Insect Pests and Diseases Affecting Raspberry Plants	4,500
Corn Borer Investigations	7,250
Investigation of Moths and Insects	50,000
Grape Work at Fredonia	2,750
Utilization of Fruit and Vegetable By-products	10,000
Seed Investigations	9,000
Legume Inoculants	5,000
Small Fruits in Western New York	5,000

The total amount of these appropriations is $133,500. The Director and the men in the several Divisions having these funds are gladly undertaking the several projects called for by the farmers of the State, but I must call your attention to a condition that has been brought about which must be remedied. During the years that these special funds have been piling up, there have been few increases in the general maintenance of the institution. One sees at once that to provide room, stenographic service, library facilities, janitor service, communication service, and the hundred-and-one other small items necessary to provide for the men who are working with these funds, the Station's general maintenance appropriations are heavily taxed. Some way must be found whereby some of these projects can be put into the general maintenance appropriations, or, perhaps better still, increases made in the several general funds that will enable the institution to carry on this work without crippling the Station. To put the matter in vernacular language, the "side shows" are seriously crowding the "main show."

The Fiftieth Anniversary of the Station's Establishment

The work of this institution dates from March 1, 1882, and therefore it comes to its fiftieth anniversary March 1, 1932. From several standpoints it is desirable that formal recognition be taken of this event. The New York State Agricultural Experiment Station is one of the few experiment stations of the country so organized that it stands apart from college or university, and of all the 48 stations it is probably the most isolated from educational institutions—a situation with advantages and disadvantages. A disadvantage is that the institution has no commencements, no fete days, no farmers' week, no special courses of instruction, no alumni, no extension staff, and, all in all, but few elements of familiarity with its farming constituents. The Station must needs make the most of opportunities to invite the public to take interest in and give it attention.

No doubt the work and influence of the Station were greatly strengthened by the celebration of the twenty-fifth anniversary, at which time there was a most notable gathering, not only from those interested in agriculture in this State but from other states as well. It is hoped that a similar celebration can be held on the fiftieth anniversary and so arouse interest in research and bring about more intimate relations between the staff and farmers.

Inspection Work

The field of activity in regulatory work is gradually broadening. For many years the Station has been responsible for the analyses of commercial fertilizers and concentrated feeding stuffs. For a lesser time it has inspected the glassware used in various tests at creameries and cheese factories. Several years ago it began testing seeds for farmers and seedsmen. Still more recently it began the analysis of insecticides. Last year legume inoculants were added to the list of farmers' commodities to be tested by the Station.

A very small part of this work is supported by fees, to be specific, only a part of the work with seeds. The inspection of legume inoculants is paid for by a special appropriation. The rest of this rapidly growing program is paid for out of the Station's maintenance funds, altho considerable amounts of money are paid

into the State Treasury for license fees in several of the inspection activities.

The task of making sure that all of the several farmers' commodities regulated are of proper grade and not illegally sold in the State is of highest importance to farmers and must be carried on in the future as in the past with the utmost diligence and care. Yet this inspection work has become a serious drain on the resources of the Station, greatly curtailing by reason of lack of funds its more proper function of research. Legislation must be asked for from the next Legislature, or a program put up in new form in the next budget, which will better unify the work of inspection as to licenses, fees, and control, and at the same time make the work self-supporting either from the moneys collected or by direct appropriation, thus relieving the Station from what is becoming a serious financial burden.

Salary Conditions

The last Legislature gave two of the 65 members of the Station staff increases of $100 each. The year before there were a very few small increases, and so on for several years. Some members of the staff have not had salary increases in 8 or 10 years. It is certain that most of the members of the staff were greatly overpaid 5 and 10 years ago or that they are now greatly underpaid. Inevitably, some of the Station's best investigators accept positions at higher salaries elsewhere, either in agricultural colleges, other stations, or in commercial houses. Serious results have come from the present salary conditions, and further losses of men are likely to follow. During the present summer, artisans employed in erecting the new horticultural building are receiving higher pay for the summer's work than a number of useful assistants in our scientific staff receive for the year. If the State expects its Experiment Station to maintain the best standards, it must give practical recognition to the fact by paying salaries high enough to obtain men of high intellectual and professional qualities.

Printing

In two previous reports I have called attention to the serious shortage of funds for printing. For several years past, the printing

fund has been exhausted before the publications for the year were all sent to press. This past year was no exception, and manuscripts have already accumulated which will make a heavy drain on the fund for the current year. If the Station's results from research are to be timely and effective, they should reach the hands of farmers soon after the findings of the staff are ready for publication. There can be no increase in the next year's printing fund, but it is most earnestly to be hoped that for the fiscal year of 1932-33 an increase of $3,000, asked for in the Station's budget for this fund, will be granted.

Death of Doctor Whitman Howard Jordan

Since the last report of this Station was submitted there has occurred the death of Dr. Whitman Howard Jordan, twenty-five years Director of this Station, and since his retirement as Director in 1921, Professor Emeritus in Chemistry at the New York State College of Agriculture at Cornell University. At a meeting of the staff of this Station May 21, 1931, a resolution was adopted which I desire to put on record as best expressing the deep sense of regard in which Dr. Jordan was held at the New York State Agricultural Experiment Station. The resolution follows:

"Dr. Jordan was born at Raymond, Maine, October 27, 1851, and died at Orono, Maine, May 8, 1931. He began his life work as an assistant in the Connecticut Agricultural Experiment Station in 1878; next he served four years at the Pennsylvania Experiment Station; then eleven years as director of the Maine Experiment Station; and finally twenty-five years as director of this Station. Thus, his career was coincident with the development of experiment stations in the United States.

"He served agriculture efficiently in this State and in the Nation. He believed that the most useful work an experiment station can do is to conduct rigidly scientific investigations of agricultural problems. To his insistence upon this fundamental principle and to his exceptional ability in expounding it to his colleagues and to the public, is due in large measure, the present high standing of the United States in the field of agricultural science and practice.

"This institution and its staff were his chief concern for thirty-five years. Altho exacting in his standards of workmanship, he directed those associated with him sympathetically, kindly, and justly. He was, besides, to each member of his staff a guardian and counselor.

"Dr. Jordan was, first of all, a man of unflinching integrity—a

vigorous, high-minded advocate of truth. In a busy life he found time to take an active part in the affairs of his church, community, and State. Invariably, he stood for righteousness. He was in every respect a good citizen.

"He has left to the members of this Staff a legacy of work well done, a life well spent, and a record of great accomplishment as scientist, administrator, and citizen. For all this we make heartfelt acknowledgment. We are grateful that he could live to the fulness of years and witness the consummation of many of his most treasured ambitions for this Station. Let us record here our enduring regard for him as man and Director, and pass on to those who are to succeed us the heritage of his achievements."

Progress of the Station's Work

Following the custom of past years, I have asked the Chiefs of Divisions to prepare brief statements showing the progress which has been made during the year upon the various experimental projects under their supervision. The following accounts from the Chiefs of the seven Divisions of the Station constitute a fairly complete, though necessarily brief and concise, review of the work of the institution during the past fiscal year.

Division of Bacteriology

BACTERIA ASSOCIATED WITH FLAVORS IN DAIRY AND VEGETABLE PRODUCTS

As stated in the last Annual Report, a study has been made of the bacteria which cause the production of the characteristic flavors in certain food products. The technical work on this problem has been completed and the results published as Technical Bulletin No. 167 and in a journal article. The laboratory results have shown that there are three common recognizable species in this group of bacteria, each of which may be identified readily by laboratory tests. From a scientific point of view, the conclusions presented in this work have given material aid in classifying these bacteria. The tests suggested will enable other workers to recognize these organisms quickly, no matter where they are encountered. The three species are named as follows: *Leuconostoc mesenteroides* (Cienkowski) Van Tieghem, *L. dextranicus* (Beijerinck) Hucker and Pederson, and *L. citrovorus* (Hammer) Hucker and Pederson.

Cultures of these organisms have been isolated from sauerkraut,

slimy sugar solutions, unroasted coffee beans, dairy starters, cheese, milk, fermenting beans and tomatoes, etc. It is of particular interest that cultures of these organisms which appear to be identical have been isolated from the dairy starters in use in Holland, Denmark, Germany, and Canada as well as in the United States.

The technical study of this group having been nearly concluded, the practical aspects of the investigation that are of interest in New York are at present receiving major attention. Inasmuch as these organisms, in connection with certain other bacteria, are essential in dairy "starters," their effect upon the flavor and quality of dairy products is being investigated. Several starters in use in dairy plants in the State have been submitted to the laboratory for examination and aid has been given in selecting high-quality starters.

The importance of this group of bacteria in determining the flavor in cheddar cheese has received attention. During the year, a number of experimental cheeses were made in a New York State cheese factory using various cultures of these organisms as starters. The cheeses were then cured in a commercial storage plant and examined at regular intervals. It is planned to continue these investigations as opportunity offers.

SAUERKRAUT INVESTIGATIONS

Experiments have continued with sauerkraut in which certain organisms of this type have been used. Two technical bulletins have been published discussing the organisms involved in naturally fermenting and in inoculated krauts and the effect of pure and mixed culture inoculation with various organisms in the sauerkraut fermentation. The first of these (Technical Bulletin No. 168), entitled "Floral Changes in the Fermentation of Sauerkraut," is the result of a study of the organisms from eight krauts, five of which were inoculated with pure cultures. Several hundred cultures were studied and grouped. Four species, *viz., Leuconostoc mesenteroides* (Cienkowski) Van Tieghem, *Lactobacillus cucumeris* Bergey, *Lactobacillus plantarum* (Orla-Jensen) Bergey, and *Lactobacillus pentoaceticus* Fred, Peterson, and Davenport, were the common organisms of fermenting kraut. The first named is responsible for the early acid development in kraut. The first and last produce alcohol and acetic acid, while all produce lactic acid. When kraut is inocu-

lated with pure cultures of *L. cucumeris* decided changes are produced in the bacterial flora.

The results of the inoculation of 47 krauts in comparison with 25 normal krauts are given in the second bulletin (No. 169) entitled "The Effect of Pure Culture Inoculation on the Quality and Chemical Composition of Sauerkraut." It has been shown that pure culture inoculation with *Streptococcus lactis* (Lister) Löhnis results in a somewhat improved kraut. On the other hand, no method of inoculation with the organisms common to kraut has been developed as yet that gives good fermentation and many inoculations actually proved detrimental.

During the year studies have been continued on the inoculation of kraut cabbage with pure or mixed cultures of bacteria. Studies have also been continued on the causes and remedies for various forms of kraut spoilage. A manuscript is being prepared for publication which discusses the preparation of kraut, the changes which take place in kraut fermentation, faulty practices in preparing kraut, and kraut spoilage, such as soft, pink, dark, slimy, or rotted kraut.

Investigations of the fermentation of sauerkraut with special reference to the rate of fermentation in relation to temperature have been carried out during the year. Bulletins discussing these problems will be issued when the studies are completed.

FOOD SPOILAGE STUDIES

Altho several types of food spoilage have been encountered, only one proved to be unusual. In this case certain resistant types of yeasts were found to ferment a fountain syrup with a grape juice base. The preservatives used in the syrup were sugar and sodium benzoate. The cause of the spoilage has been worked out and better means of preservation are being studied.

UTILIZATION OF FRUIT AND VEGETABLE PRODUCTS

Increased appropriations have been made available to begin July 1, 1931, for studies on the utilization of fruit and vegetable products. While the fermentation of sauerkraut has been studied for several years, a great number of other fruits and vegetables are also subject to a lactic acid fermentation and it is proposed to study the utilization of these fruits and vegetables for pickling. Observa-

tions on troubles connected with faulty fermentations in brine and dill pickles have been continued.

Fruits and fruit juices lose much of their fine, delicate flavors in the various preservation processes in which heat is used. This is due both to the volatilization of flavors in cooking and to the effect of heat. Other methods of preventing spoiling by bacteria, yeasts, and molds are to be studied during the coming year.

BACTERIA ASSOCIATED WITH PREPARED INFANT FOODS

During the last year the work on the bacteria found in commercially prepared infant foods has been concluded. As a result of these investigations, the manufacturers of these compounds have made a special effort to reduce the number of bacteria in these products to a minimum. Certain of these manufacturers have established control laboratories, and recognizing the importance of a product of a high sanitary quality, have raised their sanitary standards. Users of commercially prepared infant foods are at present reasonably assured that such commercially prepared products are produced under controlled conditions and producers of these foods are endeavoring to meet as rigid standards as are dairymen who are producing milk primarily for infant consumption. The results of these investigations have appeared as Bulletin No. 584 of this Station.

Members of this Division have served on a committee appointed by the American Dairy Science Association to draw up suggested methods for the bacteriological examination of dry milk powders and related baby food preparations. The manuscript of the report is in preparation and it should appear in the *Journal of Dairy Science* during the coming year. During the past year a similar report on bacteriological methods of analyzing butter has been completed and published.

HEAT-LOVING BACTERIA IN PASTEURIZED MILK AND OTHER DAIRY PRODUCTS

The general occurrence of heat-loving (thermophilic) bacteria in milk pasteurized by the holding process has given rise to several new problems. One of the most natural questions which has been asked very frequently is, "Do heat-loving bacteria have any significance from the public health standpoint?" There is good reason for the general belief that these bacteria are perfectly harmless from

the standpoint of the health of the consumer, tho they are known to affect the flavor and keeping quality of pasteurized milk. However, as no previous investigations have been made to answer this question definitely and since its possible importance to the dairy industry is so great, the Station has during the past year carried out a series of experiments in which milk containing large numbers of these heat-loving bacteria was fed to rabbits and guinea pigs. No harmful effects were obtained as a result of these feeding experiments and a manuscript discussing the results has been prepared for publication.

The Station has also given attention to the occurrence of heat-loving bacteria in evaporated milk during the past year. Conditions favorable for the development of this type of bacteria commonly occur in plants which evaporate milk. As these bacteria are also especially resistant to heat their presence is likely to prevent complete sterilization of the cans of evaporated milk. The Division became interested in this problem when it was asked to study the cause of spoilage in this dairy product. Thus far, the investigation has been limited to an isolation of the types of heat-loving bacteria which may be found in evaporated milk. A report of the work is in preparation.

Some of the newer types of pasteurizers which utilize a high temperature and short time for the process of pasteurization have been and are being studied in order to determine whether truly heat-loving bacteria are likely to develop when pasteurizers of this type are used for some time under practical milk plant conditions. The operation of two of these new type machines in Albany since July, 1930, has provided convenient material for studies that have been carried out in the laboratory of the Department of Agriculture and Markets.

A general report on the progress of the studies that have been made at the Station which deal with the general problem of heat-loving bacteria in their relation to the pasteurization of milk has been prepared for presentation at the World's Dairy Congress which is to be held in Copenhagen in July, 1931. This paper is a review of earlier work and also includes some unpublished data on the general behavior of heat-loving bacteria in milk.

CHANGES WHICH OCCUR DURING THE RIPENING OF CHEDDAR CHEESE

Altho cheese making has been hard pressed by the market milk industry in New York, it still plays an important part as a distinct phase of dairying which, during the past few years, has offered the most satisfactory outlet for large amounts of surplus market milk. This makes further information regarding the unsolved problems in regard to the ripening of this well-liked food product of importance to the dairy industry.

Studies have been made during the year on the changes which take place in ripening as influenced by the two commonest types or varieties of lactic organisms found in dairy starters, namely, *Streptococcus lactis* (Lister) Löhnis and *Streptococcus cremoris* Orla-Jensen. Cheeses have been made with both of these organisms. Chemical and bacterial studies have been made on the changes produced in the ripening of normal cheese in contrast to those that were made with the special starters. This work is being repeated at present in order to substantiate further the results secured from the first set of analyses.

THE ORGANISMS ASSOCIATED WITH MASTITIS

For some years members of this Division have been interested in sanitary milk control problems. One of the most serious difficulties facing dairymen in this field at the present time is the question of mastitis or "garget." Of prime importance is the development of methods for the accurate detection of "garget," as well as the possible significance of the organisms associated with infected udders from the public health standpoint.

This Division has undertaken a study of these matters as an outgrowth of the fundamental studies that have been made on the types of streptococci found in dairy products and as an outgrowth of studies made on the sanitary significance of streptococci and white blood corpuscles (leucocytes) in market milk. It is hoped that the technical information now at hand regarding the bacteria causing mastitis will prove useful in aiding dairymen to meet reasonable regulations designed by public health authorities to eliminate milk from infected udders from the general milk supply.

METHODS OF CONTROLLING THE QUALITY OF MARKET MILK

The Division has continued to assist the Committee on Standard Methods of Milk Analysis of the American Public Health Associa-

tion in their efforts to standardize the methods that are used so extensively in New York dairy districts in making the bacterial counts that serve as a basis of payment of premiums to dairymen. Assistance has been given to members of the bacteriological laboratory of the State Department of Agriculture and Markets in their studies of various illuminating and magnifying devices used in bacteriological laboratories in counting colonies of bacteria that develop on petri plates. Some of the procedures now in use were found to be unsatisfactory and standard specifications covering the use of these devices are now in preparation.

Studies made at the Station during the year have shown that faulty bacteriological incubators that do not maintain the temperatures that they are supposed to maintain play an important part in producing the type of discrepancies in counts that result in one laboratory reporting results almost invariably higher than those secured on duplicate samples of milk in some neighboring laboratory, and vice versa.

At the same time, statistics have been gathered for the Standard Methods Committee showing the extent of the use of these laboratory methods for examining the quality of milk. Incomplete returns show that in 1929-30 the public health laboratories of the United States analyzed more than 540,000 samples of milk by the agar plate technic, more than 294,000 samples of milk by direct microscopic examination, and more than 146,000 samples by the methylene blue reduction method. During the same period, the laboratories maintained by the dairy industry analyzed more than 2,074,000 samples by the agar plate technic, more than 750,000 samples by direct microscopic examination, and more than 538,000 samples by the methylene blue reduction method. These figures show in a striking way that the dairy industry is more and more accepting responsibility for determining that the quality of milk and cream is what it should be before they are offered for sale to the public; and that the industry depends less and less on complaints from public health officials before correcting bad conditions.

THE NAMES USED FOR THE VARIOUS TYPES OF BACTERIA

Unlike those biologists who study higher plants and animals, bacteriologists have never generally adopted internationally accepted rules, governing the choice of names for the species of bacte-

ria. Thereby much confusion and waste of effort has resulted. The fact that the organism causing Bang's disease in cattle was originally named *Bacterium abortus,* while the organism in goat's milk causing Malta fever was called *Micrococcus melitensis* played its part in delaying for many years the recognition of the close relationship or even possible identity of these organisms.

This situation led the First International Microbiological Congress (Paris, July 1930) to undertake the organization of an International Commission whose duty it should be to assist in bringing about uniform usage in the names used for the different kinds of bacteria. The Station has been asked to cooperate in this work thru the appointment of the chief of the Division as a permanent secretary of the Commission to serve for the field of Agricultural and Industrial Bacteriology.

As a contribution to bringing about better international cooperation and understanding, two members of the Division have cooperated with others in the translation into English of the classic German work in this field, *viz.,* Lehmann and Neumann's "Bakteriologische Diagnostik." This translation has been completed during the year.

GROWTH OF BACTERIA IN SOILS OF LOW PRODUCTIVITY

Work on this subject reported last year in a preliminary way has been continued during the present year and is still in progress. Technical Bulletin No. 172 on the "Influence of Various Non-Nitrogenous Compounds on the Growth of Certain Bacteria in Soils of Low Productivity" has been issued during the year. Altho the results given in this bulletin are technical, they suggest certain possibilities that may have practical importance. It has been shown that certain poor soils of New York, altho very high in nitrogen, seem to contain too little of this element in available form to support the growth of bacteria. The nitrogen can, however, apparently be made available by adding certain nitrogenous mineral compounds. These results suggest that the poor growth of plants on these soils may be explained in some similar way. Work is being undertaken to show whether there is a correlation between these findings and the practical handling of the soil in question. The results obtained in this work also have much theoretical interest as indicating the conditions under which bacteria can obtain benefit from the food elements present in the soil.

TESTS TO INDICATE THE FERTILIZER REQUIREMENTS OF SOIL

The work just outlined has shown that certain kinds of bacteria fail to grow in some soils without the addition of certain fertilizer ingredients, while in other soils additions of these particular ingredients are unnecessary. It is thought to be of interest to see whether such observations show any correlation with the fertilizer requirements of the soils in question. Various Stations have given much attention in recent years to bacterial tests intended to determine this point. The tests made elsewhere have been carried on by a different method and with a different kind of bacteria. In some places very good correlation with fertilizer requirements has been found, and in other places no correlation. It is planned accordingly to look into this matter here and to see whether the type of bacterial tests that are being made at this Station show any greater correlation with practical results than the methods developed elsewhere.

TESTING OF LEGUME NODULE BACTERIA

As stated in the report for the last year, legislation went into effect the first of January, 1931, requiring dealers in plant or soil inoculants to register with the Department of Agriculture and Markets and directing the Station to test samples of these inoculants to determine whether or not they fulfill the claims made by the manufacturers. In the case of adverse findings by the Station, the Department of Agriculture and Markets is authorized to refuse a permit to the company desiring to sell these cultures in New York. Altho this law went into effect last January, it was not possible to start culture testing with the facilities at hand. Funds have now been made available and work is to start as soon as facilities can be provided after July 1. As a result of work in this field the legume inoculants on the market should subsequently prove to be of a more reliable nature than they have been in the past. The survey already made at the Station shows that inspection of this sort is necessary as some of the inoculants now on the market are highly unsatisfactory, and that they are also sometimes sold to farmers after they are old and worthless.

ROUTINE AND OTHER INVESTIGATIONS

The Division has continued to cooperate with the City of Geneva in controlling the sanitary quality of the city water and milk sup-

plies; with the sauerkraut manufacturers of the vicinity in developing a routine laboratory control of the fermentation of the cabbage; with the Dairy Division in the routine control of tuberculosis, mastitis, and contagious abortion in the Station herd; with the Botany Division in studies on tomato canker; and with the Chemical Foundation in the standardization of biological stains. The diversity of these problems again illustrates the varied ways in which bacteria have an importance from the agricultural standpoint.

Division of Botany

APHIDS ON SPROUTING POTATO TUBERS

The occurrence of aphids on sprouting potato tubers was noted in the last Annual Report. Infection experiments made at this Station corroborate similar experiments made in Ireland in showing that aphids may spread leafroll freely among sprouting seed potatoes. An account of these experiments has been published in Technical Bulletin No. 171. It is recommended that seed potatoes which have sprouted before planting be examined for aphids. If aphids are present it is important to discover them and get rid of them early.

ASTER SEED TREATMENT AND STORAGE

Since several of the diseases of China aster are seed-borne, it seemed a possibility that there might be devised a method of seed treatment which would be helpful in combating them. A thoro study of this subject has been made and it is gratifying to be able to report that a successful method of seed treatment for aster seed has been found. Briefly, the method consists in first soaking the seed for 30 minutes in water at 100° F, then for 30 minutes in a 1 to 1,000 solution of corrosive sublimate, after which the seed is washed for 5 minutes in cold running water, and, finally, spread out on a towel to dry. There are several details of the treatment which require attention. These are fully described in Technical Bulletin No. 177 which contains an account of the investigation.

In the course of this investigation an improved method of storing aster seed was also discovered. The seed is thoroly air dried in a heated room during the winter and then given air-tight storage in an "E-Z Seal" fruit jar. Aster seed treated in this way may live 4 years, or even longer; while seed stored in a cloth bag kept in a concrete warehouse may die during the summer following its

harvest, as moisture destroys the viability of aster seed. The seed should be dried as quickly as possible after harvest and storage in damp, unheated buildings avoided.

DISEASES OF CANNING CROPS

Experiments with the root diseases of peas.—Probably the limiting factor in pea production in New York is the root disease complex called by various names, of which root-rot is the most descriptive. This disease is being studied intensively in order to develop a cheap method of control. This is necessary because the return per acre from canning peas is relatively low.

First of all a study of the relation of environment to the development of the disease must be made to learn if it may be modified in such a way as to reduce the ravages of the disease. Experiments and surveys show that root-rot is much more severe on untiled than on tiled land and more destructive to the peas growing between lines of tile than to those directly over them. Also, the malady is worse on portions of the field packed by the fitting machinery than on unpacked soil. These field observations agree with results obtained under controlled conditions of automatic irrigation, showing that the disease develops more destructively in soil with high water content or high water-holding capacity. The facts suggest the remedy. Peas should be grown on well-drained land. Other environmental factors, such as soil temperature and soil acidity, are being studied in their relation to the development of the malady.

Also, the pathogenic organisms involved in the cause of the disease complex, varietal and individual resistance, and the control of the disease by seed and soil treatment are being investigated. During the past two years several soil treatments, including land plaster, have been tried on contaminated soil with pleasing results. The beneficial effect of gypsum in offsetting the ravages of root-rot is being investigated in collaboration with the Division of Vegetable Crops. The use of this material as a method of control is exceedingly promising, but it may not be of practical application because of the aforesaid low income per acre from peas.

Combating damping-off of tomato seedlings.—Damping-off is very troublesome to growers of seedling tomatoes both in the seedling flat and in the transplanted flat. Several new seed treatments

developed for combating the disease in the seedling flat have met with the enthusiastic approval of growers. Striking increases in stand and reductions in seedling loss have been obtained in several commercial greenhouses by dusting the seed with monohydrated copper sulfate or by soaking it in a bluestone solution. (See Bulletin No. 586 and Circular No. 120.) For controlling the disease in the transplanted flats, several promising chemical treatments have been devised, but these are as yet in the experimental stage.

RASPBERRY DISEASE INVESTIGATIONS

Virus diseases of black raspberries.—Technical Bulletin No. 175 contains an account of recent studies on the symptoms and rate of spread of the three virus diseases—red mosaic, yellow mosaic, and mild streak—that are prevalent in black raspberry plantings in New York. A brief summary of these studies was given in the last Annual Report.

Mosaic resistance in variety crosses.—Several seedling black raspberries chosen because of particular merit as promising new varieties have been studied as to their susceptibility and klendusity (disease escaping quality) to red mosaic. Of seven such seedlings, as yet unnamed, one has stood out as highly klendusic but very susceptible. It behaves in much the same manner as the red variety Herbert. A stand of about 130 plants of this seedling has shown only one diseased plant in 3 years, while the seedling in the adjoining two rows has shown in the 3 years 18, 15, and 4.5 per cent red mosaic. The variety Dundee adjoining this seedling showed 81, 28, and 22 per cent red mosaic. Of the other five seedlings, after being freed of small amounts of red mosaic the first season, four have remained free and one has shown about 10 per cent each year. From these seedlings will be chosen new named varieties that should assist greatly in red mosaic control because of their high klendusity.

Of the red raspberry seedlings resulting from different crosses of standard varieties that have been studied for resistance and klendusity to red and yellow mosaic, those resulting from certain parents are characterized, in some cases, by lack of klendusity and high susceptibility to red mosaic, while others are highly klendusic and resistant. The Newman x Herbert crosses are outstanding in klendusity or immunity and resistance to both yellow and red mosaic.

Seasonal relations in the expression of mosaic.—The determination of red and yellow mosaic in red raspberry varieties and seedlings is complicated by variations in the seasonal weather conditions, the susceptibility of the variety, the length of time the plant has been affected, and the vigor of the plant. In the early summer of 1930, yellow mosaic in red raspberries was expressed strongly in the entire fruiting lateral and in all of the sucker foliage that was expanded up to the time the fruiting laterals produced terminal blossoms. In the early summer of 1931 yellow mosaic symptoms were confined to the basal leaves of the fruiting laterals, and to a very few leaves at the base of the earliest suckers. For these reasons, the effect on the health of the plant was more severe in 1930 than in 1931, and, furthermore, identification of affected plants that were resistant to yellow mosaic was difficult in 1931. On the other hand, general weather and growth conditions caused red mosaic to be strongly expressed in 1931 on the tip foliage of the fruiting laterals and in sucker leaves just above those that showed yellow mosaic symptoms. Furthermore, after being strongly expressed in a few sucker leaves, the later foliage was either entirely free of symptoms or only lightly mottled according to the resistance of the variety. Seasonal variations in this way have been found to have a marked effect on the injury caused to fruiting laterals of the season and the growth of the new canes for the following season's crop. In a similar manner the conditions of 1931 were favorable for the minimum injury by red mosaic to the vigor of the fruiting canes in the case of black raspberries that had not been dwarfed previously.

New mosaic-control experiments in western New York.—The prevalence of red mosaic in the black raspberry plantings of western New York has become so acute that a special appropriation was made by the last Legislature to begin control investigations there. The first problem under way is to determine if 50 acres of disease-free stock now planted in blocks representing varying degrees of isolation from diseased plantings can be kept free from virus diseases by roguing. Such methods with adequate isolation have proved successful elsewhere for control of severe streak and leaf-curl, while the experiments in western New York are concerned principally with red and yellow mosaic in a district where isolation

is difficult to obtain due to intensive cultivation of large acreages of red, purple, and black varieties.

PLANT DISEASE INVESTIGATIONS ON LONG ISLAND

Treatment of vegetable seeds.—In connection with the treatment of vegetable seeds for the control of seed-borne plant diseases there have arisen several important questions concerning the effect of such treatment on germination and plant vigor. The results of an extended investigation of this subject are now ready for publication. Altho stimulation of growth sometimes appears to result from the treatment of seed with copper and mercury compounds, no basis was found for the claim that growth stimulation is one of the advantages of seed treatment. With lima beans retardation of growth results regularly from seed treatment with mercurials. Treatment of the seed with organic mercurials may increase the stand of plants if soil and weather conditions at time of planting are unfavorable for rapid germination. Under conditions favorable for germination no such increase occurs. Dust treatments with organic mercurials may be made safely at any time in advance of planting, but liquid treatments should not be made longer than a month before planting. Liquid-treated seed rapidly loses its viability. Injury from hot water treatments is greatest with seeds of low vitality. For safety, the hot water treatments should be used only on seed of good vitality and should not be made far in advance of the time of planting.

Cucumber diseases.—The cucumber disease investigations have included seed treatment, spraying experiments, and attempts to breed disease-resistant varieties. The most important diseases are mosaic, wilt, and blight or downy mildew. None of these diseases are controlled by seed treatment, yet seed treatment is of value, when the seed is sown early, as a protection against decay. Of the seed treatments tested, dusting with Semesan Jr. gave the best results. This treatment is recommended for all cucumber seed planted before June 1. Wilt may be prevented by giving the plants thoro protection against striped cucumber beetles during the first six weeks following planting. While this has been accomplished fairly well by the use of certain dusts, the best results have been had with a 3-3-50 Kayso-calcium arsenate spray mixture. Spraying for

downy mildew should begin the last of July. Applications should be made twice a week, the first three with a 3-4-50 bordeaux mixture, and later ones with 6-8-50 bordeaux mixture. Spraying does not control mosaic. Apparently, the only possibility of controlling mosaic on Long Island is thru the development of disease-resistant varieties. A full report of the cucumber investigations has been published in Bulletin No. 590.

APPLE SCAB AND ITS CONTROL IN THE HUDSON VALLEY

Timing of sprays.—The number of the previous year's scabby leaves overwintering and the temperature and amount of rainfall in the spring determine the severity of apple scab. The critical period for apple scab infection generally extends from the time the buds show green in the early spring until about 2 to 4 weeks after the petals fall. The number of sprays to apply and the time to put them on are constant problems of the grower.

Experiments show that in some years it is the pre-blossom sprays that are essential, while in other years it is the calyx or cover sprays. This seasonal irregularity takes the timing of the critical sprays beyond the scope of the orchardist. While growers can be advised when to spray for apple scab, it is not recommended that they follow recommendations too closely in an attempt to outguess the weather and scab development, but that they keep the susceptible host parts covered. This will permit the substitution of milder fungicides in the spray program after danger of primary infection is past. Thoroness of coverage is very important.

Selection of spray material.—The selection of a fungicide is an individual problem and depends on the location and environment of the orchard, the method of orchard practice, and the successfulness of spraying programs of previous years. No single fixed schedule of applications can be recommended as the most efficient and economical for all seasons and situations. With this in mind an attempt is being made to define the merits of the more promising spray materials available.

It is evident from the experiments that lime-sulfur, lime-sulfur plus copperas, lime-sulfur and dry-mix (half and half), and dry-mix and Cal-Mo-Sul (calcium monosulfide) were equally effective in those orchards where scab had been kept under commercial control and good horticultural practices followed.

The data also show that lime-sulfur, lime-sulfur plus copperas, and lime-sulfur and dry-mix (half and half) are approximately equally effective in situations where scab is extremely severe. Dry-mix was decidedly inferior to the spray containing lime-sulfur in these critical tests. Lime-sulfur did not seem to be materially improved by the addition of copperas. Scab lesions on the foliage were satisfactorily burned out with lime-sulfur. It would seem from the data that the best results can be obtained with the application of lime-sulfur in the pre-blossom, calyx, and perhaps the first cover sprays and the substitution of milder treatments for the subsequent sprays. This practice depends on the choice of correct treatment, the timeliness, and the thoroness of application.

Sprays applied after infection periods.—The general idea in spraying practice is that effective sprays must precede and prevent infection. In view of the fact that it may be possible to control scab by applying sprays after infection periods, certain studies are being made along this line. There are data to show that scab can be controlled with lime-sulfur after infection has taken place; that is, within two days or so from the time an infection period begins. While it is evident that scab can be controlled with lime-sulfur after comparatively short infection periods, particularly on the fruit, this practice is not recommended except in emergency situations in which for some reason the spray has not been applied.

Injury vs. spray materials.—The quest for an effective fungicide that is non-injurious or for a material that may be used to eliminate injury is an urgent one under Hudson Valley conditions. Field trials show that the addition of copperas to lime-sulfur did not lessen the amount of injury under these conditions. Lime-sulfur and dry-mix (half and half) was effective and was decidedly less injurious than the lime-sulfur or lime-sulfur and copperas sprays. The milder treatment, such as dry-mix and Cal-Mo-Sul, caused no injury.

The amount of injury caused by the various treatments varied with the location and condition of the trees, the method of spraying, and the amount of spray applied. Altho lime-sulfur caused rather severe foliage injury, it was apparent that this was decidedly less intensified on the trees which had been well grown and were in

a vigorous condition. The method of spraying caused more injury than any other one factor.

WORK OF THE SEED TESTING LABORATORY

Official seed testing.—During the year, 264 officially collected samples of field seeds were received from the Commissioner of Agriculture and Markets. Technical analyses of these samples were made and reported to the Commissioner, who administers the seed law. These samples represented lots of seed offered upon the open markets and about which more information was needed before the stocks could be considered as adequately labeled or described, according to the interpretation of the seed law. The results of this analytical work are published by the Commissioner.

In general, it is quite evident that the seed law is being complied with in a satisfactory manner by the larger seedhouses and the professional seed growers, and also by some of the smaller dealers, but that there are some local dealers and elevator men who apparently have made no serious attempt to label their seed offerings properly. This inspection has not been comprehensive enough to cover farmer to farmer sales and in this connection it would seem that each buyer must look out for himself to a certain extent, taking advantage of the protection afforded by the seed law, and in every instance act as his own "seed inspector."

Vegetable seed packets.—In addition to the above-mentioned officially collected field seed samples there were received from the Commissioner of Agriculture and Markets 773 sealed paper packets or small purchases from bulk garden seeds. Tests of these goods show that during the past 3 or 4 years there has been a great improvement in the quality of vegetable seeds offered in this State. This improvement has come about thru the effect of publicity concerning the offerings of some of the more unreliable "commission-box" merchants. This work must be continued until every dealer who places commission-box packets upon sale knows upon whom he can depend for a uniformly good quality of dependable garden seeds.

Routine or service work.—During the year, 2304 samples of seed, representing many kinds, were received for the regular routine analyses. These analyses were desired in order that the buyer, the

grower, or the dealer might know the quality of the seed stock in qustion. Also, many analyses were made so that the seed stock might be properly labeled to comply with the law. There is an ever-increasing interest in the matter of known varieties, freedom from disease, extent of scarification, and possible origin of seed stock. These demands are becoming more exacting as farmers face the serious problem of making any crop a profitable one.

In addition to the regular routine analyses, more than 100 detailed analyses were made in connection with carrying on the official referee work of the International and the North American Seed Testing Associations. Also, check tests were made upon several large shipments of seed consigned to some point within this State. Several purely investigational analyses were made upon interstate shipments of seed and upon mail-order deliveries of out-of-state mail order seed houses.

Effect of hot-water treatment on cabbage seed.—In cooperation with cabbage growers, some 300 separate lots of cabbage seed representing several hundred pounds were tested for germination both before and after hot-water treatment. This was done in order to ascertain the amount of possible injury to the stock by the proposed hot-water treatment for disease control. The results of these tests show that many lots of seed are in no way injured by the treatment and that only an occasional lot is materially injured by the treatment.

Seed-borne diseases.—Combined germination and disease tests were made upon 2,304 samples of peas, beans, and sweet corn. Seed growers who supply the canning crops growers with their special seed stocks are most concerned with these practical disease tests. Many canners will not supply seed stocks to their growers upon contract until such seeds have been shown to be free from certain diseases which affect quality and yield.

Seed studies.—The large volume and variety of seed material received has presented an excellent opportunity for study along several practical lines. One of these has been a study of the method of testing and measuring the vitality of seed stocks which were injured during maturity at the time of the prolonged drought of last season. Alfalfa, peas, beans, and corn appeared to be most

noticeably affected. In many cases it was necessary to test the seeds in soil in order to establish the probable plant-producing ability of the stock.

Lawn grass seeds.—As more knowledge is gained of the relative usefulness of certain turf grasses for lawn making and as new strains are developed, there is greater need for vigilance in securing the desired sorts. Park commissions, golf greens committees, and certain State institutions are using the seed testing laboratory to a much greater extent than formerly as a means of checking upon their rather large purchases of these special grass seeds. It has been necessary to make special laboratory studies of some of the new strains in order that they may be identified with a fair degree of certainty. Plantings made of special mixtures as used by the trade showed that the so-called "domestic" ryegrass as known in the trade does carry perennial forms which apparently over-winter; also, that the imported perennial ryegrass sometimes contains strains which are very hardy and persistent and will not die out as is expected by the lawn owner. The presence of these persistent clumps of ryegrass become bothersome to the lawn owner who wants a pure turf of some particular grass or grasses.

Field trials or trial-ground plantings.—Samples of seed corn collected upon the open market, as well as some of the sealed paper packets of vegetable seeds, were again planted in the field and grown to maturity. The results of the corn trials showed that many of the descriptive names used for varieties were apparently meaningless and often very confusing if not misleading. There is still some evident substitution of unknown varieties for some of the more popular and high-yielding sorts of ensilage corn. Some of the lots of western-grown corn proved much too late in maturing to be suitable for this section of the State. This type of field work has proved to be one of the most valuable phases of the seed inspection and control work. The trial grounds were also utilized to grow to maturity a few of the special lots of vegetable seeds which were suspected of being untrue to variety name and description. There was found to be substitution of varieties in a few instances.

Division of Chemistry

ANALYSIS OF THE SIMPLEST CASEIN

Following studies on the molecular weight of the three proteins found in casein and serological studies on their further differentiation from one another, we have determined the content of certain of the amino-acids, sulfur, and phosphorus in the simplest of these three proteins. These results not only show the amount of each of the essential dietary constituents present in the protein, but also permit us to arrive at the weight of the protein molecule by a method entirely independent of the centrifugal method which we have employed before. The results obtained by the two independent methods agree very well with each other.

CHEMICAL REACTIONS OF CERTAIN SPRAY MATERIALS

The chemistry of the reactions between acid lead arsenate and calcium and magnesium hydrates and carbonates has been studied. Both calcium and magnesium hydrate used in sufficient quantity suppress the formation of soluble arsenic, while small amounts of these hydrates increase the amount of soluble arsenic formed. Calcium and magnesium carbonates react with lead arsenate to form large quantities of soluble arsenic. Magnesium carbonates produce more soluble arsenic than calcium carbonates. Hydrates high in calcium content are superior to hydrates high in magnesium content for the suppression of soluble arsenic in lead arsenate sprays.

Studies have been made on the rate of carbonation of hydrated lime when exposed to varying conditions of temperature and humidity. It has been found that complete carbonation may take place in a few hours or it may take days, depending on conditions of temperature and humidity. High humidities and high temperature increase the rate of carbonation, humidity being the more important factor. The data now available give more accurate information as to the value of hydrates in our spray schedule and the part they may be expected to play in crop pest control.

CHEMICAL STUDIES ON CANNERY PEAS

During the past year the research work on the chemistry of cannery peas progressed considerably further. An effort is being made to devise mechanical tests for fresh peas by which the quality of the canned product may be predicted. A crushing tester has been

devised which gives measurements of the hardness of fresh peas that may forecast their toughness after canning. The use of the crushing tester gives promise of enabling the canner to determine when fields should be harvested in order to obtain the maximum of both quality and quantity and a canned product that will be above the standard for toughness as specified under the McNary-Mapes Law which went into effect during the current year.

Other studies were made to determine the differences in the organic and inorganic constituents of peas brought about by differences in fertilizer treatments, in time of harvesting, in variety, and in the detrimental changes caused by enzymes after shelling and before canning. Records of crushing tests, puncture tests, and quality after canning were taken and compared with these analyses. These data have been used in the development of a "quality index" to give numerical figures representing the stage of maturity and the quality of peas.

In these experiments efforts have been made to determine the chemical constituent of peas that is chiefly responsible for the toughness. These studies are still incomplete and are being actively prosecuted.

CLARIFICATION OF FRUIT JUICES

A study was begun of the pectic constituents of fruit juices. This resulted in the development of a new method for the clarification of cider and grape juice. In this method the pectic substances of the juices are decomposed by an enzyme which results in the precipitation of the bulk of the suspended material and leaves a clear supernatant juice. This enzyme decomposes the solutions of commercial pectins as well. The precipitate formed has been found to contain some acid-hydrolyzable higher carbohydrate and some material similar in its properties to the lignic acid obtained by others by the acid decomposition of pectin. The weight of the purified precipitate amounts to about 3 per cent of the weight of the original pectin. In the case of grape juice about two-thirds of the pectin is decomposed by the enzyme and the major part of the decomposition products of the pectin remain dissolved in the grape juice.

CHEMICAL STUDIES ON GRAPE JUICE

Further study has shown that the quantity of dissolved pectin in grape juice gradually decreased during several months of stor-

age. In a storage period of more than a year nearly eight-tenths of the dissolved pectin disappeared before the grape juice became as clear as immediately after the enzymic clarification. It has been found that the uronic acids which constitute the nucleus of the pectin are still present in the grape juice, but are no longer combined in such a way as to be recognizable as a pectin compound.

A study of the tartrates of grape juice has shown that potassium and tartaric acid are present from the beginning in the requisite quantities for forming the insoluble potassium acid tartrate.

COLOR DEVELOPMENT OF APPLES

Experiments have been carried on to determine the quality of light essential to proper color development of McIntosh apples. Apples showing but a trace of red or those unevenly colored were, upon exposure to sunlight for 2 to 3 days, changed to full red color. By the use of standard light filters the color of the light causing the change was determined. The results of these experiments indicate that the wave lengths of light most influential in color formation lie between 3,600 and 4,500 angstrom units. This is between the visible range and the ultra violet. Whether or not it may be possible or practical to improve the color of apples artificially remains to be determined by future investigations.

EFFECTS OF SALTS ON PROTEINS

Continuing the studies on the effect of salts on the optical activity of gelatin, we have concluded the series with respect to potassium salts. Our experiments have confirmed and extended our conclusions published 4 years ago relative to the effect of salts on the constitution of proteins and have indicated that the seat of this change in constitution is probably in the "zwitter-ion" portion of the protein molecule. Contrary to the conclusions of Loeb, the salts arrange themselves as to this effect in the usual Hofmeister series.

FERTILIZER AND FEEDING STUFFS INSPECTION

During 1930 there were received for analyses 768 samples of fertilizers and 2,137 samples of feeding stuffs. Of the total number of complete fertilizers analyzed, 47 per cent were nearly equal to or were above the guaranteed analyses in all constituents. Of the remaining 53 per cent which showed a deficiency, 38 per cent were

deficient in one constituent, 12 per cent in two constituents, and 3 per cent in all three constituents.

The general quality of feeding stuffs sold in the State compares favorably with those sold in other states. About 5 in every 100 samples are materially deficient in protein and fat. The percentage of samples misbranded and not licensed is also about 5 per cent.

The trend in types of feeds is towards practical applications of the results of investigations in animal nutrition with reference to special purpose feeds.

The results of analyses covering the inspection of fertilizers and feeding stuffs are published in bulletins of the Department of Agriculture and Markets. Two bulletins are published covering the feeding stuffs inspection, the first covering the period of January 1 to June 30 and the second covering the period of July 1 to December 31. Bulletins are also published covering analyses of commercial fertilizers and also a separate bulletin covering analyses of agricultural liming materials. A bulletin was compiled by the Inspection Laboratory during the past winter and published by the Station showing the composition and cost of commercial fertilizers in New York from 1913 to 1930.

INSPECTION OF INSECTICIDES AND FUNGICIDES

In 1930, 152 official samples of insecticides and fungicides were received from the Department of Agriculture and Markets. In order to determine the percentage amounts of the many ingredients present in these samples, 287 chemical determinations were made. Of the 19 deficiencies found, only 5 or 6 were of such extent as to be of material importance. Several preparations were found to contain excessive amounts of soluble arsenic. Many new preparations are placed on the market each year and should receive special attention to ascertain their value as insecticides and fungicides. Those interested in a more detailed report of this inspection work should direct a request to the Department of Agriculture and Markets at Albany.

PECTIN FROM STORED APPLE POMACE

Study was made of the pectic constituents of stored dry apple pomace. Storage with a moisture content as low as 7.5 per cent

decreased the amount of acid hydrolyzable pectin (protopectin) and resulted in a lower yield and quality of pectin. This decrease in the pectin content of apple pomace was neither the result of enzymatic reaction nor mold contamination.

QUALITY OF PUMPKIN AND SQUASH AS RELATED TO CHEMICAL COMPOSITION

The composition of 4 varieties of squashes and 12 of pumpkins was determined before and after canning, the constituents determined being moisture, protein and non-protein nitrogen, reducing and total sugar, starch, soluble and insoluble solids, and crude fiber. Differences in composition between varieties were very striking and appeared to be sufficient to explain the differences in the canned products which have been ascribed by others to effects of differences in climate, soil, and cannery operations. Certain of the varieties of squashes were characterized by comparatively high amounts of dry matter, due largely to high starch content, and these varieties gave canned products of a thicker consistency. The consistency of other varieties appeared to be related to the total dry matter. High starch content was generally correlated with high total solids and high insoluble matter.

A study of the chemical changes during ripening and storage of one variety of pumpkin and three of squashes has been completed for the past growing season. The greatest changes were found to be the increase in weight and the proportion of dry matter to the total weight. The relative amounts of the different chemical constituents remain fixed to an unexpected degree. In view of these facts, the relative importance of harvest dates may be expected to be small. Analyses have also been made of cannery wastes to determine the losses in soluble material during processing. An attempt to develop a mechanical tester for indicating the stage of ripeness seemed to indicate that the toughness of the shell simply increases without passing thru a maximum. The mechanical tester, therefore, is of little practical value.

SPRAY RESIDUE ON FRUIT

During the past year about 100 samples of apples and 20 samples of cherries from commercial sprayed orchards in the State were analyzed for spray residue. Due in part to the unusual drought conditions that prevailed thruout the summer, the amount of resi-

due found was in excess of that for the two preceding years. The purpose of making these analyses was to inform the growers of the condition of their fruit with respect to the quantity of residue in order that they might take such steps as seemed necessary in preparing the fruit for market so that it would be practically free from all adhering residues.

Experiments in cleaning fruit by chemical and mechanical methods were carried on last fall in cooperation with the Division of Entomology. Washing machines using dilute hydrochloric acid as a washing solution were found to be very efficient in removing arsenical residues. In all cases the arsenic content of residues was reduced to a very small quantity, well within the limits of the international tolerance for arsenic on fruits. Generally speaking, commercial dry cleaners were found to be less effective in removing light residues, altho they markedly improve the appearance of the fruit. Further work will be carried on this year and will be included in a more detailed publication on this subject.

Division of Dairying

DAIRY HERD MANAGEMENT

A few years ago attention was called in the Annual Report to the endeavor to use proved sires in the development of the Station herd. It is difficult to purchase proved sires at a nominal cost so most stress has been laid upon careful selection from the standpoint of breeding and long-continued use after the sire's value has been established. At the present time two sires, 8 and 9 years of age, head the Station herd of Jerseys and their continued use over a period of years has resulted in a gradual increase in total production per cow. At the present time the herd produces approximately 400 pounds of fat per cow per year on the basis of all cows in the barn irrespective of the length of the lactation period.

BASIC VISCOSITY OF ICE CREAM MIXES

Considerable importance has been given recently to the so-called basic viscosity of an ice cream mix as having special significance in indicating its whipping properties and the body and texture of the finished ice cream. Basic viscosity is the minimum viscosity which could be secured under certain conditions of whipping in the absence

of air. Studies on this problem have already indicated that basic viscosity, as it is now determined, is not a constant, altho it varies to a lesser degree than the so-called apparent, maximum, or false viscosity. This abnormally high viscosity which is destroyed by whipping is due primarily to the aggregation of the fat globules and a true minimum basic viscosity can be secured only in case all clusters of fat are broken up. No method for doing this is yet available so that too much importance cannot be given to basic viscosity.

AGING ICE CREAM MIXES

The fact that most of the important properties given to an ice cream mix thru aging are secured in 2 or 4 hours at a temperature of 35° to 40° was given in last year's Annual Report. These findings have been subjected to a series of tests organized and sponsored thru the International Ice Cream Association. It has been found that in practically all instances these short aging periods have been entirely satisfactory in plant practice.

VISCOSITY OF CREAM

A number of years ago an investigation on the viscosity of cream was completed in which it was shown that the aggregation of the fat globules was of most importance in varying the apparent viscosity or thickness of the cream of uniform fat content. There have been numerous unsuccessful endeavors made in experiment stations and in laboratories in milk plants to adapt these findings to milk plant practice. Since the first work on viscosity was done at this Station, various experiments have been conducted to adapt some procedure for affecting the clumping of fat globules to milk plant practice. Thus far it has been possible to increase materially the viscosity of cream by certain plant processes, but it has been practically impossible to control sufficiently the extent of the increase in viscosity. For this reason it is undesirable at this time to give the procedure for increasing viscosity, because it would cause much confusion to publish an imperfect method. In this connection it should be stated that there is no desire to make market cream appear richer than it actually is, but there can be no reason for requiring that cream should appear to disadvantage. Raw cream as it was produced many years ago was much heavier and apparently richer than present day market cream due primarily to

requirements of pasteurization which force milk plants to destroy most of the apparent richness of cream which is secured thru fat clumping. This investigation is planned to restore that viscosity which pasteurization has destroyed.

MILK STRAINERS FOR USE ON THE FARM

The results of the study of milk strainers for use on the farm have been published in Bulletin No. 585, but the investigation has not been discontinued due to the large number and variety of strainers which are being forwarded to this Station for trial and for comments concerning improvements in design. The report given in the bulletin shows that single-service cloth strainers employing material of the approximate consistency of a heavy outing flannel have greater capacity but remove less visible sediment from milk than do cotton pads. Most strainers using cotton pads have had too little capacity, but in the past year considerable improvement has been made in the capacity of cotton pads by their manufacturers. It is essential, however, in securing capacity with cotton or with cloth to support the cotton with some device which occupies as little space as possible. Wire grids or wire supports of various designs are most satisfactory, but care should be used in their selection to secure one which can be washed fairly easily. It was also recommended that the foot of the strainer should be as large as possible and still fit into the neck of the can to give ample capacity. The capacity of the strainer is also greatly affected by the temperature of the milk at the time of straining. Generally, there will be no difficulty with capacity during the summer months, but a strainer which has ample capacity in the summer time may not have sufficient capacity in the winter, particularly when rich milk is being strained.

COOLING MILK IN INSULATED TANKS

The investigation of the practicability of electric refrigerators for use on the dairy farm, which was reported in Bulletin No. 581, has been considerably extended. The experiments using natural or artificial ice in place of an electric refrigerator have clearly demonstrated that ice in a water tank insulated with 2 or 3 inches of compressed cork or its equivalent did much better cooling than one would expect from reports in the literature or from results secured

in practice. Ice will maintain a temperature of 35° to 40° and will cool milk with sufficient rapidity to make it unnecessary to stir it in the cans. In case grade A raw milk is being produced and it is essential to secure a temperature of 50° or less within 1 hour, it has been shown that the rapid agitation of the water in the tank, beginning at the time that the first can is placed in the tank and ending 1 hour after the last can has been placed in the tank, will cool all of the milk to 50° or less within 1 hour after milking, even tho the milk in the can is not stirred. It is probably a more desirable practice to stir the water in an insulated tank than it is to stir the milk in the cans within the tank, since the former procedure can introduce no contamination and will give sufficiently rapid cooling.

PASTEURIZATION OF MILK AT HIGH TEMPERATURES

The re-introduction of the pasteurization of milk by the electrical procedure has again brought attention to the pasteurization of milk at higher temperatures than are generally employed, using steam or hot water as the heating medium. An investigation has been completed and will soon be published showing the relationship of the time at which milk can be held at any given temperature to the creaming ability of the milk. It has been found that 160° or 162° F is the maximum temperature that can be safely employed without impairing the creaming ability of the milk. The time that milk can be held at these high temperatures is only 20 or 30 seconds which makes it evident that all machinery used in this process must be working very efficiently or irregular results will be secured. There is a possibility of using a lower temperature for a longer period of time, such as 155° for 1 minute. A high temperature for a short period of time makes it possible to adapt the pasteurization of milk to continuous operation within a plant to better advantage than the present pasteurization at 142° for 30 minutes which is so generally employed.

PASTEURIZATION AND COOLING OF MILK IN THE VAT

It has been recognized for years that milk can be satisfactorily heated in the vat, but the cooling is so slow or the agitation is so severe that the cream layer volumes are much reduced when the pasteurized milk is cooled in the vat. As a result of our experiments previously published as a Station bulletin, it was recognized

that the speed of cooling was of greatest importance and the agitation of the milk of minor consideration. A manufacturer of dairy equipment designed a vat pasteurizer to employ the principle of extremely rapid heating and cooling of milk with vigorous agitation and the pasteurizer of another manufacturer was altered at this station to employ the same principles.

It was found that by employing low brine temperatures, such as 10° or 15° F for cooling the milk in the vat after the temperature had first been reduced to 90° or 100° by cold water, it was possible to cool milk entirely in the vat without a decrease in its creaming ability. The rapid agitation apparently did not affect the creaming of the milk and cooling surfaces made it possible to pasteurize, hold, and cool the milk within a period of approximately 1 hour. As a matter of fact, if the cooling of the milk at 40° F was not accomplished within 20 minutes, the creaming of the milk was partially impaired. A pasteurizer of this type has special application to small dairies or milk plants for it reduces the total amount of equipment.

THE RELATION OF SOLUBILITY OF DRY MILK TO ITS UTILIZATION IN CREAM CHEESE AND ICE CREAM

The conclusions of this study have been reported in Technical Bulletin No. 174 of this Station. It was shown that solubility is not of great significance in determining the value of dry milk or milk powder for use in ice cream or cream cheese. It has always been assumed that the texture and body of ice cream were influenced unfavorably by decreased solubility of the serum solids, particularly the proteins, but this study has shown there is not much relationship between solubility of dry milk and the body and texture of ice cream. It should be recognized that decreased solubility of dry milk is generally associated with poor flavor and the flavor of dry milk is of great importance in the manufacture of ice cream and cream cheese. For this reason it is difficult to secure dry milk of good flavor which is relatively insoluble, but some samples of dry milk which were relatively insoluble and which had a good flavor were secured for this study. They could be utilized in the manufacture of ice cream equally as well as dry skimmilk which was completely soluble and which was of good flavor.

INSPECTION OF BABCOCK AND BACTERIOLOGICAL GLASSWARE

The Station has continued, in accordance with State laws, the testing of all Babcock and bacteriological glassware used in the State for determining the fat content or the bacterial count of milk or cream wherever such tests affect the price paid to farmers for milk or cream. It is of interest that the total quantity of glassware received during the past year was not as great as in recent years, but that the percentage of inaccurate glassware has been materially reduced. This is particularly true in the case of bacteriological glassware which in former years has always shown a much higher degree of inaccuracy than Babcock glassware. Rejections of glassware of all types during the past year have been extremely small. The fact that during the first year that bacteriological glassware was inspected more than 10 per cent of all glassware received was rejected and during the past year less than 0.1

SUMMARY OF ALL GLASSWARE TESTED FROM JUNE 1, 1930, TO JUNE 30, 1931.

TYPE OF GLASSWARE	NUMBER OF PIECES RECEIVED	NUMBER OF PIECES INACCURATE	NUMBER OF PIECES BROKEN
Babcock:			
Milk bottles, 8 per cent	25,576	37	86
Cream bottles, 50 per cent, 9-gram, 6-inch	3,993	2	8
Cream bottles, 50 per cent, 9-gram, 9-inch	313	...	1
Cream bottles, 50 per cent, 18-gram, 9-inch	24	...	...
Pipettes, plain 17.6 cc	6,142	225	94
Miscellaneous, not marked S. B.	9	...	...
Total Babcock	36,057	264	189
Gerber:			
Milk bottles (butyrometers)	348	...	...
Milk pipettes, 11 cc	85	...	...
Milk Syringes	4	...	...
Total Gerber	437	...	...
Bacteriological:			
Pipettes, 1.0 cc	22,837	16	42
Pipettes, 0.01 cc	222	...	...
Total bacteriological	23,059	16	42
Total glassware, all kinds	59,553	280	231

per cent of all glassware received was rejected indicates that the routine inspection of this glassware has had a marked effect in increasing the accuracy of the glassware used in milk testing laboratories of this State.

Division of Entomology

APPLE INSECTS

The codling moth.—The unusual season of 1930 proved to be especially favorable for the development of the codling moth, with the result that damage to the apple crop from wormy and stung fruit was higher than usual.

The variation from year to year in the time of appearance of the first brood and the wide fluctuations in the size of the second generation emphasize the necessity of a clear understanding of the seasonal activities of the insect as a basis for the proper timing of the summer sprays. To insure accurate information for the apple industry in western New York, emergence cages and bait traps are located at pivotal points thruout the fruit belt, from which centers seasonal indications are transmitted to growers thru the Farm Bureau Spray Service.

The work with new insectitudes has been continued, and of the materials tested for the control of the second generation certain oils gave promising results. The principal objection to these sprays is that it is necessary to sacrifice protection against certain plant diseases notably apple scab, since a combination of sulfur and an oil or an application of oil to foliage recently treated with sulfur may cause much harm. Summer oils when used alone have not proved equal in effectiveness to arsenate of lead. However, they may prove of value as a substitute for the last summer application of an arsenical, since they do not increase the arsenical deposit on the fruit and they are effective for a time as ovicides. The addition of nicotine sulfate increases the efficiency of an oil spray and the combination of lead arsenate and oil makes an effective treatment against the codling moth. The field of usefulness of this combination remains to be determined, in view of the fact that the omission of a fungicide complicates the spray program with respect to apple scab; while the employment of an oil in late summer applications may render wiping or

washing to remove spray residues more difficult, especially if the fruit is stored before cleaning. It has been practically impossible to wash fruit so treated satisfactorily after it has been in storage for a few months. Repeated tests have shown that when more than two applications of summer oil are made there is considerable danger of russeting of apples.

Many orchards in western New York consist of very large and old trees in the neighborhood of 100 years or even older. In such plantings spraying is a much more difficult task than in orchards 20 or 30 years of age, and likewise a high degree of control of certain pests can only be secured by a large outlay for materials and labor. For this reason it has been necessary to give some consideration to orchard practices in general. Proper thinning out of surplus branches in addition to lowering the tops that are beyond the range of the spray-gun not only makes for better insect control but also renders possible a considerable economy in spraying. Larger dosages per tree and more rapid and thoro spraying, made posssible with higher pressure and spray machines of larger capacity, are now becoming the practices of the more successful growers.

The leafroller.—Each year there are a considerable number of orchards in which the fruit tree leafroller (*Archips argyrospila* Walk.) is considered as a major pest. The dormant oil sprays constitute the principal method of control in severely infested plantings. However, when for any reason the oil is not applied, heavy dosages of poison during the pre-blossom period afford a degree of protection. Observations over a period of years have shown that too much dependence should not be placed on the arsenical sprays since during those seasons when growth is rapid and rainy periods are frequent it is practically impossible to keep the trees sufficiently protected to secure noticeable benefit. Efforts are being continued to develop better control measures. Not all oil sprays have been found equally efficient, and the various tar washes, after three years of trial, have proved to be of little value for this species.

The red-banded leafroller (*Eulia velutinana* Walk.) is on the increase and the late summer feeding of the larvae on the fruit is noticeable in many orchards. The blemishes appear as shallow feeding areas of varying size and shape and are found at the calyx, or stem end, or on the side of the apple. Recent experiments relative

to control have shown that applications of arsenicals for the codling moth are valuable in reducing this type of injury. The life history of the species, with special reference to the number of broods in this section, is now under investigation.

The bud moth.—The bud moth continues to be a problem for many fruit growers, and those who have had experience with this insect do not hesitate to say that it is one of the most difficult to control. In general, studies have shown that the bud moth is most susceptible to applications of nicotine early in the season just as the buds are breaking and to treatments with arsenate of lead at the period when the eggs are hatching during midsummer. Growers who follow these methods are securing a high degree of protection.

The rosy aphis.—Major attention has been given to the tar washes as ovicides for apple aphids during the past season. This is the second year that they have been tested and, so far as these pests are concerned, they have proved very effective, altho injury in some instances was caused to fruit buds. Attention has also been given to fall spraying to destroy the egg-laying generation on apple trees. One year's experiments have indicated that noticeable benefit may be derived from such treatment provided the applications are made with reference to the appearance of the aphids on the apple trees in the fall. Defoliation experiments to prevent egg-laying have not been especially successful.

The leafhoppers.—The collection and classification of leafhoppers from orchards in western New York have shown that injury is largely the work of two species, *Typhlocyba pomaria* McAtee and *Empoasca fabae* Harris. *Empoasca maligna* Walsh is also common, but the injury is usually unimportant.

T. pomaria is responsible for most of the stippled leaves and speckled fruit, while *E. fabae* is found on the terminal growth where it curls and distorts the foliage. The latter species is usually more important on nursery stock and is capable of damaging severely whole blocks of young trees by injuring the growing tips.

Methods of control which have given most promise are those directed against the immature forms. The nymphs of *T. pomaria* are practically all hatched by the calyx period and are easily killed at that time with a nicotine spray. Dormant treatments with 6 per cent lubricating oil emulsions and tar washes in an attempt

to kill the overwintering eggs proved ineffective. No system of treatment has been found satisfactory which is aimed at the destruction of the adults.

The nymphs of *E. fabae* were readily killed with contact insecticides such as nicotine and pyrethrum sprays applied before the leaves curled. However, of the sprays tested, the most striking results were obtained with bordeaux mixture. The nymphs were killed, even in the curled leaves, when the foliage was coated with this material.

The cranberry rootworm.—A number of apple orchards, most of which are located in Wayne County and not far from Lake Ontario, have suffered considerable damage from attacks of the cranberry rootworm beetle (*Rhabdopterus picipes* Oliv.) This species altho primarily a pest of the cranberry, constitutes an addition to the list of insects that attack the apple. The injury consists of irregular shallow feeding scars on the surface of the fruit which so damage the crop as to render it unmarketable, except for canning purposes or for the production of cider or vinegar. The life history and habits of the insect have been worked out, and tests during the past two years have shown that lead arsenate sprays, if properly timed, afford a high degree of protection. The beetles occur in the orchards during the latter part of June and early July, and the control depends upon keeping both fruit and foliage protected with the arsenical during that period.

RESPONSES OF VARIOUS ORCHARD INSECTS TO LIGHT

In connection with the work on the reactions of the bud moth (*E. ocellana*), fruit tree leafroller (*A. argyrospila*), and codling moth (*C. pomonella*) to light, it was found that in an orchard under natural conditions thousands of bud moths and leafrollers, but comparatively few codling moths, were attracted to lights at night. An intensive study of the physiology and histology of the eyes of the codling moth and the relation between various conditions of the eyes and the daily and nightly activity of the moths was therefore undertaken. It was found that the diurnal and nocturnal conditions of the eye are clearly differentiated by the position of the distal pigment granules, which move in and out under the influence of changing light intensity. The codling moth was found to be most active dur-

ing the periods of morning and evening twilight. It is during these times that the distal pigment is in the process of migration from one position to the other. It was discovered in the laboratory work that codling moths respond to the light stimulus most quickly and most certainly after they have been completely dark adapted. Since in the natural state they do not become dark adapted until sundown and are not attracted to lights until after it is dark, it is indicated that at least a partial dark adaptation is necessary before a definite response to artificial light takes place.

It has been found that, altho the moths are flying at twilight, if the temperature falls below 60° by the time darkness has fallen the flight in response to the stimulus of light is very definitely inhibited. In other words, the influence of the ordinary 75-watt electric light bulb is not strong enough to counteract the tendency of moths to remain quiet during periods of low temperature. Efforts are now being made, therefore, to determine whether or not bulbs with a greater ultra-violet production and transmission will attract the moths at times, when, because of light or temperature conditions, they would normally be quiet. Other experiments are being tried in which mechanical and chemical forms of stimulation are applied in order to arouse the moths and cause them to be aware of the lights.

CANNING CROP INSECTS

Of the insect pests that have a direct bearing on the production or quality of canning crops in New York, the following in particular have demanded attention during the past season: The carrot rust fly, the raspberry fruit worm, the cherry fruit fly, the cabbage maggot, and the seed corn maggot.

The carrot rust fly.—In addition to the cultural operations already worked out for combating the carrot rust fly, efforts during the past season have been directed chiefly toward lengthening the maggot-free growing season of the crop by means of insecticide applications. Of the various materials that have been under investigation with this object in mind, crude naphthalene proved to be the most promising. When applications of this material were properly timed with regard to the activites of the insect, by means of special emergence cages, it proved to be surprisingly effective in protecting the crop from damage.

It was found that by the use of this material the growing season of the main crop of carrots could be extended from one to two months, which in some cases resulted in almost doubling the yield of clean carrots.

The raspberry fruit worm.—In regard to the raspberry fruit worm it has been found that this pest can be largely held in check by the use of properly timed arsenical sprays. It is difficult, however, to eliminate the insect entirely from a planting by this means or to reduce the infestation to a point where the fruit will always meet the high standards demanded by the canning industry. The results so far secured are encouraging, however, and indicate that by consistent spraying or dusting at the proper time the insect can be held to a point where it will no longer be the serious menace that it has been in the past.

Methods for effectively combating the cherry fruit fly by the use of arsenical sprays have been well standardized and leave little to be desired so far as control is concerned.

Efforts during the past season have had to do chiefly with establishing the smallest dosage of such arsenicals that can be counted on to control the insect, with the object of reducing to a minimum any possible residue on the fruit at harvesting time.

Orchard experiments have shown that under ordinary conditions the amount of arsenic regularly used in the fruit fly sprays can be greatly reduced without seriously affecting the degree of control. When it is important to guard against the possible presence of spray residue on the mature fruit, the logical procedure is to use the more concentrated sprays for the first fruit fly application and to reduce the dosage later in the season when the normal removal by weathering will be much less pronounced than while the fruit is growing rapidly.

The cabbage maggot.—The cabbage maggot is of importance in the production of kraut cabbage chiefly as a seedbed pest. In the main cabbage-growing sections of the State, where millions of seedlings are regularly produced, the cabbage maggot frequently causes tremendous losses.

While a number of effective methods for protecting cabbage seedbeds from the maggot are already in use, there is a field for the development of a simpler, more economical means of control. In

view of the encouraging results secured with naphthalene in carrot rust fly control, an attempt was made to adapt this material to the cabbage seedbed for maggot control. It was found that maggot injury to the seedlings could be greatly reduced where naphthalene was used, from three to five applications ordinarily giving a marked degree of control. The control in all cases was not perfect, however, and further work will be needed before the place of naphthalene in seedbed work can be finally determined.

The seed corn maggot.—The seed corn maggot periodically causes serious losses in plantings of corn, beans, peas, and cucumbers that are grown for canning. Extensive tests have been carried out with various seed and soil treatments to prevent injury by this pest. While some of these tests are suggestive, the work has not progressed far enough to warrant any final conclusion being drawn from the results.

INSECTS OF NURSERY AND ORNAMENTAL PLANTS

This phase of the work deals primarily with investigations of insects which attack evergreens and ornamental plants under nursery conditions. The purpose of this study is to devise satisfactory control measures for the various pests. Urgent needs of the nursery industry are information relative to identity and habits of the more destructive species and definite systems of treatment for the different host plants such as prevail in the fruit and vegetable industry.

The spruce gall aphid continues to be one of the important nursery insect problems. In some instances where infested trees have been allowed to grow without special treatment over a period of years a large proportion of such trees are rendered worthless by this insect. For example, in a block of 45,000 Norway spruce 3 to 5 feet in height, 2,000 trees were cut and destroyed during the past season. This means a loss of at least two thousand dollars to the nurseryman. Continued experiments for the control of this insect indicate that, altho early spring applications of miscible oils and lubricating oil emulsions have insured good control, in a number of instances they have been attended by injury to the trees. The damage varied directly with the type of material used and the concentration employed. Applications of lime-sulfur or nicotine and

soap continue to show good control without any noticeable deleterious effect upon the trees. Further work is necessary to determine more fully the relative merits of these materials from the standpoint of safety, economy, and efficiency.

The black vine-weevil (*Brachyrhinus sulcatus*) and the strawberry root-weevil (*Brachyrhinus ovatus*) have occurred in injurious numbers in several localities as nursery pests. They have been particularly destructive to such plants as spiraea, yew, and hemlock. Injury from these root weevils has reduced the sale of these plants from certain areas. Serious loss has also been incurred both in nursery shade houses and in the field. Studies are now under way to work out the life history and satisfactory control measures for these species.

PEAR INSECTS

Investigations of insect enemies of the pear have centered around three species of considerable importance to pear growers, namely, the pear psylla (*Psyllia pyricola*), the pear midge (*Contarinia pyrivora*), and the quince curculio (*Conotrachelus crataegi*).

The pear psylla.—In efforts to find an economic and efficient system of control of the pear psylla, it has been necessary to test a large number of materials under varying environmental conditions. Other phases of this investigation have also considered the chemical and physical properties of the materials involving studies of the toxicity to and penetration of insect and vegetable tissues. Also, the effects of such materials on the health of the trees are being noted.

The field tests fall under the following main divisions: Dormant oil treatments, cluster bud sprays, foliage applications, and quantitative studies of environmental complexes, including the relation of insects to the same. A portion of the investigations relative to oil sprays has been the continuation of tests that have been in progress for the past 5 years in which various types of lubricating oils, emulsified by means of bordeaux mixture, and a number of the more popular commercial brands of oil sprays have been applied as the buds were swelling. The results indicate that most of the treatments, when the material contained 3 per cent of lubricating oil, were very effective in controlling pear psylla during the spring

and early summer. Of the home-made emulsions, those containing an oil similar to the brand "Diamond Paraffine" were the safest and most economical. However, even these safer oils, when used at the rate of 3 per cent, produced injury under certain conditions if consecutive applications were continued for a period of years. Commercial brands also varied in their deleterious effects on trees.

Another series of experiments were made in which the oil content of the spray was reduced. The results indicate that very efficient control with less likelihood of injury to the trees can be secured by the use of 2 per cent of oil, emulsified by means of a weak bordeaux mixture, provided the trees are thoroly sprayed. Tests were also made in which various materials were dissolved in the oil, but such combinations seem to decrease the effectiveness of the oil spray. Tests of tar oil emulsions indicate that dormant spring applications of materials containing 4 per cent of tar oil control psylla effectively, but, as with certain oil sprays, the safety factor needs further consideration.

Cluster-bud applications of lime-sulfur, 1 to 8, and of lime-sulfur, 1 to 8, with the addition of 1 pint of nicotine sulfate to each 100 gallons of mixture were found to control psylla during the spring, the latter formula being somewhat more effective than the former.

As regards foliage sprays, one aim has been to find materials which are toxic to psylla, but so far none have proved as effective and economical as nicotine in bordeaux mixture (2-40-100). Another aim has been to determine the value of sprays containing reduced amounts of nicotine. When used with bordeaux mixture, ¼ pint of nicotine was found to be as effective against psylla as was 1 pint, thus effecting a considerable reduction in cost of treatment. Even ⅛ pint of nicotine in bordeaux appears to give fair commercial control. Incidentally, it may be mentioned that the infestation of pear psylla in an orchard is generally decidedly non-uniform. In order to overcome this heterogeneity of infestation in field tests the Latin square arrangement of plats has been used extensively.

Another phase of psylla investigation which may be termed *ecological control* has been in progress for several years. Orchards that are not too large and which are swept by north and northwest winds do not seem to be attractive to psylla. It is believed that

both wind velocity and temperature are important factors in producing this effect. These studies indicate that the cost of control can be greatly lessened by attention to the proper location of plantings, and, with respect to many orchards, modification of surroundings may assist materially in rendering the trees less susceptible to attack by the pest. In order to measure the effect of environmental conditions, a considerable mass of data is necessary. The foundation for further investigation is being laid by surveys of selected areas and the construction of accurate ecotopographic maps. On these maps are shown the topography of the land and the height and location of objects near the orchard which may serve as shelter, such as fences, buildings, trees, and other vegetation. With such maps the wind velocities, temperatures, and psylla movement and activity taken simultaneously thruout the area can be plotted and differences correlated with the extent of shelter.

The pear midge.—Altho pear midge is very common in the Hudson valley, there are only scattered areas of infestation in western New York. In field tests with insecticides, nicotine sprays have been found to be very effective against the adults. About equally good results were secured regardless of whether 1 pint of nicotine was added to any one of the following spray mixtures: Lime-sulfur, 1 to 11 or 1 to 40; bordeaux (2-10-100), summer oil emulsion, 2 per cent; or fish-oil soap, 3 pounds in 100 gallons of water. Proper timing of the applications is the most important point to be emphasized in pear midge control. The field tests seem to prove that treatment should be made at the true "cluster-bud" stage for Bartlett and Clapp Favorite varieties. Soil fumigation tests are in progress and the results are encouraging.

The quince curculio.—The quince curculio, when abundant, causes very serious losses in pear orchards. Fortunately for pear growers, its distribution is sporadic and serious attacks are generally desultory. Since the time when the adults emerge and oviposit in pears is quite erratic, a more detailed study of the seasonal history of the pest is in progress in order that there may be a reliable basis for timing spray applications. Results of field tests made in 1930 indicate that the curculio can be controlled by means of arsenate of lead, provided the applications are properly timed.

A pear leaf curling midge was discovered during June 1930 in

three neighboring localities in Ulster County. This insect appears to be *Cecidomyia pyri,* a species reported from England, but further study is necessary to determine the question of its correct specific position. Adults, puparia, and larvae have been found. The insect prefers to deposit its eggs on new terminal growth, the leaves of which are usually destroyed by the larvae. Since the young larvae upon hatching go into the folds of the leaves they secure a certain amount of protection from sprays and dusts. Treatment with a soap and nicotine spray did not appear to prove very toxic to the larvae.

INVESTIGATIONS OF TAR DISTILLATE SPRAYS

A comprehensive study of tar distillate sprays has been in progress for the past 3 years. The project involves not only the testing of a number of the leading brands on various fruit insects, but it also provides for the determination of the fractions that are most valuable from an insecticidal viewpoint. Since there appear to be fundamental differences between various coal tars and since their distillation fractions, even between the same temperature limits, may vary, it is desirable that the principal constituents be isolated and tested before attempts are made to standardize tar washes. At present most of the tar distillate emulsions or their ingredients are imported and the emulsifying agents consist of expensive ingredients which make the cost of the applications relatively high. Many of the products of American coal tar distillation are cheap, so tests of such materials are being made to ascertain their value for orchard treatment. Parallel with these efforts studies of cheaper emulsifying materials are being conducted. Extensive greenhouse and orchard tests with these materials are being conducted against apple aphids, apple red bugs, bud moth, leafrollers, European red mite, San Jose scale, apple leafhoppers, pear psylla, and spruce gall aphis.

Field trials were made at Geneva on apple, pear, and spruce; at Cayuga on apple, pear, and peach; and on apple at such fruit centers as Hall, Hilton, Kinderhook, Perry, Phelps, and Poughkeepsie.

All the dilutions given below refer to the actual tar oil content. On apples the concentrations were 4, 5, 6, 7.5, 8, and 10 per cent;

on pears 4, 5, and 6 per cent; on peach 4 per cent; and on spruce 0.8, 2.4, and 4 per cent (1, 3, and 5 per cent of emulsion). The results as regards efficiency on insects were excellent with all dilutions tested on apple aphid eggs, pear psylla eggs and adults, and on spruce gall aphis. Also, good control of bud moth at 8 per cent was secured. With apple red bugs the control was fair at the higher concentrations, but the efficiency, generally speaking, was not sufficiently high. On leafroller eggs the toxicity was low and no appreciable results were secured against apple leafhopper eggs.

Unfortunately, with several varieties of apples, severe bud injury occurred with concentrations of 8 and 10 per cent of certain tar oils.

Mixtures of lubricating oil emulsions and tar oil emulsions were tested on a limited number of apple trees in one Station orchard to determine their effects on the buds. Mixing the two classes of oils was an endeavor to find a dormant spray that would be effective on San Jose scale and on eggs of aphids, red bugs, and leafrollers. Several lubricating oil emulsions and several tar washes were mixed. Two concentrations were used, *viz.*, lubricating oil 8 per cent and tar oil 6.4 per cent (8 per cent of the emulsion); and lubricating oil 4 per cent and tar oil 4 per cent. The first concentration killed all the buds on every variety on which the test was made. The second concentration injured the first leaves and caused excessive retardation of the buds on most varieties receiving such treatment, and with certain sorts severe bud injury occurred. With present knowledge, therefore, it seems as tho such combinations are inadvisable under New York conditions.

THE EUROPEAN CORN BORER AND OTHER CORN INSECTS

From our surveys, as well as reports from county agents and canners, it appears that the general status of the European corn borer (*Pyrausta nubilalis* Hubn.) during the season of 1930 remained little changed from the situation the previous year. Decreases were noted in some counties in western New York and only slight increases in others. In the Mohawk and Hudson River Valleys marked decreases were everywhere in evidence. It seems probable that the abnormal lack of rainfall from July to the end of the summer acted unfavorably on the development of the insect. Cool evening temperatures during the first part of July in western

New York when the moths were in flight also contributed in reducing the normal increase of the insect by having an adverse influence on oviposition. The only increase of importance occurred in Oswego and Jefferson Counties where some loss was sustained by growers of sweet corn for the canning factory. On Long Island the corn borer situation is somewhat complicated by the fact that the insect is two-brooded in part of that area as compared with one annual brood in the upper part of the State. The seriousness of this situation is further enhanced by a heavy infestation of the corn ear worm which is causing the growers of sweet corn considerable losses. The corn ear worm was also a pest of prime importance in Chautauqua and Erie Counties in 1930. A light first brood in early sweet corn during the latter part of July increased to a large second brood in late corn during September. In many cases as high as 75 per cent of the ears were infested.

Corn borer investigations over the past 3 years have shown that cultural practices play an important part in the rate of infestation, particularly those practices having to do with the disposal of corn stalks by siloing and clean plowing. These practices put into effect on a community basis in the Eden Valley section in Erie County the past 3 years have kept the infestation at a level where the insect was of practically no importance. Delayed planting has also been shown to be a means of reducing the infestation. In areas where the earliness of the corn is not a factor and where the length of the growing season will permit, this is probably the simplest means of growing corn at least moderately free from injury. Some canners are practicing this means of corn borer control and they report that satisfactory results are being obtained. Insecticide investigations have been continued with materials which show promise of being effective against the insect. Fluosilicates appear toxic to the insect, but they have the disadvantage of being injurious to the corn plant. Summer oil emulsion combined with arsenate of lead seems to be the most satisfactory combination from the standpoint of effectiveness against the insect and safeness to the plant. This work is still in the experimental stage and before anything definite can be said it will be necessary to determine many details on the method of applying and the frequency and time of applications.

The corn borer work will be continued with the emphasis placed

on the effect of various cultural practices on the activities of the insect, especially the effect of the time of planting of various varieties of sweet corn on the rate of infestation. Seasonal life history studies are being made, special attention being given to the seasonal abundance of the insect as correlated with meteorological conditions from year to year.

In view of the fact that sweet corn is also subject to much injury in certain localities from the corn ear worm (*Heliothis obsoleta* Fab.), it has been necessary to consider the activities of this insect. Extensive life history and hibernation studies are being made on Long Island and in western New York to determine whether the infestation in this State is developed from individuals which have wintered over or whether it is due to a flight of moths from infested areas further south. Since satisfactory control measures are lacking in New York, a number of materials will be tested with a view to finding an insecticide which can be dusted on the ears to prevent the entry of the young larvae.

THE ORIENTAL PEACH MOTH

In our insecticide experiments tests were made involving 20 materials, 172 applications, 1,100 trees, and 14 representative orchards distributed over the area of infestation in Niagara County. In this work, 83,951 peaches were examined, of which 80,379 were cut open since the external condition of fruits does not generally reveal infestation.

Altho 20 materials were tested, only 5 gave over 50 per cent reduction of injury. Considering the number of applications required and the cost of the treatments, control of the pest by applications of insecticides which so far are available to peach growers is at present of doubtful utility.

In view of the discouraging results with insecticides, major emphasis has been placed on the breeding of parasites and their liberation in the principal centers of infestation of the oriental peach moth. The larvae-infesting parasite *Macrocentrus ancylivora* is at present the most efficient species, for which reason it is receiving major attention. It has been found that the segregation of the males and females immediately after fertilization, and liberation of only fertilized females insured a much lower mortality during ship-

ment. Accordingly, only fertilized females were shipped and liberated in orchards during the past year. Approximately 2,000 were colonized from material collected in New Jersey. In addition, 1,765 were released in cooperation with H. W. Allen of the U. S. Bureau of Entomology. Nineteen liberations were made in Niagara County, three in Chautauqua County, and three in the Hudson Valley.

Comprehensive data on the seasonal parasitism in all orchards in which *Macrocentrus* were liberated seemed highly desirable, therefore we have made weekly twig collections from 26 orchards in Niagara County. This included 18 new colonies of this season and 8 colonies established in previous years. In no new colonies have we secured the great increase in parasitism reported in other areas of the United States, however, we have never failed to establish a colony in Niagara County. In weekly collections from these 18 new colonies, 22,689 twigs were collected and examined. From these the combined emergence of moths and parasites totaled 10,788. Of this number 835 represented *Macrocentrus*. The seasonal parasitism by *Macrocentrus* was therefore 7.74 per cent in these new colonies. In weekly collections from eight orchards in the area colonized in previous years, we secured 12,348 twigs. The combined emergence from these was 5,571. Of these 2,738 were *Macrocentrus,* which means that the seasonal parasitism by *Macrocentrus* in this area was 49.15 per cent. The orchard of Morgan Brothers in this area showed an average of 65.61 per cent of the twig-infesting larvae parasitized by *Macrocentrus* during the season.

In order to determine the spread of *Macrocentrus* from the area colonized in previous years, collections were made at various times from 41 orchards located at various distances up to 10 miles from the area previously colonized. In these collections we secured 5,572 twigs from which a total emergence of 2,740 moths and parasites resulted. Of these, 156 were *Macrocentrus,* or a parasitism of 5.69 per cent. This indicates a decided spread of *Macrocentrus*. However, most of the parasitism was secured within a 3-mile radius of the above area.

The record for all collections made in Niagara County during 1930 is as follows: Twigs collected, 40,609; total emergence, 19,099; total *Macrocentrus,* 3,729; percentage parasitism by *Macrocentrus,* 19.52. In addition to the parasitism by *Macrocentrus,* 17 species of

native larval parasites accounted for 5 per cent of the larvae of the oriental peach moth during the season, bringing the total parasitism by all species to 24.5 per cent.

During the course of experiments in the laboratory rearing of *Macrocentrus,* we produced some 5,000 individuals, none of which were liberated but were held at the parasite laboratory as stock cultures.

In 1930, approximately 10 million of the egg parasite, *Trichogramma,* were produced. About half of these were supplied to growers during the summer season. The remainder were used in laboratory work incidental to building up the breeding stock. Due to the difficulty in obtaining accurate counts and the amount of time involved, we made no check-up on these liberations.

The fruit infestation in Niagara County was decidedly lower than in 1929. The average injury was 15.37 per cent as compared with 59.89 per cent in 1929. This surprising reduction in fruit injury was probably brought about by three factors, *viz.,* (1) increased amount of fruit (crop nearly double that of preceding year) present in 1930; (2) unusual weather conditions; and (3) parasitism.

A survey of the parasitism in the Hudson Valley showed *Macrocentrus* to be present in considerable numbers in all orchards from which collections were made. Other larval parasites were scarce in this area. During the spring of 1931, a total of about 1,000 *Glypta rufiscutellaris* were released in six counties in the Hudson Valley.

A sub-laboratory has been established at Lewiston to handle the distribution of parasites in western New York during the season of 1931. Distribution of parasites in the Hudson Valley and on Long Island is being carried on thru the Farm Bureau in the different counties. These agencies are also assisting in further parasite surveys.

POTATO INSECTS ON LONG ISLAND

Spraying and dusting experiments were continued during 1930 as in the four previous seasons. At the close of the season the results from these experiments during five successive years were summerized and recommendations made in the light of the results and experiences of such work. These are given in Bulletin No. 592.

The results of such experiments during 1930 confirmed to a large

degree the findings during previous years, namely, that in this locality normal spray and dust applications continued during the later period of plant growth (during July) did not result in significant gains in yield over plants receiving limited spray treatment during June.

This result is thought to be due to the early withering of the foliage in August, a phenomenon which spray or dust treatment could not effectively prevent and because of which sprayed and dusted plants did not outyield plants receiving limited treatment.

The importance of early planting as a means to surmount the adverse conditions commonly met with locally at midsummer was again emphasized by the results from experiments in which potatoes were planted at weekly intervals thruout the planting season. The earliest planted potatoes gave the highest yield and showed the least benefit from spraying as indicated by the yield, while later plantings showed successively smaller yields, but more marked benefit from spraying as denoted by the greater differences in yield between plants receiving treatments during the later period of growth and those in which such treatment had been discontinued. The greatest differences were found in the last planting, but such yields were very inferior to those in earlier planted plats.

CAULIFLOWER INSECTS ON LONG ISLAND

Aphids (*Myzus persicae* Sulz.) and thrips (*Thrips tabaci* Lind.) were the most injurious pests of the cauliflower seedbed during 1930. In the later sown plantings thrips were particularly numerous and difficult to control on account of weather conditions favorable to the insect which were characterized by a prolonged dry period during July and August.

In the case of thrips none of the so-called contact insecticides in spray form served to preclude the possibility of reinfestation within a few days, however effective the kill had been at the time of application. The most effective means of preventing reinfestation was the use of an additional cover spray of kayso with an arsenical.

In a closer study of the relative value of nicotine sprays in reducing aphid and thrip infestations it was found that an aqueous solution of nicotine at standard strength was much more ineffective than such sprays containing soaps or miscible oils. When soap

emulsions were used against aphids it was found possible to reduce the nicotine content of the mixture one-half without seriously impairing the effectiveness of the spray, and to this extent served to reduce slightly the cost of the spray mixture.

MEXICAN BEAN BEETLE INVESTIGATIONS ON LONG ISLAND

The Mexican bean beetle has been known to occur on Long Island since 1928. Since its arrival it has spread to all parts of the Island, but as yet has done no commercial damage. Experiments were commenced in 1930 to determine the relative value under local conditions of various spray and dust mixtures that have been recommended for use against the Mexican bean beetle, as indicated by the tolerance of bean plants to such spray or dust treatments.

It was found that spray or dust mixtures containing lead or calcium arsenate were decidedly toxic to the plant. The "burning" effect of such mixtures was slightly reduced when the arsenicals were used with bordeaux mixture or copper-lime dusts. Magnesium arsenate and barium fluosilicate appear to be non-injurious to the plants, but the results with cryolite were inconclusive.

FRUIT INSECTS IN THE HUDSON VALLEY

In the fall of 1929, British authorities discovered in American apples some lots which were infested with the apple maggot (*Rhagoletis pomonella* Walsh). Since this species is not known to be established in England, steps were immediately taken to prevent further entrance of infested fruit. An outright embargo was averted on the condition that a rigid inspection service be set up which would certify freedom of infestation of the 1930 and subsequent crops. This action and recently enacted domestic and foreign restrictions regarding obnoxious spray deposits have introduced new and serious problems to the fruit grower in New York and in neighboring states. The situation is even more important in New York than elsewhere because of the large volume of apples produced and also because much of the crop is customarily marketed abroad.

In the Hudson River and Lake Champlain fruit districts apple maggot has long been troublesome. Commercial orchards in western New York have rarely been injured in past years, altho light infestations were found in the 1930 crop.

Funds were appropriated by the Legislature in 1930 which made it possible for this Station to assume the technical leadership in efforts to solve these new difficulties. Most of the experimental work in 1930 was done in the Hudson River Valley and Lake Champlain areas, altho in the 1931 season observations on apple maggot are also being made in western New York. Effort has been directed principally in four fields, *viz.*, (1) testing the efficiency of poison sprays and dusts as a control measure for apple maggot, (2) searching for a practical means to kill the maggots in picked fruit, (3) investigating the life habits of other major apple pests in eastern New York whose periods of destructiveness more or less parallel that of the apple maggot, and (4) studying the nature of spray and other abnoxious residues on New York apples and methods for their removal.

The use of arsenate of lead sprays or dusts against the apple maggot has been advanced as the most practicable control measure available to the grower. Information on the efficiency of such treatments prior to 1930 was much too incomplete, especially when standards of control for the export trade required that a crop be 100 per cent free from infestation. The series of 12 large-scale orchard experiments carried thru in 1930 have shown that thoroly applied and properly timed sprayings offer a highly effective means of control. These findings are likewise borne out from records taken in 115 grower-treated orchards. In most commercial orchards in the Hudson River valley, 2 treatments in July should reduce apple maggot injured fruits to 1 per cent or less, according to these recent findings. The efficiency of spraying in neglected orchards or where apple maggot injury was severe the preceding season was likewise pronounced. In orchards of this second type the cumulative benefits of spraying were strongly indicated. For example, three careful sprayings reduced maggot injured fruits to from 4 to 10 per cent, where otherwise 100 per cent of the fruit would have been injured. More than one season's careful treatment is apparently necessary to reduce injury in these plantings to a desired low point.

Spraying prevents losses from apple maggot by poisoning the pest in the fly stage. After emerging from the earth the new fly does not lay eggs until about a week to 10 days elapse, altho during

this period she feeds freely on such food as can be found on the surface of the leaves and fruit. Spray materials are apparently mistaken for food or accidentally ingested along with food. The first flies appear in New York orchards toward the end of June and new individuals continue to come from the ground daily thruout July and even into August. Obviously, spraying, to be effective, must preserve an adequate covering on the trees during this period.

Location of traps in 1930 apple maggot investigations in the Hudson Valley.—Since the timing of spraying operations is so dependent on a knowledge of when the flies appear, 86 large trap cages were placed in various orchards in eastern New York. The accompanying map shows their location. The following table shows the general variation in fly appearance for the several localities in 1930 as determined from records taken daily of new flies trapped in the 86 cages.

APPROXIMATE DATE OF APPEARANCE OF APPLE MAGGOT FLIES IN 1930.

COUNTIES	FIRST FLIES APPEARED	PERIOD OF MAXIMUM NUMBERS	LAST FLIES APPEARED
Rockland and Orange	June 20	July 13–19	Aug. 1
Ulster and Dutchess	June 20	July 14–20	Aug. 5
Greene and Columbia	June 25	July 14–20	Aug. 5
Saratoga and Warren	June 27	July 17–24	Aug. 10
Clinton and Essex	June 27	July 20–26	Aug. 15

At the time this report is being written more than 100 cages are in operation for the guidance of growers' spraying operations in the 1931 season.

The significance of the later appearance of flies in the Lake Champlain Valley was indicated in spraying tests. A higher degree of control was obtained in 1930 in Clinton County from 3 sprayings applied July 5, July 22, and August 7 than from 2 applied July 5 and July 22.

Cold storage gives promise of offering a practical means to sterilize picked fruit infested by apple maggot. Temperatures customarily maintained in commercial apple cold storages will kill 99 per cent or more apple maggot larvae with a month's continuous storage,

Location of Trap Cages for the Apple Maggot in the Hudson Valley.

according to extensive series of experiments conducted in 1930. Studies of this method are still in progress. The potential value of being able to kill all maggots in harvested fruit is that it could be used to supplement spraying in attaining that goal of 100 per cent control.

The three major late-season insect pests of the apple in eastern New York are the apple maggot, the plum curculio, and the codling moth. All are very important and their periods of destructiveness overlap to a greater or less extent. In addition to apple maggot studies, investigations were likewise started on those phases of the life habits of the codling moth and plum curculio essential to devising control measures. In this way it has already begun to be possible to coordinate properly spraying operations for all three pests. The foreign markets object to wormy fruit, whether it be caused by the apple maggot, codling moth, or curculio.

Some orchards in the Champlain Valley were badly damaged in 1930 by the true apple curculio *tachypterellus* (*Anthonomus*) *quadrigibbus* Say). This newcomer among apple pests in the State parallels in life habits the plum curculio so common in Hudson Valley apple orchards. It has a reputation, however, of being much more difficult to control. A series of studies were started on the apple curculio in 1931.

The use of sprays and dusts late in the season, such as are needed for control of the apple maggot and codling moth, may cause complications arising from the presence of spray deposits on the fruit at harvest. A study is in progress, in cooperation with the Division of Chemistry, in which all aspects of the residue questions are being considered.

Under present conditions in the Hudson Valley, apples sprayed to secure commercial control of apple maggot and codling moth are unlikely to have residues in excess of the tolerance specifications. This will vary principally with the amount of rainfall following the last spray and the picking date of the fruit. Cleaning equipment as devised for residue removal in the Pacific Northwest was found to need certain modifications if put to removing residues which are more or less peculiar to New York. Machines equipped with an acid wash and air drier satisfactorily reduce the arsenic, but sulfur residues persist and leave the fruit unsightly.

Likewise, this type of machine is inefficient in removing road dust and spotting caused by apple leafhoppers. A machine equipped with an acid wash and cloth drier is more successful in removing the several kinds of residues. Dry cleaners, where the cleaning principle consisted either of rotating cloths or brushes, imparted a good finish to the fruit but were less successful in arsenic removal than machines with an acid bath. These studies in 1930 indicate that the removal of residues should properly consider efforts towards improving the finish of the fruit—and hence increasing its sales value—as well as lowering the arsenical load to the tolerance established by law.

Division of Pomology

SOIL INVESTIGATIONS

Orchards respond to nitrogenous fertilizers.—With the gradual change in orchard soil management from clean cultivation to sod, which has taken place during the last 10 years, it is becoming generally recognized that some kind of orchard fertilization must be resorted to if sod orchards are to be kept in a productive condition. Due also to a general letting down in cover or green manuring crop utilization in orchards and a depletion of soil humus by annual cultivation, many orchards still cultivated must receive additional food.

Altho the older pioneer experiments in this field which were carried on by this Station for over 30 years have been completed, new work along this line was begun 4 or 5 years ago in order to meet these new tendencies in the management of orchard soils.

A McIntosh orchard which had been under strip cultivation for some years but during the past five years has been in quack sod has responded markedly to nitrogenous fertilizers, but very little to phosphorus and potassium. Several hundred per cent increase in crop in some years has been common when fertilized and unfertilized trees are compared. A Rome orchard which was clean cultivated for years but which was left to quack sod since the second year of the present experiment has also responded markedly to nitrogen fertilization. Marked differences in foliage characters and production were evident the first year while the orchard was still clean cultivated. This orchard is especially interesting since

the same variety on the Station grounds gave negative response to all fertilizers, including barnyard manure, over a period of 25 years.

The present indications are that in New York orchards more attention must be paid to proper tree feeding in relation to soil type and previous soil management.

Nitrogen carriers differ in value for orchards.—A part of the new experimental work in orchard soil management has been a determination of the comparative value of different forms of nitrogen as measured by tree growth and production. With the increase in new forms of commercial fertilizers price differentiation has become more marked. The year 1930-31 was marked in this field by a large price difference between several standard carriers of nitrogen so that more exact information as to relative values of these carriers is demanded.

From 2 to 4 years' results in four different orchards and three different varieties of apples indicate that there is considerable difference in the availability of the various forms of nitrogen. In this study the following fertilizers are being compared: Nitrate of soda, sulfate of ammonia, calcium nitrate, cyanamid, urea, calurea, calnitro, lunasaltpeter, ammophos, ammophosko, and nitrophoska, the latter three being checked against home-mixed goods of similar analysis.

Some of these materials have given marked increases in yields; other little or none. Attention is also being given to time and method of application, as well as to amounts.

Many factors may contribute to variations in tree yields.—Meteorologists have found that the apple yields of the State as a whole are quite dependent on the temperatures existing at certain periods of the year. This Station has found that the production in individual orchards is quite dependent on the amount of rainfall at certain critical periods during the growing season.

Furthermore there is another kind of variation in yield which takes place among the individual trees of the same variety in the same orchard. The causes of such variation have been studied by the Station for several years. Technical Bulletin No. 164 deals with some of these causes. The amount and permanency of these variations have been studied and analyzed.

Trees of the same variety set in the same orchard at the same time may vary in size on reaching maturity to a degree represented by a coefficient of variability of 11.5 per cent. Variation in the yield of individual trees may be much greater. Such variation in yield may amount to from 20 to 55 per cent for 3 to 5 year periods.

Furthermore, these variations in size and yield seem to persist year after year. In other words, a poor or a good tree seems to remain a poor or good tree indefinitely. This naturally raises the question as to causes and means of preventing such variation, either by selection of trees before setting or by treatment after setting. As a matter of fact no ordinary treatment, such as fertilization, cultivation, seeding down to sod, or manuring, seems to influence individual tree performance to any extent.

The natural environment of the individual tree has some effect on its comparative performance, but this is not marked. There are some indications that with trees well cared for uniformly thru a period of years the variations in growth and yield tend to be smoothed out.

Studies on seedling and nursery trees indicate marked variation in growth tendencies so that more can be accomplished toward later uniformity in performance by proper selection of first stock than by subsequent treatment after the trees come into bearing.

These studies have been extended the past year to subsoil studies in orchards in which marked high- and low-yielding trees occur. This work is in cooperation with the Department of Pomology at Ithaca.

Reactions of the tissues of the apple tree to application of salts, with special reference to nitrogen.—Studies have been made for the past 2 years of changes in composition of the tissues of the apple tree caused by application of fertilizer salts to the soil and also by direct injection of such salts into the tissues of the tree. The purpose has been to determine in this way the relative availability and effectiveness of various nitrogen carriers, the form in which nitrogen is absorbed, and the effects of raising the sap concentration of the tree in nutrient ions.

Methods of technic, dosage, toxic concentrations, and the rate of transfer of various ions in the tissues have been studied extensively. For comparison of effects, however, it has been found that it is very

difficult to sample tree tissue and secure duplicate samples which do not show a high degree of variability in composition. Stage of maturity is a large factor in this. Tissues in a growing condition show more readily the effects of treatment but are highly variable, while mature tissues, altho being much more stable in composition, respond very slowly or not at all to variations in treatment.

Nitrogen and water relations in legume and non-legume crop rotations.—The new lysimeter work started in 1914 will be completed in its present form this year and some new experimental work begun with trees under controlled conditions. The nitrogen and water relations of the rotations have been published in Technical Bulletin No. 166. The other mineral relations, as well as the nitrogen balance, will be reported on during the coming year.

Among the many major findings reported in the summary of the above publication, several of the most outstanding are here briefly mentioned. Nitrogen fertilization of a rotation reduced the water utilization per unit of dry matter production. Nitrogen exchange has been totally different in legume and non-legume rotations. Nitrate losses in drainage have been large but variable. These have varied from 10 pounds of nitrogen per acre per year for a timothy and small grain rotation to 86 pounds per acre per year for an alfalfa and fallow rotation.

Alfalfa has maintained the soil at a high nitrogen level which has had a marked effect on crops following it. Timothy, on the other hand, seems to have depressed the growth of the following grain crops. Additional nitrogen applied to alfalfa has increased this crop only to a small extent. The crop immediately following alfalfa is the one to consider in an economical utilization of the available nitrogen.

By far the greatest loss of nitrogen from a soil is thru crop removal. This has amounted in some cases to six times the amount which was lost thru drainage. Alfalfa apparently fixes less nitrogen when a plentiful supply is provided.

It was found that soil 8 feet deep, altho producing 8 per cent more dry matter than soil 2 feet deep, nevertheless lost by drainage 25 per cent more water and 47 per cent more nitrogen. A physical explanation of this is presented.

Nitrogen relations in certain unproductive soils.—For several years a study has been made of the reasons why some soils of wide extent, altho high in total nitrogen, are comparatively unproductive in the field. This is especially true of soils of the Volusia and Lordstown series and to some extent of some other soils. It has been found that certain soil organisms will utilize the nitrogen in such soils if supplied with certain salts not commonly recognized as direct fertilizers.

Since these salts apparently aid in making available to these organisms the nitrogen in these soils, the same salts are being used in the field in the endeavor to determine if they are equally effective in releasing nitrogen for the growth of agricultural crops. A preliminary publication on the subject has been prepared in Technical Bulletin No. 172.

The effects on plant and soil of long-continued applications of certain salts.—This work was begun by the Station in 1890 and continued until the present time. The work will be terminated this year and the results published. The salts used in this work include sodium chloride, sodium sulfate, magnesium sulfate, calcium sulfate, calcium carbonate, and iron sulfate. Yield data of many kinds of crops grown on the plats and their composition are being analyzed at present. Special attention also will be given to the base exchange relations in the soils of the plats after the long-continued application of these salts.

Soil profile studies.—In connection with the work on the cause of individual tree variability already mentioned, it has been found very profitable to make examinations in such orchards of the soil profiles. Soil structure, texture, and water relations vary so widely in glaciated soils in comparatively small areas that examination of the profiles thruout an orchard has proved very valuable in studying the relation to the performance of individual trees. A machine has been constructed to facilitate the quick and efficient removal of such profiles in quantity.

VARIETY TESTS OF FRUITS

During the past year many new varieties collected from different parts of the world have been secured for testing. Undoubtedly, many of these kinds may have no direct value, but they may possess

characters that will prove of great value in the breeding of new fruits. The results obtained from the variety tests are published from time to time in the Station bulletins and circulars and in fruit monographs. During the past two years considerable work has been spent in bringing *The Apples of New York* up to date. This revised edition should be ready for publication within a year or two. The new fruits are exhibited on various occasions and are also shown to numerous visitors.

A few noteworthy fruits that deserve consideration include the following: Gorham, a pear of the Bartlett type that ripens about two weeks later than Bartlett; Early Rivers, an early black cherry that ripens a few days after the Seneca; Emperor Francis, a light-colored firm cherry of the Napoleon type but less subject to cracking; Victor, a light-colored cherry that ripens before Napoleon; Stanley, a blue prune that ripens about 10 days before the Italian; Hall and Albion, large purplish colored plums, the latter being the best late plum tested; Fredonia, a very early ripening black grape; Golden Muscat, a high quality grape with a muscat aroma that ripens after Concord; Newburgh, a firm large red raspberry that has proved to be remarkably free from mosaic; and four strawberries of large size and good quality known as Clermont, Culver, Cato, and Camden.

FRUIT BREEDING

The fruit breeding work has been continued on an extensive scale. During the spring of 1931 the following number of seedlings were set in plats for fruiting: 1,539 peach, nectarine, and apricot; 109 cherry; 87 plum; 603 pear; 827 apple; and 1,264 grape. In addition, 196 grape vines selected for a second test were planted and 1,056 more will be ready for planting in the fall of 1931. From the seed produced in 1930 from crosses and selfs, 11,537 seedlings were transplanted in the nursery.

Approximately 7,000 strawberry seedlings fruited on first test and from these 223 have been selected owing to their various merits. Many of the seedlings give much promise due to their season of ripening, vigor, and productiveness. The 173 strawberries on second test and 13 on third test gave about 25 seedlings that were deemed worthy of a more extensive trial.

During the year many thousand black, red, and purple raspberry seedlings came into fruiting and a number have shown outstanding merit. As in the case of all fruits, the selected types have been or will be propagated for comparison with the standard varieties. Many promising grape seedlings have likewise been selected. It is obvious that one cannot put too much dependence upon the performance of one plant, for unless a seedling is superior in some respect to the standard kinds, it should not be named.

At the present time there are thousands of tree seedlings in the plats, but most of them are too young to fruit. From now on many of them will come into bearing. Last year a promising late black cherry appeared which was deemed worthy of further trial owing to its size and quality. Some of the peach and nectarine crosses fruited and, as expected, proved to be peaches. A few of them had peaches equal to the Elberta in size and the best were crossed back on nectarines. The next generation should produce both nectarines and peaches.

An interesting block of 161 cherry seedlings, the seed of which was obtained from the mountains of Carniola in Yugoslavia, has commenced to fruit. Approximately one-fourth of the seedlings bloomed very late, in fact the latest were two weeks later in blooming than the normal varieties. Altho these late-blooming types may be of no value so far as their fruit is concerned, they should prove of value in the breeding of late-blooming varieties and as a source of mazzard seed.

In a brief report, it is impossible to give an account of all the crosses that are being grown and the objects sought. It may be said, however, that many crosses have been made between varieties and seedlings of most of the fruits adapted to the soil and climatic conditions of New York, and that each cross has been made with the object of either securing superior kinds or obtaining further data on the inheritance of plant and fruit characters. As all those versed in the laws of inheritance know, large populations have to be grown in order to secure many possible combinations. Unfortunately, it requires from 8 to 15 years to determine the merits of tree fruits, and consequently there is a slow turnover in land. Trees are now being planted very close, 4x9 feet, for fruiting, but even with these distances the available space for planting will soon be

depleted. This means that either the breeding of new fruits must be seriously checked or that more land and labor must be obtained.

POLLINATION EXPERIMENTS

The matter of pollination is an important factor to the fruit grower, especially if he is planting new varieties. Such being the case, we have been making a study of the self-and cross-compatibilities of many of the recently introduced apples, pears, plums, and cherries. The information obtained from these experiments is published from time to time in bulletins and reports.

Further work is also being carried on to determine the advisability of artificial pollination of the pollen-sterile grapes. It has been shown that in the pollen-sterile varieties insect pollination is ineffective and that artificial pollination is required to obtain compact clusters.

Work has been in progress for several seasons to determine the degree of self-fruitfulness of Early Richmond, Montmorency, and English Morello sour cherries. The Chase, a Morello type, has also been studied and, as will be reported later, requires a pollinator.

MICROSCOPIC WORK CONNECTED WITH THE MAKING OF NEW FRUITS

In breeding fruit varieties and any other plants it is helpful to know the fine anatomy of the sex cells which will produce the new generation. As every clock has a definite number of wheels, every cell in a given plant contains within its nucleus a definite number of small bodies called chromosomes, which are considered the ultimate carriers of the properties and characters of a plant. The chromosome numbers of 19 species of the apple and pear family were published during the year. Also, counts were made on 41 apple and 10 pear varieties, and numerous seedlings were checked.

Study of the chromosome.—The chromosome which is thought to be the ultimate carrier of the properties and characters of a plant appears to consist of at least two substances. More information on the mechanics of these substances will lead to a better understanding of the basic principle of growth, namely cell division. The chromonema or stainable core of the chromosomes has been isolated by special methods of fixing and staining, and some of the workings are being described.

Improving methods in cytology.—As cytology or the science of the cell as a living unit deals with objects that are far too small for unaided visibility, a study of methods is requisite and has resulted in the development of a new technic for staining pollen tubes in the style on their way to the ovary in fresh material. Also, a new rare metal, Ruthenium tetroxide was found useful in killing and fixing nuclear protoplasm.

INFLUENCE OF APPLE POLLEN ON THE APPLE IMMEDIATELY PRODUCED

Scientific men have for a long time been unwilling to accept that the pollen from one variety might alter size, shape, color, or other characters of the apple of another variety which was fertilized by this pollen. Experiments show that a very slight influence of the pollen is active beyond the seed of the apple and can be detected in size, shape, weight, and color in certain cross-fertilizations. The influence is not considered sufficiently large, however, to affect the practices of pollination as advocated by this Station.

A THUMB TEST FOR DISTINGUISHING MAZZARD AND MAHALEB CHERRY STOCKS

Iron alum used as an indicator solution on small pieces of roots readily separates the two stocks, the Mazzard showing a darker discoloration.

THE CELLS OF TOUGH PEAS UNDER THE MICROSCOPE

The anatomy of peas from water cultures containing variable amounts of nutrients was studied. Thickness of skin alone does not mean toughness. Information was gained and published on the appearance of cells under variable conditions of nutrition.

IMPROVEMENT OF PEPPERMINT

As there is much room for the improvement of peppermint due to its wide range of application and to its many variations, an extensive collection of *Mentha* species has been made and breeding work has been carried on.

BOTANICAL WORK

Identification service.—The growth of the Station herbarium and its reorganization during the past 3 years have enabled the

Station to aid nurserymen and growers in identification of trees and shrubs. The number of determinations has increased gradually from year to year, and with the augmented facilities of the new horticultural building, the taxonomist will be enabled to handle such material with greater effectiveness.

Studies on basic species of horticultural plants.—During the past year studies of the cultivated apple and its allies have added to the knowledge of the relative status of the wild and cultivated forms.

The beans and their allies, in so far as the species cultivated in this State are concerned, have been carefully studied and the resulting monographic treatment is included in the forthcoming part of *The Vegetables of New York* now in press. Further studies on the pomaceous fruits and upon the cucurbits and sweet corn are being made.

WORK AT THE CHAUTAUQUA VINEYARD LABORATORY

Since many of the projects at this laboratory were started as long time ones, the work for the past season has quite largely been a carrying out of the details of experiments started more than 20 years ago. As before, various areas on two soil types are involved. Some of the tests, notably those with commercial fertilizers, have now run 22 consecutive years under the same treatments. Since the inception of the work, other plats and materials have come into the tests. The pruning and training experiments are now in their 20th year. The testing of old and new named varieties of grapes has been under way for 18 years. Many varieties have been discarded, while annually new ones are added. Station seedlings bred at Geneva and Fredonia are also given a thoro test in a section of vineyard assigned for the purpose. A planting of 2 acres of seedlings bred at Fredonia will come to full fruiting in 1932. One seedling developed at the laboratory, Fredonia, is fast coming into commercial production. Three others under tentative designations are in their final test period. The growing of the principal commercial grape varieties on vigorous rootstocks has been a part of the work of the laboratory for 15 years, and within the past few years additional work along this line has been undertaken. New insecticides and fungicides are subjected to test under commercial

conditions. Variety storage tests are a continuous subject of study. Winterhardiness and resistance to diseases and insects claim a part of the time. As other problems of the growers arise the laboratory attempts to solve them as facilities permit.

HORTICULTURAL WORK IN THE HUDSON RIVER VALLEY

Horticultural experiments have been conducted in the Hudson River Valley since 1924. Three experiments using nitrogen, phosphorous, and potash alone and in combination on a young bearing McIntosh orchard, on a McIntosh orchard planted in 1924, and on a bearing Newtown orchard have been under way since the beginning of the work in the Valley. Two years ago a pruning experiment was also included in the Newtown's. These experiments are showing the comparative value of these three plant foods, particularly the young bearing McIntosh orchard and the McIntosh orchard planted in 1924. The differences in tree performance of the various plant foods are becoming more pronounced from year to year. These tests will be continued indefinitely.

Tests of several of the nitrogen-carrying fertilizers are being conducted in three McIntosh orchards, and in one currant patch. During the 3 years of this work, none of the newer forms of nitrogen-carrying fertilizers are outstanding, and the two old forms seem to be as good and possibly somewhat better than some of the newer forms. A complete fertilizer test is also being carried on with currants.

Two experiments were started last year, one consisting of the application of varying amounts of a nitrogen-carrying fertilizer on a bearing Delicious orchard and the other a pollination study of the Chase cherry. Both of these have been continued this year, but the latter will be dropped now as we have conclusive evidence which will be published this year along with similar work done at Geneva. The test on the Delicious orchard will be continued indefinitely. Since the beginning of this test, the differences in the different amounts of nitrogen on trees in this sod orchard have been marked.

The variety test of apples, pears, peaches, grapes, plums, and small fruits will be continued. Many of these fruits have been bearing, but the apples are just commencing. These tests are be-

coming more important each year to the fruit grower considering new plantings.

These various fertilizer experiments are being carried on on many different types and kinds of soils, some in sod and others under cultivation, and their variable reactions to the various soils and their management studied. Four of these tests are carried on in Columbia County, two in Dutchess, three in Ulster, and one in Orange.

NURSERY INVESTIGATIONS

Seed supplies.—The source and the variety of seed for seedling stock production continues to be a serious problem in nursery work. During the last 4 or 5 years domestic supplies of seed have been generally superior to foreign supplies, so that there has been an increased utilization of domestic seed. Unfortunately, the increased demand has resulted in a lowering of the standards of domestic sources, especially with cherry seed. It has been shown at this Station that seed from early-ripening varieties of cherries is not viable, while that from late-ripening varieties is uniformly good. In view of the fact that many of the domestic wild Mazzard trees from which the supply of domestic seed has been secured are early ripening, it may be that this factor is the important one. Furthermore, seed of the stone fruits seems to be easily injured by improper handling. Accordingly, intensive studies are being conducted, both cytologically and chemically, to determine the exact causes of inferior seed supplies, so that definite recommendations may be made regarding collection and handling.

Production of seedlings.—The methods of growing seedlings that have been devised at this Station have been continued each year to compare seasonal variations. The methods that have proved successful are as follows: For cherries and plum seedlings, production from seed in one year without transplanting; for apples and pears, growing the seedlings in close plantings during the first year so as to keep the seedlings small, and then transplanting the second year to rows a foot apart, 2 to 3 inches apart in the row. These methods give satisfactory branch-root stock. The branch-root seedling, especially with apples and pears, has proved quite superior to the straight-root seedling under New York conditions.

Cherry and plum seedlings branch sufficiently without transplanting.

Comparisons have been made between fall vs. spring planting of fruit tree seeds. It has been shown that unless fall-planted cherry seed is planted early in the fall, about the first of October, so that it may properly after-ripen for a period of 4 months under moist conditions and at a temperature of about 40°F, the seed will not give a good stand of seedlings. Plantings made the middle of November or the first of December have failed to germinate any good percentage the following spring, altho the seed has still appeared sound in the soil. On the other hand, seed which is after-ripened artificially under controlled conditions of moisture and temperature often begins to germinate in the spring before the ground is ready to receive it. Accordingly, early fall planting appears most promising for stone fruit seed.

With apple and pear seed, however, which require a shorter after-ripening period, namely, 6 weeks, it is possible to estimate the season and to start after-ripening processes artificially so that the seed will be ready for planting when the planting season arrives.

It has always been a problem on the heavy soil of western New York to secure a good stand of seedlings, due in large part it has been thought, to the exhaustion of food reserves in the seed before it can get thru the hard surface and begin manufacturing its own food supplies. Accordingly, tests have been conducted using various coverage materials, such as peat moss, mulch paper, and sand. The tests indicate clearly the superiority of peat moss for this purpose and consequently it is being used regularly in the seedling beds in experimental plantings.

Performance of lining-out stock.—The tests that have been made each season with lining-out stocks secured from different sections of America have been continued, each stock being budded to five different varieties of fruit or roses as the case may be, so as to give a thoro test as to suitability for New York conditions. Each season adds one more experience to the controversy over straight-root vs. branch-root seedlings, in which the branch-root types are superior for New York. In general, the cherry and plum stocks from the non-irrigated sections of America and from regions with a shorter growing season have given the best results. With apples

and pears the consideration has been mainly one of whether the stock is branch-rooted or straight-rooted.

Tests of vegetative stocks.—Since fruit trees are universally either budded or grafted upon seedlings, they present the possibility of great variation in roots. Recently, progress has been made in the propagation of clonal root stocks with the idea of developing more uniform root systems for orchard trees. Collections have been made of all the principal vegetatively propagated root stocks, and these have been grown as discussed in a previous paragraph. These stocks have then been lined out in the nursery and budded to several standard varieties, since it has been shown that some types of vegetative stocks, altho producing excellent stands in the nursery, fail to unite with the cion top or else do not make a satisfactory orchard plant. Hatton's Type XIII appears especially promising for American apple varieties, with Type XII next. Type IX, Jaune de Metz, has proved satisfactory as a dwarf stock for apples.

Performance of two-year trees.—The growth relation between two-year-old trees and the size of the one-year buds the year previous shows a high correlation. The records for 3 years with several thousand stocks, yearling trees, and two-year trees are being subjected to statistical analysis, and considering the large numbers involved should give significant data as to the relation between size of stock and size of tree, a question which has been one of great controversy for several years. This material should be in published form this year.

Green manure crops.—The test of green manure crops for nursery stock is in its second year; and altho it will take another year to complete the records of this test, the benefit upon the physical condition of the soil, for which cover crops have been grown, is already apparent. White sweet clover grown for 2 years has put the nursery soil in excellent tilth, so that it can be worked to better advantage and does not bake as badly as where no cover crop has been grown. As yet no recommendations can be made as to which of several cover crops is best, altho their value in general is already proved.

Factors in the production of cherry trees in the nursery.—The renewed interest in Mazzard (*Prunus avium*) seedlings in pref-

erence to Mahaleb (*P. mahaleb*) as understocks for both sweet and sour cherries makes the factors involved in the production of cherry trees in the nursery assume major concern. Nurserymen have complained that they secure very poor stands of trees on Mazzard stock as compared with Mahaleb stock. Several factors have been selected from the many involved to determine their importance, namely, species of stock, type, source, time of digging and method of handling, size, method of budding, premature defoliation and winter injury, protection from defoliation by spraying, fertilizer applications, and height of soil water table.

First of all it has been found that the percentage of Montmorency trees produced from a given number of Mazzard and Mahaleb stocks is not as great as has often been claimed. The percentage of two-year-old trees on Mahaleb roots for the budding season of 1928 was 54.1 per cent and the percentage of Mazzard 49.1 per cent. Altho these figures are solely for the budding season of 1928, the data for 1927, 1929, and 1930 support them.

Altho there is variation as regards vigor, color of bark, shape of leaf, and so on in Mazzard and Mahaleb stocks, this factor has been outweighed in importance by others. The time of digging the seedlings and the source from which they have been secured are more important. Stock dug as early as October 12 gave no plants of sufficient vigor the following summer to be budded, whereas plants dug November 15 gave a 54 per cent stand of vigorous seedlings, and stocks that were stored out of doors over winter gave 69 per cent good plants. Stocks from sections of long growing seasons have not been as good in general as those from localities where the stock ripens earlier and more uniformly. This factor has been of great concern to nurserymen since the quarantine has gone into effect.

A fourth important factor has been the low tolerance of cherry stocks for poorly drained land. It has been found that Mahaleb roots will stand more water than will Mazzard roots, altho neither will stand as much as the Myrobalan plum and the chokecherry. Failure of nurserymen to recognize these facts has undoubtedly resulted in some poor stands of trees on Mazzard roots.

Perhaps the most important factor in successful stands of buds, especially on Mazzard stock, has been premature defoliation by

leaf spot. Where defoliation occurs as early as the middle of August, the stock stops growing, the bark no longer slips, and buds that are inserted at that time fail to unite with the stock. Mahaleb stock is seldom seriously affected by leaf spot so that the budding season is seldom interrupted by this factor. On the other hand, Mazzard stock is often entirely defoliated at an early date.

That this is an important factor has been shown by records of winter injury in which plants that were entirely defoliated the first of September were killed both in roots and in tops by severe cold, whereas trees which were defoliated September 13 were killed back in the tops 12 to 18 inches, and plants only partially defoliated were killed back only 6 to 8 inches. Stock that was sprayed to protect it from leaf spot, on the other hand, showed no injury whatsoever and produced a fine stand of trees the following spring.

It is suggested that these factors are the important ones in determining the percentage stand of cherry trees on Mazzard stock.

Propagation of rose stocks.—In a further test with the propagation of *Rosa multiflora japonica* plants during July and August from soft wood cuttings, it was shown during the season that cuttings struck after August 15 failed to ripen sufficiently and were seriously injured by winter cold. The most satisfactory stock was secured by cuttings made prior to August 15. Plants from cuttings made the last week in July were thoroly matured by fall, so that no losses were experienced from the plants from this last class left out of doors during the winter of 1930-31.

Use of granulated peat moss in vegetative propagation.—Because of the quarantine which has been placed upon fruit stocks from abroad, there has been a shortage of vegetatively propagated understocks for fruit trees in America. Up to this time most of the dwarf apple and quince stocks, which fall in the class of vegetatively propagated stocks, have come from Europe where climatic conditions and cultural practices are different from those in America so that there is no basis for growers to work upon in the propagation of these stocks in America.

During the four growing seasons that the nursery investigations have been under way, and anticipating the quarantine, collections have been made of the most promising vegetatively propagated fruit stocks from different localities thruout the world. These have

been grown by different methods, such as trench-layering, mounding, and the like, endeavoring to standardize vegetative propagation to suit American conditions.

In this work the use of granulated peat moss in field propagation has given some striking results. Using peat moss at the rate of 52 bales to the acre, spread broadcast between the rows of mounded stock and working the material into the soil during the regular cultivation and mounding operations, rooting of apple and quince stocks has been increased. With Hatton's Type XII trench-layered 44.4 per cent of the shoots from the mother plants were well rooted during the season of 1930, whereas the same stock grown in the same way except for the surface application of granulated peat moss has given 70.7 per cent of saleable plants. Furthermore, the quality of the roots from the peat-treated plats has been superior to those from the non-treated plats. With Hatton's Type XIII, which at present looks very promising as an improved understock for American apples, the use of peat moss has increased the rooting from 28.9 per cent to 59 per cent, while with Type I it has been increased from 57.2 per cent to 62.9 per cent. In both of these cases, too, the rooted plants from the peat-treated plats were superior and commanded a higher market value.

In the case of mound-layered quinces, rooting was increased from 76.2 to 85.3 per cent, the quality of the peat-treated plants again being markedly superior.

In general, the indications from this work are that types of vegetative stock which root easily are less benefited by peat than are those which root with greater difficulty. In addition, trench-layering is less successful for weak-growing plants than for stronger-growing sorts, since weak stocks when trench-layered tend to make very irregular weak shoots which are commercially undesirable. The same sorts grown in stools send up fewer shoots and give a larger number of uniform, well-rooted plants. A report of this work was published in full detail in the 1930 proceedings of the American Society for Horticultural Science.

Storage of nursery stock.—In a test conducted in cooperation with New York nurserymen, using sweet cherry trees, storing the trees in various conditions over winter and later planting them out in the field to test their performance, the outstanding result has

been that trees from some producers were excellent, while those from others were weak and inferior. In the case of the trees from three concerns, the percentage of trees that survived a year in the orchard, regardless of storage treatment, were as follows: 100, 100, and 93; whereas from two other nurseries, only 32 and 7 per cent, respectively, survived.

Among the treatments used were coating the stock with different kinds of paraffin and wax, trenching the stock in sand, cording the stock in bins, and cutting back severely prior to storage. With the exception of slight benefit from pruning, there has been no great advantage from any of the treatments used, the significant point being that the lots of stock that were properly grown and properly handled prior to storage withstood the various storage treatments satisfactorily, whereas lots of stock that were not properly grown and handled prior to storage failed to come thru the winter storage in satisfactory shape.

The results of this test have been so significant that they have been used by the nursery trade and by nursery publications to call attention to producers of nursery stock that methods of growing and methods of handling are more important than any of the artificial treatments that have been suggested for improving stock.

Fruit trees trained to special forms.—Altho in Europe it has been the custom for generations to train fruit trees to special forms, such as against walls and fences, and in various shapes along garden walks, this practice has not been developed in America. In view of the increased interest the ornamental plantings thruout the country, a new project is being carried on endeavoring to adapt European methods to American conditions.

Division of Vegetable Crops

CANNING CROPS STUDIES

Rotation and fertilizer experiment with vegetable canning crops.—This experiment, involving two 4-year rotations, is now in its sixth year. Each fertilizer is put on the same plats each year, but no cumulative effects of any of the fertilizers are apparent. The highest returns on all of the crops are obtained where liberal amounts of phosphorous are applied. However, when the phosphorus deficiency has been supplied, from then on, with increased

amounts of fertilizers, nitrogen and potash also aid in increasing the yields if the amount of phosphorus is also increased.

The rotations have been compared with continuous cropping of peas and tomatoes. Continuous cropped peas were a failure after the third year and have been discontinued. Peas in the 4-year rotation now repeating on land used for peas 4 years ago seem to indicate that a longer rotation than 4 years would be desirable for maintaining a permanent system of profitable production of peas. Good drainage is of the utmost importance in maintaining a profitable rotation.

Tomatoes grown continuously on the same soil produced a fairly satisfactory crop, but at the end of 5 years tomatoes grown in rotation outyielded the continuous tomatoes by more than 30 per cent. Liberal fertilizing (1,200 pounds per acre of a 4-16-4 fertilizer) is more profitable to the grower than lesser amounts on tomatoes and cabbage. However, on beans, peas, sweet corn, and beets, from 300 to 600 pounds of fertilizer is all that can be applied profitably.

Side dressing tomatoes with various nitrate fertilizers.—This experiment has been conducted for 5 years on tomatoes that had been fertilized with 600 pounds of a 4-16-4 fertilizer per acre drilled in just before the plants were set in the field. The side dressings were applied when the first cluster of blossoms was set. Nitrate of soda at the rate of 100 pounds per acre was compared with equal amounts of nitrogen in the form of ammonium sulfate, Ammo-Phos, and Calurea. The results show that ammonium sulfate has given the highest returns and that side dressing tomatoes is a profitable practice.

Experiments in fertilizer placement.—Experiments have been carried on for 4 years to determine the best method of applying fertilizer to corn, beans, and peas. This spring a very much more comprehensive experiment in fertilizer placement was started in cooperation with the United States Department of Agriculture by means of specially designed machinery provided by the government specialists. In this experiment, fertilizer has been placed accurately above the seed, with the seed, at various depths below the seed, and at both sides of the seed, to determine the most advantageous placement. It is plainly evident that a farmer can save considerable on his fertilizer by placing the fertilizer close

to the seed, thus fertilizing the crop rather than the soil. However, very serious injury results if the fertilizer is in actual contact with the seed.

Tomato selection and breeding.—As a result of several hundred crosses and selections made in 1926 and 1927, three very promising selections of the John Baer tomato have been developed. The yield of these three strains has been consistently better than any other strain or variety under test in 5 years. These three strains have been tried elsewhere with good results, and are being multiplied this year for further distribution and testing.

Comparison of different methods of growing tomato plants and different dates of sowing seed.—For 6 years this experiment has been conducted in comparing March 10, March 25, and April 10 for sowing tomato seed for canning. It is clearly evident that tomatoes sown March 10 have to be held back too severely and do not yield as large a crop or even earlier tomatoes than the plants sown at the two later dates which are not so severely checked. Whether March 25 or April 10 is the best date depends on the season. In an early season the earlier date gives slightly better results, but in more than half of the seasons April 10 seeding has given the best yields and has certainly been the cheapest method of growing tomatoes because greenhouses and cold frame space is needed for a shorter time.

Another method of growing tomato plants which is by far the cheapest, and which has proved satisfactory in the last two years, has been to sow the seed in cold frames rather thinly on March April 10, and take these plants, without any intermediate transplanting, directly to the field. By filling in an inch of soil in the cold frame when the tomatoes are about 6 inches high, an additional root system is formed which enables the plant to take hold more quickly in the field.

Physiological effect and economic value of fertilizing tomatoes in the transplanted seedling flats.—In this experiment the differential fertilizer treatment began when the seedlings were 2 weeks old, the object being to determine if the earlier application of fertilizer would result in greater earliness of maturity. This experiment is only in its second year so that definite conclusions cannot be drawn. The indications are that the complete fertilizer

applied earlier in the life of the plant will result in greater earliness of maturity, in much sturdier plants, and in considerably greater yields in the field.

Strain tests of yellow varieties of corn for canning.—In an experiment begun last year comparing 30 varieties and strains of yellow corn in regard to field yields, earliness of maturity, and canning yields, it was found that the earliest variety of high quality was Golden Sunshine. This variety was 6 days earlier than the earliest strain of Golden Bantam, yielded equally well, and when canned was rated the highest in quality of any variety.

Comparison was made of five commercial strains of Golden Bantam and five hybrid inbred strains. The uniformity of maturity of the latter was remarkable and proved that such strains are particularly adapted for high-quality canned corn. The five hybrid inbred strains of Golden Bantam corn yielded almost twice as much in the field as the commercial open-pollinated strains. Altho the hybrid inbred strains cost about 50 cents per pound, or $4.20 more per acre than a good commercial strain, the use of the hybrid inbred seed would result in much greater profits to growers and canners.

Based on last year's results, the good commercial open-pollinated strains of Golden Bantam brought in an average return to the farmer of $39.19 per acre. The hybrid inbred seed which cost $4.20 more per acre brought in corn valued at $77.62, or a net gain to the grower of $38.42 per acre in favor of the hybrid inbred seed. This experiment is being conducted on a larger scale this year. The evidence clearly indicates that the hybrid inbred seed would be much more profitable to both grower and canner. The experiment this year includes many new hybrid inbreds in both yellow and white varieties. The cooperation of the Associated Seed Growers has made possible the white variety test.

Comparison of yields of sweet corn harvested for whole kernel and cream style pack.—In a preliminary experiment conducted last year, the yields to the farmer were considerably higher when the corn was harvested for the ordinary cream style pack. The experiments are conducted on a larger scale this year to determine if more satisfactory yields can be obtained for the whole kernel style of pack, which seems to be gaining in popularity with the consumer.

Pea breeding.—From a large number of pea crosses made in 1926, 40 have become homozygous, and of these, 3 give promise of being genuinely superior varieties. These 3 will be saved and multiplied next year for further trial.

Importance of early planting of peas.—For 6 years experiments have been conducted to determine the best date of planting peas. Every year the first planting of all varieties was made just as early as the ground could be worked in the spring, and the plantings were repeated each week for 8 weeks. Four varieties were used in this experiment, 3 of which were sweet wrinkled varieties. Every year at least 2, and frequently 3, of the earliest plantings were frozen in the ground and buried under snow, but at no time did any injury result. Every year the highest returns have been secured from the early planted peas. This was particularly true with the so-called late sweets which were benefited most by the early plantings. It costs no more to plant early and it will result in increased yields. In checking over the reasons for poor germination in certain plantings each year, it was found that heavy rain or snow within 24 hours after planting always reduced the germination. Similar precipitation within 48 hours also reduced germination and to a lesser extent within 72 hours. It is very evident from these results that the farmer would get better yields by planting peas after a rain rather than just before a rain.

Effect of gypsum and other soil amendments on the control of pea root-rot.—As reported last year, a marked resistance to pea root-rot was found on plats to which gypsum and calcium chloride had been applied as a soil amendment. This year the treatments were given a much more severe test. The peas in this experiment were planted on soil that was so seriously infested with root-rot that peas grown there last year were a failure. The effectiveness of the gypsum in controlling the root-rot was strikingly demonstrated and gave increases in yield amounting to greater than 50 per cent.

A new treatment was introduced this year consisting of 2,000 pounds per acre of a 4-10-6 fertilizer. Such a heavy rate of fertilizing would not be practical to a grower of canning crops, but might be practical to a market gardener. This treatment also gave large increases in yield, and apparently enabled the plants

to outgrow the root-rot. However, a much cheaper treatment consisting of 1,600 pounds of gypsum per acre plus a small amount of complete fertilizer gave better root-rot control and heavier yields. Since root-rot is one of the most serious limiting factors in growing peas for canning, this treatment is of great practical value to growers and canners of peas.

This year this experiment was laid out as a demonstration in 3 other parts of the State and in each case showed the benefit of the gypsum treatment. However, some tests also demonstrated the limitations of the treatment, namely, that it will not control all soil-borne diseases, such as fusarium wilt. The Division of Botany is cooperating in determining which of the many complex soil diseases are controlled and which are not by these soil treatments.

The effect of various fertilizers on quality of canning peas.—This experiment, which is described in Technical Bulletin No. 176, is being continued and includes field yields, chemical analyses thru the cooperation of the Chemistry Division, and commercial canning tests thru the cooperation of the Geneva Preserving Company and the American Can Company. It appears that there is an organic base exchange in peas in which calcium may be substituted for potassium and vice versa, and that calcium is the principal nutrient element causing hardness of peas. However, the general conclusion reached was that if a farmer will fertilize for quantity, quality of peas will not be adversely affected. Further work is being done thru the cooperation of the Chemistry Division to determine if a mechanical tester can be devised which will show the best stage for harvesting peas, the object being to predict in the field what quality pack will result under the new grading standards of the McNary-Mapes law.

New varieties of peas for canning.—Twelve entirely new varieties of peas for canning have been grown this season and packed thru the courtesy of the Geneva Preserving Company to determine their field yields and canning quality. Some of the outstanding varieties in this test were Maryland Alaska, Early Canner, Profusion, and Rice's Producer.

Studies of pumpkin and squash in regard to yield and canning quality.—During the past year a study was made in cooperation with the Chemistry Division in which all varieties of pumpkin and

squash suitable for canning were compared. The object of this test was to determine the most profitable varieties to be grown in this State, and to determine what factors cause heavier consistency in the can. Growers in the Pacific Northwest were producing a canned product of heavier consistency that seemed to be preferred on the market.

It was found that by growing the Golden Delicious variety of squash the canner in this State could obtain as thick a consistency as desired by blending it with any of the more watery varieties. Chemical analyses showed that the thickness of consistency was directly in proportion to the starch, total solids, and insoluble solids found in the variety. The Connecticut Field pumpkin gave the heaviest tonnage per acre, but due to its lack of starch and total solids made a watery pack and did not fill nearly as many cans per acre as the Golden Delicious squash, which, with half the tonnage, produced more cans per acre.

Comparison of vegetable varieties for preservation by quick freezing.—An experimental laboratory has been installed thru the cooperation of the Frosted Foods Corporation to determine which of the varieties of peas, beans, rhubarb, tomatoes, and sweet corn are most suitable for preserving by quick freezing. Some of the new varieties of peas have proved very satisfactory for this method of food preservation.

STUDY OF VEGETABLE VARIETIES

A rather complete trial of beans was carried out during the 1930 growing season. This trial comprised a total of 340 different varieties made up of 31 dwarf limas, 37 pole limas, 69 green pod bush, 84 wax pod bush, 11 dwarf horticulturals, 45 field beans, and 63 pole beans. Descriptive records were taken on new varieties and on varieties on which rather incomplete data were available, and the existing records checked against the material in the field. These records are being compiled for THE BEANS OF NEW YORK to be available in 1931. In connection with the trial ground work on beans, the information available in the literature on the history, origin, and introduction of varieties has been studied and compiled. This study shows the constant shifting of varieties of vegetables for any region.

Quality is an increasingly important factor in the standing of

any given variety. For garden and market varieties in wax pods the outstanding varieties with attractive pods of good quality are Pencil Pod, Brittle Wax, Improved Kidney Wax, and Sure Crop; and for green pods, Bountiful, Stringless Greenpod, Tendergreen. The varieties most suited for canning, producing meaty pods without string or parchment, were Stringless Green Pod Refugee, Giant Stringless Green Pod, Full Measure, Low's Champion, Stringless Refugee Wax, Brittle Wax, and Improved Kidney Wax. A number of newer varieties of dwarf beans that have been introduced during the last 10 years are well worth a trial, among these being Asgrow Valentine, Byers, Golden Age, and New Stringless Greenpod. There are 3 outstanding varieties of dwarf limas, *viz.*, the small seeded Henderson, the large seeded Burpee Bush, and Fordhook. There are several varieties of the dwarf beans grown for snap pods that also are suitable for the production of green shell beans, such as Low's Champion, but the outstanding variety for the production of shell beans is French Horticultural. Pole beans require a season from 20 to 30 days longer than that required for the dwarf beans. For this reason, and because of the necessity of furnishing supports, they find their chief value in the home garden. Kentucky Wonder, Black-seeded Kentucky Wonder, Scotia, and Golden Cluster Wax are the leading varieties.

The work of growing and describing varieties of other vegetable crops is in various stages of completion. Sweet corn and the cucurbits are the crops to follow beans.

THE GENEVA CUCUMBER

A limited test was made of 8 of the better selections of Geneva cucumber in the greenhouse. Small differences between these selections were noted. Four of the selections produced normal Geneva plants and fruits, 2 others produced fruit of excellent type but were slow in setting, and 1 proved to have a greater tendency to produce fruit with restricted neck. The remaining selection seemed quite promising, producing fruits which were dark green in color and quite similar to White Spine in shape. They were also seedless. Selfed seed of the 8 selections was secured and crosses made between plants of the selections and plants of 3 leading commercial varieties. Seed of the best of the Geneva selections were distributed to 68 individuals who had requested seed for trial.

Publications and Exhibits

BULLETINS AND CIRCULARS

Despite the fact that no more money was available for publication purposes than for the previous year, nevertheless the year which ended June 30 last was marked by a pronounced increase in volume of printed material over that reported a year ago. In all, 44 publications were issued, comprising 1,083 pages with a total edition of 221,000 copies, as compared with 38 pamphlets having 849 pages and 201,000 copies for the year of 1929-30. A list of the bulletins and circulars published during the past year will be found at the end of this report.

Classified mailing lists were again utilized this past year to effect the distribution of Station publications. In all, 122,720 bulletins and circulars were mailed to these lists. In addition to this distribution, 71,935 pamphlets were sent out in response to requests received in the daily mail.

NEWS SERVICES

The editorial office continues to supply the newspapers of the State, farm and trade papers, and the State Farm Bureau publications with timely news stories about the work of the Station, emphasizing particularly the results obtained in the numerous experiments reported from time to time in the bulletins and circulars. During the past year, 305 such stories were sent to newspapers and farm papers. In addition, 39 items were sent to the Extension Department of the College of Agriculture for use in Farm Bureau and other extension mediums.

NEW RADIO SERVICE

Mention was made in the last report of the desirability of the editorial office making more effective use of the radio as a means of disseminating information about the work of the Station. Within the past few months several of the leading radio stations which serve the State and the surrounding territory were approached as to their interest in a weekly service of timely items from this Station. At present from two to four pages per week are being sent to six of these stations with a fairly satisfactory response on the part of the radio audience as evidenced by inquiries stimulated by the reading of these notes.

EXHIBITS

The Editor has continued to serve as chairman of the Staff committee on exhibits, and much the same exhibit program prevailed during the past year as described for 1929-30. A unified Station exhibit was again featured at the State Fair in the fall of 1930, while the combination of Station and College of Agriculture exhibits at the winter meetings of the State Horticultural Society proved highly successful.

List of Publications

TECHNICAL BULLETINS

No. 162. July. Open pollination vs. hand pollination of pollen-sterile grapes, by Olav Einset. Pages 14, figs. 6. Distributed August 22, 1930.

No. 163. July. The Eriophyidae of New York: II. The maple mites, by H. E. Hodgkiss. Pages 45, plates 14, fig. 1. Distributed October 3, 1930.

No. 164. July. Variability and size relations in apple trees, by R. C. Collison and J. D. Harlan. Pages 38. Distributed October 3, 1930.

No. 165. July. The bacterial flora of aseptically drawn milk, by W. Dorner. Pages 39. Distributed October 3, 1930.

No. 166. July. Lysimeter investigations: I. Nitrogen and water relations of crops in legume and non-legume rotations, by R. C. Collison and J. E. Mensching. Pages 90, figs. 3. Distributed December 13, 1930.

No. 167. July. Studies on the Coccaceae: XVI. The genus *Leuconostoc*, by G. J. Hucker and Carl S. Pederson. Pages 80, plates 6, figs. 10. Distributed December 13, 1930.

No. 168. July. Floral changes in the fermentation of sauerkraut, by Carl S. Pederson. Pages 37, plate 1, figs. 14. Distributed December 13, 1930.

No. 169. September. The effect of pure culture inoculation on the quality and chemical composition of sauerkraut, by Carl S. Pederson. Pages 29, figs. 14. Distributed December 13, 1930.

No. 170. December. Xenia and metaxenia in apples, by B. R. Nebel. Pages 16, figs. 5. Distributed March 19, 1931.

No. 171. December. Aphids as vectors of leafroll among sprouting potato tubers, by F. C. Stewart and Hugh Glasgow. Pages 21, figs. 6. Distributed March 19, 1931.

No. 172. December. Influence of various non-nitrogenous compounds on the growth of certain bacteria in soils of low productivity, by H. J. Conn and Mary A. Darrow. Pages 40. Distributed March 19, 1931.

No. 173. December. Preparation of soil profiles for exhibition and soil study, by R. C. Collison and J. D. Harlan. Pages 8, figs. 2. Distributed January 14, 1931.

No. 174. March. The utilization of dry skimmilk in the manufacture of ice cream and cream cheese, by J. C. Marquardt. Pages 24. Distributed May 21, 1931.

No. 175. March. Virus diseases of black raspberries, by W. Howard Rankin. Pages 24. Distributed May 21, 1931.

No. 176. March. Factors affecting the quality of commercial canning peas, by C. B. Sayre, J. J. Willaman, and Z. I. Kertesz. Pages 76, figs. 8. Distributed June 29, 1931.

No. 177. June. China aster seed treatment and storage, by W. O. Gloyer. Pages 41, figs. 5. Distributed July 21, 1931.

No. 178. June. The enzymic clarification of grape juice, by J. J. Willaman and Z. I. Kertesz. Pages 15. Distributed July 21, 1931.

No. 179. June. Factors influencing the pectin content of stored apple pomace, by Z. I. Kertesz and E. L. Green. Pages 14, Fig. 1. Distributed July 21, 1931.

REPORT

Forty-ninth annual report for the fiscal year ended June 30, 1930, by U. P. Hedrick. Pages 99. Distributed December 13, 1930.

BULLETINS

No. 584. October. Commercially prepared infant foods, by G. J. Hucker and Alice M. Hucker. Pages 13, figs. 5. Distributed December 13, 1930.

No. 585. October. Straining milk on the farm, by A. C. Dahlberg. Pages 22, figs. 6. Distributed January 9, 1931.

No. 586. October. Combating damping-off of tomatoes by seed treatment, by J. G. Horsfall. Pages 22, fig. 2. Distributed January 9, 1931.

No. 587. December. The quality of packet vegetable seed on sale in New York in 1929 and 1930, by M. T. Munn, Olive Hoefle Sipple, and Mary E. Woodbridge. Pages 27. Distributed January 14, 1931.

No. 588. December. Filberts, by G. L. Slate. Pages 32, figs. 3. Distributed January 14, 1931.

No. 589. December. A new method for enzymic clarification of unfermented apple juice, by Zoltan I. Kertesz. Pages 10, fig. 1. Distributed January 14, 1931.

No. 590. January. Cucumber disease investigations on Long Island, by E. E. Clayton. Pages 20, figs. 5. Distributed March 19, 1931.

No. 591. February. How the cream layer forms on milk, by A. C. Dahlberg and J. C. Marquardt. Pages 11, figs. 2. Distributed May 21, 1931.

No. 592. February. Spraying and dusting experiments with potatoes on Long Island, by H. C. Huckett. Pages 38, figs. 5. Distributed May 21, 1931.

No. 593. March. The creaming of raw milk, by A. C. Dahlberg and J. C. Marquardt. Pages 11, figs. 2. Distributed May 21, 1931.

No. 594. March. Composition and cost of commercial fertilizers in New York from 1913 to 1930, by A. W. Clark, W. F. Walsh, and F. J. Kokoski. Pages 19. Distributed May 21, 1931.

CIRCULARS

No. 31 (Revised). April. Strawberries, by G. L. Slate. Pages 11.

No. 33 (Revised). April. Raspberries, blackberries, and dewberries, by G. L. Slate. Pages 9.

No. 58 (Reprinted). November. Counting bacteria by means of the microscope, by Robert S. Breed and James D. Brew. Pages 12, figs. 6.

No. 105 (Revised). July. Available publications. Pages 7.

No. 115 (Revised). April. How to whip cream, by J. C. Hening. Pages 5, figs. 4.
No. 116. July. Bulletins and circulars available at the Experiment Station. Pages 6, figs. 3.
No. 117. December. Identification of Mazzard and Mahaleb cherry rootstocks, by H. B. Tukey. Pages 12, figs. 7.
No. 118. February. The treatment of pea seed with chemical materials, by Leon K. Jones. Pages 3.
No. 119. February. Aphids on potato sprouts, by F. C. Stewart and Hugh Glasgow. Pages 6, figs. 2.
No. 120. February. Damping-off of tomatoes combated by seed treatment with copper compounds, by James G. Horsfall. Pages 4, fig. 1.
No. 121. March. Orchard management. Pages 21.
No. 122. May. Aster seed treatment, by W. O. Gloyer. Pages 6, figs. 2.

JOURNAL ARTICLES

In addition to the bulletins and circulars listed above, a number of technical articles reporting on various phases of research work under way on Station projects have appeared in scientific journals or trade papers during the past year. These articles are listed below.

Breed, Robert S. Udder infections due to streptococci. *Proc. 23d Ann. Conv., Intern. Assoc. Milk Dealers, 57-75. 1930.*
Breed, Robert S., Hansen, P. Arne, *et al.* Determinative Bacteriology of Lehmann and Neuman. (Translation of 7th German edition). *New York: G. E. Stechert, Vol. I, 1930; Vol. II, 1931.*
Carpenter, D. C. The molecular weight of casein, III. *Journ. Amer. Chem. Soc.*, **53**, *1812–1826. 1931.*
Carpenter, D. C. Recent research and discoveries in dairy chemistry, with special reference to the caseins of milk. *Proc. 23d Ann. Conv., Intern. Assoc. Milk Dealers, 5–27. 1930.*
Carpenter, D. C., and Hucker, G. J. Serologic studies on the proteins found in casein. *Jour. Infect. Dis.*, **47**, *435–442. 1930.*
Chapman, P. J. Apple maggot studies in 1930. *Journ. Econ. Ent.*, **24**, *686–691. 1931.*
Chapman, P. J., Parker, M. M., and Gould, G. E. The Euonymus scale. *Jour. Econ. Ent.*, **24**, *764–765. 1931.*
Chapman, P. J. Corrodentia of the United States of America: I. Suborder Isotecnomera. *N. Y. Ent. Soc. Jour.*, **38**, *219–290; 319–403. Pls. XII–XXI. 1930.*
Chapman, P. J. Apple maggot studies in New York State. *Mass. Fruit Growers' Assoc., 37th Ann. Rpt., 29–41. 1931.*
Chapman, P. J. The apple maggot. *Proc. 76th Ann. Meet., New York State Hort. Soc., 201–210. 1931.*

Collison, R. C. The relation of organic matters to fruit growing. *Proc. 76th Ann. Meet., New York State Hort. Soc., 102–110. 1931.*

Conn, H. J. Progress in the standardization of stains: Cancer research. *Stain Tech.*, **5**, *77–78. 1930.*

Conn, H. J. The history of staining: The staining of blood and parasitic protozoa. *Stain Tech.*, **5**, *127–134. 1930.*

Conn, H. J. Progress in the standardization of stains: Stains for frozen sections. *Stain Tech.*, **6**, *1, 1931.*

Conn, H. J. Progress in the standardization of stains: How much is certification worth? *Stain Tech.*, **6**, *33–36. 1931.*

Conn, H. J. Notes on technic: Methylene blue for staining the diptheria organism. *Stain Tech.*, **6**, *65–66. 1931.*

Dahlberg, A. C., and Hening, J. C. What the dairy scientists have learned about ice cream. *Ice Cream Trade Jour.*, **26**, *No. 7. 1930.*

Dahlberg, A. C., and Marquardt, J. C. Better milk cooling equipment on the farm. *Amer. Cry. and Poultry Prod. Rev.*, **70**, *No. 18. 1930.*

Daniel, D. M. Oriental peach moth experiments. *Jour. Econ. Ent.*, **24**, *317–318. 1931.*

Daniel, D. M. The oriental peach moth. *Proc. 76th Ann. Meet., New York State Hort. Soc., 8–10. 1931.*

Gambrell, F. L. The fruit flies of New York. *Jour. Econ. Ent.*, **24**, *226–232. 1931.*

Gambrell, F. L. The spruce gall aphid, *Adelges abietis*, as a nursery problem. *Jour. Econ. Ent.*, **24**, *355–361. 1931.*

Glasgow, Hugh. The present status of carrot rust fly control in New York. *Jour. Econ. Ent.*, **24**, *189–196. 1931.*

Glasgow, Hugh, and Gaines, J. G. The carrot rust fly problem in New York. *New York State Dept. Agr. and Markets Bul. No. 240, 70–76. 1930.*

Glasgow, Hugh, and Cook, Harold T. Onion maggot control in New York. *New York State Dept. Agr. and Markets Bul. No. 240, 76–84. 1930.*

Gloyer, W. O. The drought of 1930 and its effect upon plant disease. *Proc. 76th Ann. Meet., New York State Hort Soc., 4–8. 1931.*

Hamilton, J. M. Studies of the fungicidal action of certain dusts and sprays in the control of apple scab. *Phytopathology*, **21**, *445–523. 1931.*

Hamilton, J. M. Some relations of environment of apple scab and its control. *Proc. 76th Ann. Meet., New York State Hort. Soc., 185–189. 1931.*

Hansen, P. Arne. Lactic acid bacteria and the ripening of cream. *Festskrift Orla-Jensen. 1931.*

Harman, S. W. The cranberry rootworm as an apple pest. *Jour. Econ. Ent.*, **24**, *180–182. 1931.*

Hartzell, F. Z. The Latin square arrangement of experimental plats. *Jour. Econ. Ent.*, **23**, *747–753. 1930.*

Hartzell, F. Z. The pear midge. *Proc. 76th Ann. Meet., New York State Hort. Soc., 189–197. 1931.*

Hartzell, F. Z. Investigations aimed at reducing the cost of pear psylla control. *Jour. Econ. Ent.*, **24**, *71–77. 1931.*

Hartzell, F. Z. Ecotopographic maps: Their use in entomology and notes on making. *Jour. Econ. Ent.*, **24,** *151–157. 1931.*

Hartzell, F. Z., and Gambrell, F. L. Relation of environment to pear psylla infestation. *Jour. Econ. Ent.*, **24,** *66–71. 1931.*

Hening, J. C. Some observations on the basic viscosity of ice cream mixes. *Jour. Dairy Sci.*, **14,** *84–92. 1931.*

Hening, J. C. The basic viscosity of mix. *Ice Cream Trade Jour.*, **27,** *41–42 and 45. 1931.*

Hening, J. C. Results of recent technical research in New York State. *Ice Cream Field,* **18,** *No. 5. 1930.*

Hervey, George E. R., and Hartzell, F. Z. Influence of planting dates on European corn borer infestations. *Jour. Econ. Ent.*, **24,** *183–188. 1931.*

Hervey, George E. R., and Horsfall, James G. A simple device for humidity regulation. *Science,* **73,** *617–618. 1931.*

Hucker, G. J., and Hucker, Alice M. Commercially prepared infant foods. *Concentrated Milk Industries,* **1,** *No. 9, 11–12. 1931.*

Hucker, G. J. The general relationships of certain of the lactic acid bacteria. *Festskrift Orla-Jensen. 1931.*

Huckett, H. C. The tolerance of beans to sprays and dusts for the Mexican bean bettle. *Jour. Econ. Ent.*, **29,** *200–204. 1931.*

Kertesz, Z. I. The acidity optimum of yeast hexosediphosphatase. *Jour. Amer. Chem. Soc.*, **52,** *4117–4119. 1930.*

Kertesz, Z. I. Changes in the chemical composition of picked and shelled cannery peas. (In Hungarian) *Mezögasdasági Kutatások.*, **3,** *451–457. 1930.*

Kertesz, Z. I. The estimation of enzyme yield in fungus cultures. *Jour. Biol. Chem.*, **90,** *15–23. 1931.*

Kertesz, Z. I. The discharge of saccharase from the mycelium of *Penicillium glaucum. Plant Physiol.*, **6,** *247–264. 1931.*

Marquardt, J. C. Solubility of milk powders. *Dairy Products,* **37,** *No. 12, 8–10. 1930.*

Marquardt, J. C. Importance of the solubility of milk powders. *Concentrated Milk Industries,* **1,** *No. 1, 41–43. 1930.*

Marquardt, J. C. Solubility of milk powder and its significance. *Milk Plant Monthly,* **15,** *No. 12, 18–20. 1930.*

Mundinger, F. G. Studies in apple maggot control in the Hudson Valley. *Jour. Econ. Ent.*, **23,** *764–769. 1930.*

Mundinger, F. G. Apple maggot investigations in 1930. *Jour. Econ. Ent.*, **24,** *80. 1931.*

Mundinger, F. G. The pear midge. *Journ. Econ. Ent.*, **24,** *196–200. 1931.*

Nebel, B. R. Lacmoid-martius-yellow for staining pollen-tubes in the style. *Stain. Tech.*, **6,** *27–29. 1931.*

Nebel, B. R. A thumb test for distinguishing Mazzard (*Prunus avium L.*) and Mahaleb (*P. mahaleb L.*) rootstocks. *Amer. Nat.*, **65,** *95–96. 1931.*

Nebel, B. R. Recent findings in cytology of fruits (cytology of Pyrus, III). *Proc. Amer. Soc. Hort. Sci.*, **1930,** *406–410. 1931.*

Parrott, P. J., and Hartzell, F. Z., Glasgow, Hugh, and Harman, S. W. Hints at new spray procedures. *Jour. Econ. Ent.*, **24,** *297–302. 1931.*

Parrott, P. J. Old spray problems from new angles. *Proc. 76th Ann. Meet., New York State Hort. Soc., 22–31. 1931.*

Pederson, Carl S. Bacterial spoilage of a Thousand Island dressing. *Jour. Bact.*, **20,** *99–106. 1930. The Spice Mill,* **54,** *405–407. 1931. The Canner,* **72,** *3, 33. 1931.*

Sayre, C. B., and Nebel, B. R. Some effects of different nutrient solutions on the structure, composition, and quality of peas. *Proc. Amer. Soc. Hort. Sci.,* **1930,** *221–226. 1931.*

Sayre, C. B. Growing vegetables for the canning industry. *New York State Dept. Agr. and Markets Bul. No. 240, 118–128. 1930.*

Sayre, C. B. Relation of the variety of pumpkin and squash to starch content, consistency of the canned product, and yield. *The Canner,* **72,** *No. 10, Part 2, 63–67. 1931. Canning Age,* **12,** *No. 3, 177. 1931. Canning Trade,* **53,** *Part 2. 1931.*

Sayre, C. B. Field yield of corn in relation to whole kernel and cream style pack. *The Canner,* **72,** *No. 10, Part 2, 148–152. 1931. Canning Age,* **12,** *No. 3, 165. 1931. Canning Trade,* **53,** *Part 2. 1931.*

Stewart, F. C., and Glasgow, Hugh. Aphids as vectors of leafroll among sprouting potato tubers. Abs. in *Phytopathology,* **21,** *103–104. 1931.*

Streeter, L. R. Studies on spray residue. *Proc. 76th Ann. Meet., New York State Hort Soc., 51–54. 1931.*

Streeter, L. R., Chapman, P. J., and Pearce, G. W. Experiments in spray residue removal. *Jour. Econ. Ent.*, **24,** *240–244. 1931.*

Tukey, H. B., and Brase, Karl. Factors in the production of cherry trees in the nursery. *Proc. Amer. Soc. Hort. Sci.,* **1930,** *88–92. 1931.*

Tukey, H. B., and Brase, Karl. Granulated peat moss in field propagation of apple and quince stocks. *Proc. Amer. Soc. Hort. Sci.,* **1930,** *106–108. 1931.*

Tukey, H. B. Factors in the production of cherry trees in the nursery. *Florists Exchange,* **76,** *No. 4, 31. 1931.*

Tukey, H. B. Are you, too, killing your plants before you sell them? *Nat. Nurseryman,* **39,** *No. 5, 5–6. 1931.*

Van Eseltine, G. P. The taxonomic status of the cultivated apple. *Proc. Amer. Soc. Hort. Sci.,* **1930,** *430–434. 1931.*

Wellington, Richard. Present status of fruit pollination studies in the United States and Canada. *Royal Hort. Soc. Rpt. and Proc. IXth Intern. Hort. Congress (London), 297–304. 1930.*

Wellington, Richard. The value of the European grape in breeding grapes for New York State. *Proc. Amer. Soc. Hort. Sci.,* **1930,** *416–421. 1931.*

Wellington, Richard. New peach varieties. *Proc. 76th Ann. Meet., State Hort. Soc., 220–222. 1931.*

Yale, M. W., and Breed, Robert S. The control of thermophilic bacteria in pasteurizing plants. *Amer. Jour. Public Health,* **20,** *1192–1198. 1930.*

Financial Statement

EXPENDITURES DURING THE YEAR ENDED JUNE 30, 1931

Expenditures contracted for and chargeable to preceding year, but paid for after July 1, 1930:

From Appropriation by Chapter 593, Part 1, Laws of 1929:		
Maintenance and operation:		
Fuel, light, power, and water	$214 66	
Printing	728 93	
Equipment, supplies, and materials	2,022 88	
Travel	100 82	
Communication	189 39	
Repairs	3,312 12	
Contingencies	25 00	
Total maintenance and operation		$6,593 80
Maintenance undistributed:		
Long Island Vegetable Research Farm	$187 13	
Hudson Valley Horticultural Investigations	832 53	
Nursery shrubs and plants	1,201 94	
Corn borer investigations	285 34	
Total maintenance undistributed		2,506 94
Maintenance undistributed:		
Chapter 361, Part 1, Laws of 1929:		
Investigations of certain moths and insects	$1,451 04	
Total maintenance undistributed		1,451 04
Fredonia Deficiency:		
Chapter 85, Part 2, Laws of 1930	$1,565 97	
		1,565 97
Expenditures chargeable to current year's funds, from appropriations Chapter 85, Part 1, Laws of 1930:		
Personal service:		
Salaries	$166,450 00	
Labor	33,999 50	
Total personal service		$200,449 50

Maintenance and operation:		
Fuel, light, power, and water	$9,750 00	
Printing	8,042 34	
Equipment, supplies, and materials	31,302 02	
Travel	4,999 99	
Communications	2,997 15	
Repairs	13,649 96	
Rentals	3,130 40	
Fixed charges	682 40	
Contingencies	47 00	
Total maintenance and operation		74,601 26
Personal service:		
Long Island Vegetable Research Farm	$7,000 00	
Hudson Valley Horticultural Investigations	9,750 00	
Diseases of small fruits	3,500 00	
Hudson Valley, miscellaneous labor	1,200 00	
Total personal service		21,450 00
Maintenance undistributed:		
Investigations and Control of Insect Pests and Diseases Affecting Raspberry Plants	$999 97	
Corn borer investigations	7,067 24	
Long Island Vegetable Research Farm	1,665 81	
Hudson Valley Horticultural Investigations	3,489 92	
For study of the problems of Production, Storage, and Distribution of Nursery Shrubs and Plants, including personal service	13,132 35	
Investigations of Moths and Insects, personal services and expenses	10,187 54	
Grape Work at Fredonia, service and expenses	1,999 98	
Total maintenance undistributed		38,542 81
From Federal funds:		
Hatch fund:		
Salaries	$1,500 00	
Total Hatch fund		1,500 00
Adams fund:		
Salaries	$1,500 00	
Total Adams fund		1,500 00

Purnell fund:		
Salaries	$4,500 00	
Labor	1,260 00	
Equipment, supplies, and materials	240 00	
Total Purnell fund		6,000 00
From income from sale of farm products:		
Personal service	$541 16	
Labor	4,636 89	
Fuel, light, power, and water	350 77	
Sale of books returned to comptroller	293 50	
Printing	54 44	
Equipment, supplies, and materials	2,035 37	
Traveling expense	806 08	
Repairs	3,328 68	
Rent	202 00	
Insurance	337 80	
Communication	31 19	
Total income from sale of farm products		12,617 88
Total expenditures		$368,779 20

APPROPRIATIONS FOR THE YEAR ENDED JUNE 30, 1931

Funds available from appropriation by the Legislature of 1930 were as follows:

Personal service:		
Salaries of staff, etc.	$166,450 00	
Laborers	34,000 00	
Long Island Vegetable Research Farm	7,000 00	
Hudson Valley Horticultural Investigations	10,950 00	
Diseases of Small Fruits	3,500 00	
Total personal service		221,900 00
Maintenance and operation:		
Fuel, light, power, and water	$9,750 00	
Printing, and advertising	9,000 00	
Equipment, supplies, and materials	31,500 00	
Traveling expenses	5,000 00	
Communication	3,000 00	
Fixed charges and contributions	725 00	
Rent	3,200 00	
Repairs, and alterations	13,650 00	
Contingencies	100 00	
Total maintenance and operation		75,925 00
Maintenance undistributed by Chapter 85, Part 1, Laws of 1930:		
Controlling Raspberry Pests and Diseases	$1,000 00	
Corn Borer Investigations	7,250 00	
Long Island Vegetable Research Farm	1,800 00	
Hudson Valley Horticultural Investigations	3,500 00	
For the Study of the problems of Production, Storage, and Distribution of Nursery Shrubs and Plants, including personal services	13,450 00	
Investigations of Moths and Insects	13,000 00	
Services and expenses in Grape Work at Fredonia	2,000 00	
Total maintenance undistributed		42,000 00
Maintenance undistributed by Chapter 765, Laws of 1930:		
Oriental Peach Moth Investigations	$37,000 00	
Total maintenance undistributed		37,000 00
Total available for the year		$376,825 00

APPROPRIATIONS FOR THE YEAR ENDING JUNE 30, 1932

Funds made available from appropriations by the Legislature of 1931 are as follows:

By Chapter 21, Laws of 1931 to be available for the year ending June 30, 1932:

Personal service:		
Salaries of staff	$170,630 00	
Laborers	35,000 00	
Long Island Vegetable Research Farm	7,800 00	
Hudson Valley Horticultural Investigations	11,750 00	
Controlling Pests and Diseases Affecting Raspberry Plants	3,500 00	
Total personal service		228,680 00
Maintenance and operation:		
Fuel, light, power, and water	$9,750 00	
Printing, and advertising	9,000 00	
Equipment, supplies, and materials	33,000 00	
Traveling expense	5,000 00	
Communication	3,250 00	
Fixed charges and contributions	450 00	
Rent	3,200 00	
Repairs	13,650 00	
Contingencies	50 00	
Total maintenance and operation		77,350 00
Maintenance undistributed:		
For expenses, including personal service, of an Investigation into Methods of Suppressing or Controlling Insect Pests and Diseases Affecting Raspberry Plants	$1,000 00	
Corn Borer Investigations	7,250 00	
Long Island Vegetable Research Farm	3,500 00	
Hudson Valley Horticultural Investigations	3,500 00	
For Study of the Problems of Production, Storage, and Distribution of Nursery Shrubs and Plants, including personal service	13,450 00	
Investigations of Moths and Insects	50,000 00	
Services and expenses in Grape Work at Fredonia	2,750 00	
Utilization of Fruit and Vegetable By-products	10,000 00	
Seed Investigations, services and expenses	9,000 00	
Legume Inoculants, services and expenses	5,000 00	
Total maintenance undistributed		105,450 00

By Chapter 565, Part 1, Laws of 1931, immediately available for the year ending June 30, 1932:

Maintenance undistributed:		
Services and expenses for Investigations, Suppressing or Controlling Insect Pests and Diseases Affecting Small Fruits in Chautauqua, Erie, and Niagara Counties (including the purchase of an automobile or an auto truck at not to exceed $700).	5,000 00	
Total maintenance undistributed		$5,000 00
Total available for the year		$416,480 00

July 1, 1931.

U. P. HEDRICK,
Director.

APPENDIX

Meteorological Records, 1883 to 1930

Meteorological Records, 1883 to 1930.

Monthly Maximum and Minimum Temperatures from 1883 to 1930, Inclusive.

(Highest and Lowest Record for Each Month in Bold Face Type).

Year	January				February				March				April			
	Max.		Min.		Max.		Min.		Max.		Min.		Max.		Min.	
	Date	Temp.	Date	Temp.	Date	Temp.	Date	Temp.	Date	Temp.	Date	Temp.	Date	Temp.	Date	Temp.
1883	18	44	11	—9	17	48	24	—2	19	61	9	2	16	75	1	19
1884	14	42	26	—13	7	55	29	—3	30	54	1	—4	28	74	1	23
1885	1	61	29	—6	10	38	11	—11.5	28	48	13	—11	24	84.5	10	20.5
1886	5	52.5	13	—18.7	9	50	27	—11	16	58	2	—2.5	24	80.5	4	22
1887	24	50.7	19	—8	9	54.2	27	—4	3	51.7	1 &	8.7	11	75.7	1	17.2
1888	2	43.2	23	—6	21	49	10	—7	28	57	13	0	29	82.5	8	19
1889	18	55	20	5	23	42	4 & 24	—7	28	61.8	30	18.5	20	84	1	26
1890	6	67	29	9	5	64.5	11 & 21	9.5	13	62	8	2	13	78.8	1 & 19	23
1891	3	46	17	4	26	56.8	15	2.5	12	57	2	4.5	28	81.4	7	21
1892	3	48	10	—5	15	44	6	2.8	27	52.2	4	6	6	78	17	25.5
1893	29	46	11	—6	15	47.4	5	—1	24	54	5	9	13	75.3	26	25
1894	5	59	13	11	20	47.6	27	—8.5	18	73	26	15	21	71.3	2	20
1895*	7	45	19	4	25	46	8	—14	25	52	5 & 16	12	30	80	3	28
1896	30	44	6	—16.5	29	49	17	—21	31	56.5	24	—2	17	87	4 & 5	19
1897	5	58	20	—3.5	18	49.5	1 & 27	5.5	21	64	1	—1	26	82	20	19
1898	13	57	30 & 31	—4	12	56.5	2 & 3	—2	11	†65	2	17.5	14 & 18	69	5	18
1899	5	59	12	—4	21	52.5	11	—8	13	63	21	13	30	82	3	23
1900	23	56	1	2	14	57	27	0	10	46	12	—3	30	‡73.5	9	22
1901	16	48	20	—2	16	36	24	—2.5	24	67	6	—1	28	78	12	28
1902	3	44	28	2	28	52	6	—3	12	66.5	19	14	22	87	5	25
1903	3	48	9	—2	28	62.5	18	—4	19	78.5	1 & 2	19	30	86	5	21
1904	23	48	19	—14	7	58	16	18	26	58	4	8	24	67.5	14	16
1905	1	49	26	—2	20	45	5 & 14	—6	29	82	5	1	27 & 28	75	16	23
1906	21	71	9	4	24	64	6 & 7	—7	27	51	25	2	19	74	2	25
1907	6	53	24	—18	2	47	12	—4	29	83	7	—1	29	73	2	19
1908	22	45	31	—9	15	53	2 & 5	—14	28	73	1	8	27	78	4	18
1909	24	64	19	—7	5	52	1	—1	10	52	5	5	19	75	11	12
1910	2 & 22	45	5	—8	16	29	7	—3	24	82	14 & 18	17	4	84	7	27
1911	27 & 30	48	5	—1	17	52	22	4	27	60	16	—1	29	80	3	18
1912	18	44	14	—12	24	48	10	—10	31	62	4	—1	6	78	4	19
1913	17	57	13	8	20	65	10	—10	14 & 15	69	7 & 8	1	24	84	20	24
1914	29	51	13 & 14	—9	3	52	13 & 24	—14	26	65	12	7	19	82	9 & 13	22
1915	7	46	30	—3	21 & 23	53	10	10	25	50	1	11	25 & 26	88	5	23
1916	27	61	17	—3	1	47	15	—8	31	58	18	—3	21	73	8	26
1917	6	47	11 & 12	1	26	55	13	—8	31	68	6 & 29	11	22	80	11 & 18	23
1918	12	40	2	—10	20	55	5	—11	20	74	11	7	1 & 29	73	9	23

1919.....	21	5	12	—1	28	54	11	8	26	69	7	3	23	71	1	10
1920.....	13	39	31	—16	2	44	1	—16	26	73	2	—1	1 & 2	73	10	22
1921.....	20 & 21	52	18 & 19	0	16	57	20	11	27	84	4	12	26	86	11	23
1922.....	15 & 19	47	27	—8	23	65	17	—10	28	67	18	14	10	80	22	24
1923.....	3	41	7 & 30	—9	8	42	4	—1	21	61	28 & 29	3	21	85	1	6
1924.....	11	52	27	—4	27	40	25	—5	23	54	14	15	28	70	1	20
1925.....	7	41	28	—12	23	57	2	2	26	74	3	24	24	84	5	19
1926.....	5	54	29	—1	7 & 26	43	9	—1	22	54	6	2	24	71	15	18
1927.....	30	56	27	—10	23	55	20	11	17	74	4	13	19	82	23	21
1928.....	7	52	30	—2	14	68	26	—1	24	74	11	8	5 & 6	80	11	22
1929.....	19	57	14	—1	18	43	21	—3	21 & 23	68	10	5	6 & 7	81	2	22
1930.....	7 & 8	56	26	—4	20 & 24	64	6 & 17	—1	17	66	3	13	30	80	24	22

* Data from record kept by Mr. Edgar Parker for the year 1895; Station record not available.
† Maximum for first eleven days only. Record incomplete.
‡ Thermometers broken. Record not taken from April 19th to 24th, inclusive.

Monthly Maximum and Minimum Temperatures from 1883 to 1930, Inclusive (*Continued*).

(Highest and Lowest Record for Each Month in Bold Face Type.)

Year	May				June				July				August			
	Max.		Min.		Max.		Min.		Max.		Min.		Max.		Min.	
	Date	Temp.	Date	Temp.	Date	Temp'	Date	Temp.	Date	Temp.	Date	Temp.	Date	Temp.	Date	Temp.
1883.....	11	87	1 & 14	31	7	86.5	2	42	5	89	1	46	23	92	15	46
1884.....	24	88	30	32	25	90	15	41	2	87.5	15	50	20	95	25	44
1885.....	18	81.7	3	27.5	14	86.5	23	41.5	18	90.5	12	46.5	1	89	28	45
1886.....	23	79.5	17 & 18	37.2	14	86.2	1	42.2	7	95	1	45.2	30	91.5	6	47.7
1887.....	23	88.2	14	37.5	17	89.2	15	47.7	3	95.5	11	58.7	3	88.5	8	46
1888.....	13	79.8	3	29	23	94.1	4	40	5	89.8	16	47	9	92.6	3	48.3
1889.....	18	91.8	29	32	22	85	5	46	11	90.7	6	50.5	31	86.7	16 &17	50.3
1890.....	4	80.7	2	30	30	85.6	8	44.8	9	94.5	24	46.5	4	96.2	24	46
1891.....	11	85.5	4	29.5	16	95	6	40	14	92	31	46	12	92	29	46.5
1892.....	31	78	9	34.2	14	92	11	45.8	29	96.3	2	46.4	10	95.5	28	49
1893.....	25	88	9	35	21	94	1	44	26	95.5	24	48.4	11	94.5	13	49
1894.....	2	85.4	14	32.6	23	91.6	6	39	21	97	10	49.6	25	93	27	45.3
1895*.....	31	92	13 & 21	36	3	**96**	7	54	8	94	11	52	11	88	22	44
1896.....	11	87.5	7 & 20	40	21	89	3	41	3	94	18	49	6 & 7	96	29	44
1897.....	24	80	8	32.5	24 & 25	87.5	2	42	11	97	15	57	15	87.5	21	46
1898.....	29	79	6	34	9	90	16	40	4	96.5	12	**40**	24	90.5	28	47
1899.....	2	87.5	15	32.5	6 & 24	93	11	41.5	4	97.5	1	50	20	97.5	15	44.5
1900.....	15 & 16	88.5	7	27	25	93	10	45	17	96	1	50	11	97	2	51
1901.....	23	78	16	36	27, 28 & 29	95.5	2	42	1	97.5	20	54.5	22	90	5	52
1902.....	22	90	11	26	3	85	6	38	14 & 27	90	1	53	31	90	13	47
1903.....	19	89	2	**24**	30	86.5	1	39	9	94	15	50	18	85.5	8 & 14	45
1904.....	25	88	12	31.5	5, 24 & 25	89	12 & 17	45	19	93	3	49	25	89.5	19	45
1905.....	3	82	2	29.5	19	90	1	40	18	92	22	48.5	10	93	27	41
1906.....	24	88.5	11 & 21	30	8	92	12	37	20, 22 & 23	89	25	50	5	93	16	47
1907.....	14	85	2, 11 & 12	28	18	94	3	41	16	90	4	46	12	96.5	19	41.5
1908.....	29	90	1, 4 & 5	31	19	92	12	43	6, 11 & 30	94	9	52	4	95	25	46
1909.....	31	78	2 & 3	33	28	90	8	43	15	92	4	42	8	98	31	42
1910.....	20	79	16	31.5	22	89.9	4	**36**	9	96.5	5	50	3 & 15	90	27	44
1911.....	22	**97**	3	27	11	90.5	17	46	5	**105**	25, 26 & 27	50	8	94.5	30	47
1912.....	24	88	14	34	1	89	8	40	8 & 10	95	1	41	14	92	17	44
1913.....	**4**	91	11	30	30	92	9	37	1 & 4	95	12	50	17	98	25 & 26	44

1914.....	26 & 27	90	1	34	24 & 25	90	20	39	11	93	4	50	9	94	26	47
1915.....	23	77	3 & 4													
			10 & 27	34	18 & 19	86	4 & 9	41	31	90	22 & 23	49	1	89	27	43
1916.....	24 & 28	82	10 & 19	37	27	82	1	41	30	96	1	49	22	**101**	2 & 29	46
1917.....	19	82	4	32	13, 19 & 20	83	16 & 17	46	31	96	4	50	1 & 2	96	31	47
1918.....	6, 18 & 31	84	5	35	1 & 2	90	20	38	21, 22 & 28	95	3	48	13 & 14	98	11 & 19	45
1919.....	31	86	6	32	3	96	29	42	4 & 5	95	11	49	7 & 8	92	10	45
1920.....	19 & 27	85	5	29	29	94	19	44	13	90	16	47	8 & 9	90	3	47
1921.....	21	92	17	31	27	95	2	38	7	100	22	58	30	93	23	45
1922.....	31	86	1	29	24	92	13	42	12	95	9	51	18	92	21 & 29	50
1923.....	26	84	11 & 14	27	19	94	13 & 16	39	20 & 21	89	1 & 26	49	10	91	24	40
1924.....	7	75	21 & 22	31	20	91	1 & 9	41	6, 12 & 29	90	20	47	30 & 31	95	15	44
1925.....	31	84	3	31	5	**96**	24	42	12	94	1	49	17 & 31	90	28	39
1926.....	2	85	4 & 5	29	29	89	20	41	21	96	15	45	2	92	26	49
1927.....	22	89	3	32	30	93	3	39	1	96	4	46	23	87	26	44
1928.....	4 & 5	88	8	30	25	84	3	42	8	95	31	50	4	96	20	51
1929.....	30	91	20	32	18	93	2 & 3	40	23	93	21	45	10	92	31	42
1930.....	7	90	31	36	5 & 30	93	1	44	18 & 21 26	96	31	47	4	99	13	**33**

* Data from record kept by Mr. Edgar Parker for the 1895; year Station record not available.

Monthly Maximum and Minimum Temperatures from 1883 to 1930, Inclusive (*Concluded*).

(Highest and Lowest Record for Each Month in Bold Face Type.)

Year	September				October				November				December			
	Max.		Min.		Max.		Min.		Max.		Min.		Max.		Min.	
	Date	Temp.	Date	Temp.	Date	Temp.	Date	Temp.	Date	Temp.	Date	Temp.	Date	Temp.	Date	Temp.
1883	17	80	11	37	11	78	17 & 18	25	22	70	17	13	9 & 14	56	23	—7.5
1884	5	94	14	26	5	84.2	27	23	11	63	25	15	31	55.5	20	—15.5
1885	27	83.7	24	40	1	79	13	25	8 & 13	68	28	18	24	53	9	4
1886	11	89.5	22	49	10	76.7	17	27.5	3	68.2	28	17	11 & 25	46	6	—6
1887	22	81.7	27	37.2	9	78.5	31	21.2	28	68	30	15	12	54.7	2	—3
1888	1 & 10	83	7	40	6	62.7	22	29	1 & 3	73	23	8	27	53	22	4
1889	4	84	22, 23 & 29	40	2	68.7	24	21.2	4	61.7	17	17.8	25	60.5	4 & 5	8
1890	8	83.6	25	35.5	5	69.8	31	32	8	65.4	28	17	1	46.2	20	3
1891	26	92.8	30	43	4	89.4	12 & 25	27	1	68	29	12	5	57.7	18	7
1892	26	88	20	39	1	82	2	33.1	19	60	24	18	9	49.2	27	—3.7
1893	5	80	26	37.4	13	76	31	25	3	62	27	19	26	62	14	1.5
1894	4	90	26	33	1	76.5	15	33	3	65	29	12	17	59	29	—0.2
1895*	4	94	15 & 30	42	2	72	30	28	7	68	21	19	20 & 21	62	13	—2
1896	12	95	23	36	30	77.5	10 & 19	29	19	70	21	19.5	14	58	28	2
1897	11	98	21	37.5	16	88	10 & 18	30	6	65	24	16.5	12	61.5	24	2
1898	4	94	21	40.5	1	85.5	28	31	5	63	28	16	31	54	14	3
1899	4	92	15 & 30	30	15	86	3	26	19	60	14	25	12	60	31	—1
1900	12	95	19	37	6 & 7	89	20	28	22	70	17	19	4	55	10 & 14	4
1901	6	89	26	36	10 & 11	74	28	28	1	65	27	13	14	62	18	—1
1902	1	90	15	38	19	74	10, 22 & 30	29	14	73	29	22	2	52	9	—5
1903	14	90	29	35	1	73	25 & 27	28	4	70	26 & 27	12	3	46	19	—4
1904	3	88	23	33	10	81	31	22	3	65	29	9	23	53	16	—2
1905	30	88.5	26	36	1	85	26	20.5	12	61	14	11	29	52.5	15	1
1906	18	91.5	25	38	5	79.5	13 & 31	30	19	62	30	16	6	52	8	—1
1907	20	90	27	39	†3	80	31	24	1	59	12 & 16	22	30	57	22	13.5
1908	10	92	30	37	18	83	21	27	26	68	5	18	1	64	23	3
1909	14	93	2 & 6	35	9	82.5	29 & 30	27	11	75	24	21	6	45	30	1
1910	6	87	15 & 23	40	6	81	30	26	1	59	23	21	29	41	31	—2.5
1911	2	87	14	35	4	78	3	33	11	68	13	18	9	67.9	4 & 30	13
1912	6 & 10	95	30	34	6	83	16	31	6 & 7	69	28	20	6	65	9 & 12	12
1913	3	95	15	28	6	81	31	29	22	73	27	22	7	56	28	6
1914	22	92	29	38	10	84	27	26	1	69	24	16	2	64	26 & 27	—6
1915	14	93	28	35	13	75	25	29	1	68	18	21	25	45	31	4

1916.....	7	93	30	39	8	87	27	29	8	74	25	16	5	62	30	4
1917.....	1 & 2	82	23	35	2, 18, 19 & 30	64	10	26	11	58	27	9	24	44	30	—18
1918.....	2	82	11	31	29	78	19	29	15	65	26	20	14	55	7	9
1919.....	7	92	27	37	19	29	8 & 13	30	1	71	28	31	13	50	18	—6
1920.....	12	85	20	37	15 & 21	81	30	34	2	64	13	22	14	55	26	—2
1921.....	2	95	27	43	2	76	26	23	19	73	8 & 23	23	1	54	30	—2
1922.....	9	92	26	34	6	87	19	22	11	65	26 & 28	19	1	60	30	0
1923.....	2	90	17	32	13	83	21 & 23	29	4	58	19 & 20	22	13	61	15	16
1924.....	1	91	11	40	5	80	18	29	7	70	17 & 30	13	7	47	28	—3
1925.....	20	89	23 & 27	33	14	73	31	21	21	60	29	14	5	55	27	—6
1926.....	19, 26 & 24	84	14	37	4	85	18 & 26	30	9	65	11	20	12	43	5 & 6	0
1927.....	19	90	24	40	2	92	30	27	11	72	20	22	14	60	4 & 24	9
1928.....	11 & 12	89	26	37	12	87	30	18	17	69	26	16	24	50	22	12
1929.....	4	96	20 & 21	31	20	78	29	26	2	67	29 & 30	9	27	49	12	6
1930.....	12	91	29 & 30	40	14	84	23	26	16 & 21	66	29	9	1	48	16	5

* Data from record kept by Mr. Edgar Parker for the year 1895; Station record not available.
† Thermometer broken on the 27th, 28th, and 29th of October.

YEARLY MAXIMUM AND MINIMUM TEMPERATURES FROM 1883 TO 1930, INCLUSIVE.

(Highest and Lowest Record for THE TIME in Bold Face Type.)

YEAR	MAXIMUM FOR EACH YEAR		MINIMUM FOR EACH YEAR	
	Date	Temp.	Date	Temp.
1883	Aug. 23	92	Jan. 11	— 9
1884	Aug. 20	95	Dec. 20	—15.5
1885	July 18	90.5	Feb. 11	—11.5
1886	July 7	95	Jan. 13	—18.7
1887	July 3	95.5	Jan. 19	— 8
1888	June 23	94.1	Feb. 10	— 7
1889	May 18	91.8	Feb. 4 and 24	— 7
1890	Aug. 4	96.2	Mar. 8	2
1891	June 16	95	Feb. 15	2.5
1892	July 29	96.3	Jan. 10	— 5
1893	July 26	95.5	Jan. 11	— 6
1894	July 21	97	Feb. 27	— 8.5
1895*	June 3	96	Feb. 8	—14
1896	Aug. 6 and 7	96	Feb. 17	—21
1897	Sept. 11	98	Jan. 20	— 3.5
1898	July 4	96.5	Jan. 30 and 31	— 4
1899	July 4 and Aug. 20	97.5	Feb. 11	— 8
1900	Aug. 1	97	Feb. 27	0
1901	July 1	97.5	Feb. 24	2
1902	May 24, July 14 and 27, August 31 and Sept. 1	90	Dec. 9	— 5
1903	July 9	94	Feb. 18 and Dec. 19	— 4
1904	July 19	93	Feb. 16	—18
1905	Aug. 10	93	Feb. 5 and 14	— 6
1906	Aug. 5	93	Feb. 6 and 7	— 7
1907	Aug. 12	96.5	Jan. 24	—18
1908	Aug. 4	95	Jan. 2 and 5	—14
1909	Aug. 8	98	Jan. 19	— 7
1910	July 9	96.5	Jan. 5	— 8
1911	July 5	**105**	Jan. 5	— 1
1912	Sept. 6	95	Jan. 14	—12
1913	Aug. 17	98	Feb. 10	—10
1914	Aug. 9	94	Feb. 13 and 24	—14
1915	Sept. 14	93	Jan. 30	— 3
1916	Aug. 22	101	Feb. 15	— 8
1917	July 31, Aug. 1 & 2	96	Dec. 30	—18
1918	Aug. 13 & 14	98	Feb. 5	—11
1919	June 3	96	Dec. 18	— 6
1920	June 29	94	Jan. 31 and Feb. 1	—16
1921	July 7	100	Dec. 30	— 2
1922	July 12	95	Feb. 17	—10
1923	June 19	94	Jan. 7 and 30	— 9
1924	Aug. 30 and 31	95	Feb. 25	— 5
1925	June 5	96	Jan. 28	—12
1926	July 21	96	Jan. 29 and Feb. 9	— 1
1927	July 1	96	Jan. 27	—10
1928	Aug. 4	96	Jan. 30	— 2
1929	June 18 and July 23	93	Feb. 21	— 3
1930	Aug. 4	99	Jan. 26	— 4

* Data from record kept by Mr. Edgar Parker; Station record not available.

Monthly and Yearly Means of Temperatures from 1883 to 1930, Inclusive.

Year	Jan.	Feb.	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.	Yearly aver'ges
1883	17.4	22.3	23.6	43.3	52.0	66.6	67.4	65.6	56.3	46.6	39.1	27.5	44.0
1884	17.6	28.3	29.5	40.7	54.3	67.1	66.5	69.9	65.2	50.5	36.5	27.2	46.1
1885	20.6	11.4	18.8	41.2	54.3	63.6	69.7	65.0	58.3	49.2	39.3	27.8	43.3
1886	19.6	22.9	30.2	48.1	55.7	64.0	68.0	67.5	61.8	49.6	36.8	22.2	45.5
1887	20.2	23.2	26.3	41.1	62.5	65.7	75.6	66.5	57.7	47.0	37.6	27.6	45.9
1888	16.4	22.8	24.6	40.8	54.3	66.5	66.8	68.0	62.2	43.9	39.4	29.3	44.6
1889	29.1	18.1	33.9	45.1	58.4	65.3	70.2	66.0	60.5	44.0	40.3	35.2	47.2
1890	31.2	30.9	28.8	44.2	52.3	67.1	69.5	67.7	60.1	49.3	37.6	21.4	46.7
1891	25.9	28.3	30.8	45.3	52.0	66.4	66.4	68.5	66.2	48.3	38.4	35.5	47.7
1892	21.4	25.9	26.5	43.5	52.8	68.6	70.2	69.4	61.2	50.0	35.9	25.2	45.9
1893	15.5	20.6	29.5	41.1	54.1	68.2	69.8	68.8	58.0	52.0	38.2	27.5	45.3
1894	29.7	20.6	38.9	44.1	55.5	67.8	74.2	66.8	64.9	52.7	36.0	31.5	48.6
1895	21.8	16.9	26.9	44.4	59.0	.....	.....	71.2	61.7	45.4	39.6	31.4	.....
1896	22.4	24.1	24.4	49.3	62.0	65.9	71.4	70.0	60.2	56.5	42.9	27.1	48.0
1897	23.2	26.1	33.8	45.0	55.4	62.3	73.6	67.6	62.3	52.6	39.7	29.2	47.6
1898	26.2	26.8	.....	43.2	57.0	67.7	74.2	71.0	65.9	52.1	37.9	27.9	.....
1899	22.1	20.4	30.4	46.6	57.6	69.5	71.2	71.6	60.6	53.5	38.9	30.0	47.7
1900	26.0	22.6	23.6	43.5	56.7	68.4	72.6	74.1	66.1	57.9	41.1	28.7	48.4
1901	26.1	18.5	32.2	46.5	56.9	68.9	76.6	71.0	64.0	51.4	34.3	27.7	47.9
1902	23.2	22.2	39.5	46.6	56.1	63.2	71.2	67.6	53.6	43.1	46.3	25.7	47.4
1903	25.7	28.1	42.2	45.9	60.4	63.2	70.8	65.5	64.4	52.5	36.2	23.3	48.2
1904	18.9	23.1	30.9	41.4	60.3	67.8	70.0	68.2	61.9	48.4	36.9	22.5	45.9
1905	19.8	18.9	33.1	44.8	57.5	66.4	71.8	68.7	63.7	52.4	37.6	32.0	47.2
1906	32.5	26.1	27.6	46.4	57.5	68.2	71.4	72.8	67.3	51.2	37.9	26.1	48.8
1907	24.9	19.5	38.1	40.2	51.3	64.0	71.2	68.4	64.4	47.9	38.7	31.8	46.7
1908	25.9	21.3	34.6	44.8	59.2	68.8	73.4	68.8	67.0	52.9	40.0	29.2	48.8
1909	27.7	28.6	31.0	44.3	57.9	67.2	69.6	70.0	63.5	47.7	44.5	25.7	48.1
1910	25.1	22.1	42.1	50.1	54.9	65.2	73.1	69.0	63.2	53.1	35.7	21.5	47.9
1911	24.9	26.6	30.9	44.8	64.9	67.5	74.4	70.9	62.8	50.7	36.6	35.1	49.4
1912	15.9	21.6	28.2	45.1	58.9	64.3	73.2	68.6	68.4	53.5	42.5	33.9	47.8
1913	32.7	18.8	36.9	48.3	56.9	66.8	72.1	70.0	61.3	54.0	44.5	33.6	49.7
1914	25.4	17.7	31.7	43.4	60.2	67.3	69.9	70.5	61.4	55.4	39.2	26.0	46.5
1915	26.5	29.6	31.0	52.3	52.6	64.6	69.6	67.8	65.6	52.6	41.1	28.5	48.5
1916	29.0	19.5	27.5	49.5	59.5	61.5	72.5	73.5	66.0	58.0	45.0	33.0	49.5
1917	24.6	20.2	33.8	45.8	49.5	63.9	71.8	70.5	60.1	45.9	35.3	19.5	45.0
1918	14.8	23.4	37.6	45.6	61.9	63.2	70.2	72.2	57.4	53.5	22.1	33.6	46.3
1919	31.0	29.2	35.7	43.6	57.0	71.8	72.0	67.8	64.7	55.4	39.6	23.4	49.3
1920	16.3	21.8	39.0	45.2	56.0	67.2	69.4	70.0	64.5	58.5	38.8	32.3	47.4

MONTHLY AND YEARLY MEANS OF TEMPERATURES FROM 1883 TO 1930, INCLUSIVE (*Concluded*).

YEAR	JAN.	FEB.	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPT.	OCT.	NOV.	DEC.	YEARLY AVER'GES
1921	28.9	30.0	43.4	53.7	59.7	69.5	78.0	69.4	69.5	54.5	39.1	28.5	52.0
1922	22.6	29.7	37.0	47.4	59.7	67.2	70.6	68.7	64.3	52.1	43.1	29.2	49.3
1923	17.4	20.2	30.7	44.3	53.4	70.0	68.6	67.2	62.0	49.4	39.9	36.7	46.7
1924	26.4	21.5	32.5	43.7	51.6	64.0	69.5	68.8	60.0	51.7	39.3	26.0	46.3
1925	21.6	31.2	37.8	48.2	53.1	69.9	69.0	69.9	69.8	44.8	38.4	28.7	48.5
1926	26.3	23.0	28.0	40.6	54.8	62.4	69.5	70.2	63.9	49.1	34.5	23.8	45.5
1927	23.5	30.7	37.5	45.0	55.0	63.2	70.6	66.0	63.7	55.3	43.0	30.7	48.7
1928	28.2	27.5	32.8	48.5	57.1	64.4	72.2	72.9	63.1	54.2	42.0	33.9	49.7
1929	25.1	25.4	40.4	47.7	55.4	66.6	71.1	67.1	64.9	49.7	39.8	27.4	48.4
1930	24.6	30.5	34.2	45.2	59.9	69.6	71.5	68.1	66.0	50.4	43.6	29.3	49.3
Monthly Averages	23.8	23.7	30.9	45.1	56.6	64.9	69.4	68.8	62.8	50.9	38.9	28.5	47.1

Precipitation by Rainfall Only by Months from 1882 to 1917, Inclusive.

Year	Jan.	Feb.	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.	Yearly total
	Inches	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
1882	.....	.....	.....	.....	.....	3.69	2.42	2.37	1.25	0.62	1.22	0.55	.....
1883	0.48	1.44	0.88	1.58	4.45	4.12	2.98	3.47	2.12	2.10	1.54	0.73	25.89
1884	1.83	2.01	2.54	0.83	2.49	2.01	2.33	1.44	3.17	1.67	1.01	0.97	22.30
1885	1.07	0.61	0.12	1.26	1.58	2.49	4.64	5.02	2.11	2.88	1.36	0.76	23.90
1886	1.13	0.95	1.13	4.13	1.92	2.92	4.41	2.86	2.31	1.79	3.48	1.24	27.87
1887	0.18	2.97	0.48	1.37	0.46	2.01	6.37	3.03	0.75	1.74	1.58	1.35	22.29
1888	0.78	1.04	1.43	3.09	2.79	2.88	0.99+	4.02	2.73	3.47	2.02	1.24	20.48
1889	2.99+	0.25	0.66+	3.28	1.21	7.47	4.57	1.98	2.50	3.32	3.44	1.62	32.28
1890	2.16	1.45	2.16	2.20	5.49	4.26	1.07	4.34	5.81	4.54	2.40	.....	36.88
1891	1.44	1.57	3.25	1.63	0.49	4.31	3.52	3.16	0.47	2.65	0.74	3.29	27.52
1892	0.57	0.88	0.55	0.67	4.04	3.95	1.89	4.77	1.12	1.34	1.67	0.72	23.17
1893	1.62	3.71	1.94	2.59	4.92	3.08	2.68	5.38	2.68	1.59	1.09	1.56	33.84
1894	2.21	2.71	1.36	2.43	7.03	1.77	1.50	1.22	4.64	3.59	0.43	0.47	29.36
1895	0.96	.....	0.29	1.36	2.88	.....	.....	2.66	0.94	0.72	2.31	2.49	.....
1896	1.19	2.28	0.84	0.41	2.31	3.71	4.12	3.33	4.27	2.26	2.18	0.71	27.61
1897	0.64	0.21	2.12	1.90	2.19	3.16	5.28	1.27	2.36	0.73	2.53	1.39	23.78
1898	1.74	0.33	1.54	2.03	1.90	2.37	1.32	3.60	1.86	3.83	2.03	0.33	22.90
1899	0.37	0.30	1.22	1.12	1.69	1.71	4.15	1.05	2.23	2.69	1.36	1.46	19.35
1900	1.43	2.42	0.02	0.95	1.71	1.45	6.53	1.75	0.91	3.65	6.13	0.78	27.73
1901	0.72	.....	2.19	4.43	3.80	2.07	3.97	5.52	2.46	1.35	2.09	3.37	31.97
1902	0.86	0.66	1.94	1.92	2.84	4.33	5.29	2.41	2.88	2.32	0.74	0.74	26.89
1903	1.81	1.11	5.62	2.60	0.23	7.77	4.86	7.21	1.30	4.19	1.63	0.38	38.69
1904	0.80	1.03	2.41	1.67	4.04	3.37	5.73	2.56	3.26	2.06	0.26	1.42	28.61
1905	0.40	0.27	1.09	2.05	2.01	8.78	3.59	5.44	1.90	3.69	1.32	1.84	32.38
1906	1.46	0.53	1.60	2.08	4.24	5.31	2.37	3.68	2.16	3.56	1.40	1.54	29.93
1907	1.89	0.03	1.14	2.42	1.82	2.34	2.86	1.35	2.73	2.48	2.78	1.89	24.73
1908	0.68	1.12	1.24	3.28	3.57	1.96	4.72	1.79	1.66	2.73	0.88	0.43	24.06
1909	0.94	1.68	1.35	3.20	2.83	2.17	2.04	2.21	2.22	1.18	0.56	0.49	20.87
1910	0.87	0.53	0.28	4.56	3.45	1.55	2.39	5.47	3.29	1.73	0.62	0.38	25.12
1911	0.91	0.24	1.07	3.24	1.36	2.51	4.49	3.36	3.21	2.37	1.41	2.08	26.25
1912	0.20	0.95	1.92	3.41	7.27	2.09	4.85	2.21	5.89	1.42	1.48	1.13	32.82
1913	3.88	0.11	4.64	3.40	2.68	3.24	2.03	1.65	2.64	4.03	2.41	0.77	31.48
1914	0.98	0.15	1.28	3.10	4.00	2.69	2.18	6.05	1.62	1.55	1.08	1.13	25.81
1915	2.34	1.77	0.30	0.64	2.41	2.57	2.44	5.90	1.78	4.44	1.93	1.23	27.75
1916	2.69	1.05	0.50	3.40	5.69	5.83	1.78	3.47	2.15	1.41	1.83	1.49	31.29
1917	0.72	0.95	1.57	2.92	3.74	7.07	3.16	1.99	1.82	4.37	0.36	0.46	29.13
Averages	1.28	1.13	1.50	2.31	3.01	3.51	3.41	3.30	2.42	2.50	1.70	1.21	27.49

TOTAL PRECIPITATION, RAINFALL AND SNOW REDUCED TO EQUIVALENT RAINFALL, 1918 TO 1930, INCLUSIVE.

YEAR	JAN.	FEB.	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPT.	OCT.	NOV.	DEC.	YEARLY TOTAL
	Inches	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
1918	1.74	1.59	2.82	2.38	4.10	3.38	4.21	2.25	3.60	3.39	2.25	2.68	34.39
1919	0.78	0.93	4.15	4.34	6.52	2.47	3.52	3.58	1.00	3.73	2.67	1.91	35.60
1920	3.10	2.40	2.33	2.64	0.75	3.25	5.04	5.27	3.98	1.48	4.29	2.71	37.24
1921	0.77	3.25	2.79	2.72	0.85	2.86	2.11	1.75	1.57	1.66	7.30	1.25	28.88
1922	2.23	2.17	2.95	2.25	2.50	6.73	3.66	9.14	2.05	2.00	1.22	2.95	39.85
1923	4.20	2.05	2.64	1.54	2.52	4.19	3.53	0.68	2.71	2.64	1.66	2.39	30.75
1924	1.19	2.18	0.67	4.35	4.45	2.55	5.04	2.11	6.79	0.14	1.26	1.46	32.19
1925	4.72	2.00	2.75	3.20	1.00	3.45	4.27	1.03	5.13	3.37	3.83	2.16	36.91
1926	2.53	2.30	1.30	3.02	1.18	5.78	1.94	4.56	4.15	2.96	3.18	3.27	36.17
1927	2.37	3.05	2.61	1.97	4.60	1.39	5.42	2.81	0.63	5.62	8.24	4.14	42.85
1928	1.79	2.16	3.08	3.25	1.44	6.99	3.10	2.40	1.86	2.53	4.50	0.44	33.54
1929	3.68	2.10	1.92	6.41	4.46	1.28	2.87	1.31	2.89	3.93	1.64	3.38	35.87
1930	2.005	1.14	3.02	1.55	4.36	4.93	1.58	1.95	2.55	0.86	0.81	2.07	26.83
Averages	2.39	2.10	2.54	3.04	2.98	3.78	3.40	2.98	2.99	2.64	3.29	2.35	34.69