State of Connecticut

PUBLIC DOCUMENT No. 24

Annual Report

of

The Connecticut Agricultural Experiment Station

New Haven

FOR THE YEAR ENDING

OCTOBER 31, 1945

LETTER OF TRANSMITTAL

To His Excellency
Raymond E. Baldwin
Governor of Connecticut

The Board of Control of the Connecticut Agricultural Experiment Station herewith respectfully submits its Annual Report as compiled by Director William L. Slate for the year ending October 31, 1945. The report of the Treasurer will be found on page 68.

E. C. Schneider,
Secretary.

CONTENTS

OFFICERS AND STAFF

(As of June, 1946)

BOARD OF CONTROL

His Excellency, Governor Raymond E. Baldwin, *ex-officio, President*
Elijah Rogers, *Vice-President* ..... Southington
Edward C. Schneider, *Secretary* ..... Middletown
William L. Slate, *Treasurer* ..... New Haven
Joseph W. Alsop ..... Avon
Charles G. Morris, *Assistant Treasurer* ..... Newton
Albert B. Plant ..... Branford
Frank H. Peet ..... Kent

STAFF

Administration
W. L. Slate, B.Sc., *Director and Treasurer*
G. H. Ahlgren, *Business Manager*
H. O'D. Hunter, M.S., *Executive Secretary*
Ruth M. Hendrickson, B.A., *Librarian*
C. I. Bliss, Ph.D., *Biometrician*
Amanda Quackenbush, B.Litt., *Editor*
Emily B. Annette, *Clerk*
Norene Denny, *Clerk*
C. C. Esposito, *Clerk*
Madeline R. Pepe, *Clerk*
Emily V. Jensen, *Stenographer*
Ruth Wedmore, *Stenographer*
H. C. Engelhardt, *Superintendent of Mount Carmel Farm*
F. H. Butterfield, *Superintendent of Buildings and Grounds*

Analytical Chemistry
E. M. Bailey, Ph.D., *Chemist Emeritus*
H. J. Fisher, Ph.D., *Chemist in Charge*
W. T. Mathis, *Associate Chemist*
R. T. Merwin, B.A. } *Chemists*
O. L. Nolan
D. C. Walden, B.S.
Alphonse Wickroski, M.A.
L. G. Keirstead, B.S.
Helen L. Kocaba, B.A.
Janetha Shepard, *Technician*
R. R. Nichols, *Sampling Agent*
J. J. Smith, *Laboratory Helper*
C. W. Soderberg, *Laboratory Helper*
Mabel B. Vosburgh, *Secretary*

Biochemistry
H. B. Vickery, Ph.D., *Biochemist in Charge*
G. W. Pucher, Ph.D. } *Biochemists*
C. S. Leavenworth, Ph.B.
Rebecca B. Hubbell, Ph.D.
L. S. Nolan, *Technician*
Marjorie Abrahams, M.A., *Technician*
G. R. Smith, *Technician*
Luva Francis, *Secretary*

Entomology
R. B. Friend, Ph.D., *Entomologist in Charge and State Entomologist*
M. P. Zappe, B.S., *Deputy State Entomologist*
Philip Garman, Ph.D. } *Entomologists*
Neely Turner, M.A.
J. P. Johnson, B.S.
R. L. Beard, Ph.D.[1]
D. E. Greenwood, Ph.D.
J. C. Schread, M.S.
C. T. Parsons, Ph.D.

Entomology (*Continued*)
O. B. Cooke, *Deputy in Charge of Gypsy Moth Control*
W. T. Brigham, B.S. } *Technicians*
L. A. Devaux
B. W. McFarland
G. H. Plumb, B.S.
Bessie M. Kennedy
J. F. Townsend, B.S.
J. E. Riley, M.F., *In Charge of Blister Rust Control*[2]
A. V. Miller, *Technician*
Carolyn Beehler, *Laboratory Helper*
Viola Farley } *Secretaries*
Anna H. Milazzo

Forestry
W. O. Filley, *Forester Emeritus*
H. W. Hicock, M.F., *Forester in Charge*
A. R. Olson, *Technician*
Jean Ryan, *Secretary*

Genetics (Plant Breeding)
D. F. Jones, Sc.D., *Geneticist in Charge*
W. R. Singleton, Sc.D., *Geneticist*
Jeannette Lowe, B.A., *Cytologist*
Herbert Everett, B.A., *Technician*
Nancy Rhynedance, *Laboratory Helper*
Marie Hayes, *Secretary*

Plant Pathology and Botany
J. G. Horsfall, Ph.D., *Plant Pathologist in Charge*
E. M. Stoddard, B.S. } *Plant Pathologists*
A. E. Dimond, Ph.D.
V. W. Cochrane, Ph.D.
R. W. Barratt, M.S.
A. D. McDonnell, *Technician*
Dorothy M. Griffin, B.S., *Seed Tester*
Mary C. Frederiksen, *Secretary*

Soils
H. A. Lunt, Ph.D., *Acting Agronomist in Charge*
H. G. M. Jacobson, M.S., *Agronomist*
D. B. Downs } *Technicians*
Evelyn Smith, B.S.
Beverly J. Parker, *Secretary*

Tobacco Substation
P. J. Anderson, Ph.D., *Pathologist in Charge*
T. R. Swanback, M.S., *Agronomist*
A. B. Pack, M.S., *Plant Physiologist*
C. E. Swanson, *Technician*
Jack Yavener, *Technician*
Dorothy Lenard, *Secretary*

[1] Leave of absence to National Research Council until January 1, 1947.
[2] In cooperation with the U.S.D.A.

ANNUAL REPORT

of the

Connecticut Agricultural Experiment Station

FOR THE

YEAR ENDING OCTOBER 31, 1945

The world has again survived the affliction of war and now is entering a period of convalescence, a process once classically described as beating swords into ploughshares, but currently and less figuratively referred to as reconversion to the pursuits of peace. A struggle of world proportions has left in its wake social and political unrest and economic confusion on an unprecedented scale. Science and invention have so reduced world dimensions that peoples formerly remote are now our neighbors; and the common dangers and objectives of war have effected a community of nations to a degree not hitherto witnessed. To bring about recovery to world well-being our leaders visualize an effort of international scope. The difficulties involved are proportional to the magnitude of the undertaking, but the whole world hopes for the success of the effort.

The role of agriculture in its broader aspects, whether in war or peace, is to feed our people and to provide their basic necessities, in short, to sustain life. The preservation of soil fertility, the care and management of forests, the cultivation of crops and the protection of them against the ravages of disease and pestilence, the breeding and care of domesticated plants and animals, all are within the scope of agricultural enterprise. During the war farmers met unprecedented production demands in the face of extreme difficulties, and met them with heroic and conspicuous success. Their role in the reconstruction will be no less vital to world recovery.

Many years ago agricultural chemists conceived the idea of bringing science into partnership with agriculture. In about the middle of the nineteenth century the plan materialized in Europe, and a little later in this country, in the establishment of an institution then, and ever since, known as the Agricultural Experiment Station. Its activities greatly expanded and much diversified since its origin, it represents in truth a cooperative effort between the scientist and the farmer, and the fruits of such combined labor have no doubt far exceeded the imagination of the founders.

The dedication of our own Station, the first in this country, to "the advancement of agriculture by scientific investigation and experiment" is typical of the aim and purpose of them all. It contemplates

primarily research in the fundamentals of natural phenomena and processes. This involves two-way intercourse between farm and laboratory whereby, in the one direction, field phenomena are evaluated in the laboratory, and in the other, laboratory discoveries and methods are tested under practical field conditions. Such investigations are usually of a long-term order and the practical significance of the results may not be immediately apparent; but their ultimate benefits may be far-reaching and have unexpected applications. An illustration from our own experience is the study of the nature and composition of proteins carried on here for many years in comparative obscurity, but which, in itself and in the supplementary studies which it stimulated here and elsewhere, has had a tremendous influence on our concepts of human and animal nutrition. The methods and procedures employed have found applications even in the field of medical practice. Research in the realms of genetics and other biological and physical sciences affords parallels which might be cited.

Over the years, as in our own case, public acts sometimes have added specific duties to Agricultural Experiment Station programs directed to the more immediate needs of public welfare. Such are concerned with protecting the consumer public against unscrupulous practices in the manufacture and merchandising of foods and drugs, and of such agricultural commodities as fertilizers, feeding stuffs and agricultural seeds. These duties fall in the category of control or regulatory measures, measures which the better elements of industry and trade enthusiastically endorse. This effort, too, constitutes an important contribution to national health and welfare.

Both of these types of duties are illustrated in the summaries of current Station activities given in the pages that follow.

Looking to the future, we must not forget the spectacular achievements made during the last few years in the world of science. Some of these served humanitarian purposes, others were temporarily directed to ends of destruction. How to adapt all to the permanent welfare and betterment of mankind is our present opportunity and challenge. To determine whatever of these discoveries may be adaptable to the advancement of agriculture is within the province of our Agricultural Experiment Stations, and it may well command their special attention.

EVENTS AT THE STATION

Field Day

After a lapse of four years due to war conditions, the Annual Field Day of the Station was resumed in 1945. The event, held on August 22, attracted a gathering of more than 1,000. All Station trial plots and fields were open to the public and staff members were present for consultation with farmers, home gardeners and others interested in agriculture. Several special demonstrations and exhibits

were set up. An innovation of the 1945 Field Day was a "Trouble Shooters" session at which representatives of Station departments discussed problems related to agriculture and attempted to answer questions.

Northeastern Corn Improvement Conference

The Northeastern Corn Improvement Conference, composed of corn breeders and other scientists interested in the development of hybrid corn for the Northeastern area, held its initial meeting at the Station on February 2 and 3. The session was attended by experiment station workers and federal staff members from 15 states and two Canadian provinces. A working program aimed at fostering greater cooperation between workers in the Northeast was drawn up. This included a plan to pool the task of testing inbreds. Speakers at the sessions included Dr. George H. Shull of Princeton University and Dr. Merle T. Jenkins of the United States Department of Agriculture.

Fruit Growers Meeting

A joint meeting of the Connecticut Pomological Society and New Haven County fruit growers was held at the Station on February 13. The speakers included Professor H. A. Rollins, extension fruit specialist at the University of Connecticut, Robert F. Stevens, associate county agent for New Haven County, Charles Young, member of the Connecticut Pomological Society Labor Committee, and E. M. Stoddard, Dr. Philip Garman and Dr. J. G. Horsfall of the Station staff.

Federated Garden Club Day

The third annual "Day at Your Experiment Station" for members of the Federated Garden Clubs of Connecticut was held in Britton Auditorium on March 28. At the morning session the following staff members gave talks: Neely Turner, Dr. Donald F. Jones, E. M. Stoddard and Dr. R. L. Beard. Also featured at the morning program was a Garden Clinic at which garden club members brought their home gardening problems to a panel of Station scientists. The afternoon program was devoted to explanation of exhibits and demonstrations. The program concluded with a tea.

School for Home Demonstration Agents

A one-day school on the control of household insect pests was held for county home demonstration agents on July 27. Neely Turner, entomologist, was in charge. The agents also heard talks by Dr. E. M. Bailey and Dr. Rebecca Hubbell on the work of the Analytical Chemistry and Biochemistry departments.

Sweet Corn Field Day

More than 25 plant breeders, experiment station workers and seedsmen interested in sweet corn attended a two-day "Sweet Corn

Field Day" at the Station on September 12 and 13. The visitors inspected sweet corn trial plots at the Mt. Carmel Experimental Farm and the Windsor Substation and crossing plots of farmers in the area who are cooperating with the Station. Speakers at a dinner held on the first day of the session included Dr. D. F. Jones and Dr. W. R. Singleton of the Station's Genetics Department, Orson Robson of the Robson Seed Company, Hall, N. Y., and William Hookstra, sweet corn grower of Burlington County, N. J.

Annual Meeting of Federated Garden Clubs

The Federated Garden Clubs of Connecticut used Britton Auditorium for their annual meeting on October 5. The chief speaker for the occasion was Richardson Wright, editor of *House & Garden.*

Other Station Events

The facilities of Britton Auditorium were used by a number of groups during the past year for meetings not directly connected with the Station. These included the New Haven County Farm Bureau, New Haven County Vegetable Growers Association, the Connecticut Pomological Society, and the Connecticut Pest Control Operators Association.

WAR GARDENS

The Station continued its work in the State War Garden Program during the past year in cooperation with other agencies. Staff members served on State and local committees and gave a number of talks on home gardening subjects to various civic groups. Circular 159, "Controlling Pests of War Gardens" was again distributed. A series of 25 weekly press releases on home gardening was prepared and distributed to Connecticut newspapers during the summer months. Twenty-three weekly radio scripts on backyard gardening were prepared and aired over a Connecticut station during the growing season. In addition, special material was prepared for various newspapers, publications and radio stations throughout the home gardening season.

STAFF CHANGES[1]

E. M. Bailey retired as chemist in charge of the Analytical Chemistry Department on October 1, 1945, after 43 years of service. He first came to work for the Station in July, 1902; in 1918 he was appointed acting head of the department in the absence of J. P. Street, then on military leave; in 1919 Mr. Street resigned and Dr. Bailey became chemist in charge, retaining this post for the ensuing 26 years. His reputation as an authority on the composition of foods and drugs was recognized during this period by his appointment to such bodies as the Food Standards Committee of the U. S. Department of Agriculture and the Councils on Foods and on Pharmacy and Chemistry

[1] During period November 1, 1944, to October 31, 1945.

of the American Medical Association. He followed in the steps of Johnson, Jenkins, Winton and Street of this Station in serving as president of the Association of Official Agricultural Chemists and was in charge of two revisions of its book, "Official and Tentative Methods of Analysis". He was also a past president of the American Association of Feed Control Officials of which Dr. Jenkins was one of the founders.

Clarence E. Shepard, an associate chemist in the Analytical Chemistry Department, retired October 1, 1945 after 35 years of service. Experienced in all of the varied work of the department, he was especially interested and skilled in the examination of biological specimens and other materials for poisons. He was untiring in his efforts to explain the causes of livestock mortality that baffled owners, and he often visited their farm premises to discover possible sources of poisonous materials. This Station service, for which he was largely responsible, was highly regarded by farmers of the State, and also by veterinarians who frequently sought his aid and advice.

BENJAMIN H. WALDEN

June 3, 1879—January 6, 1946

Benjamin H. Walden, for 43 years Assistant Entomologist at this Experiment Station, died January 6, 1946, three months after he had retired. Born on a farm in Scotland, Connecticut, in 1879, he attended the usual courses in rural public schools and then entered the Connecticut Agricultural College (now the University of Connecticut) at Storrs from which he graduated with the degree of Bachelor of Agriculture in 1900. After a brief period teaching school in New Jersey and working for the Bureau of Entomology of the United States Department of Agriculture in Washington, he was appointed Assistant Entomologist at this Experiment Station on March 1, 1902. He held this position until October 1, 1945, when he retired because of ill health.

During his long and useful career, Mr. Walden exemplified those personal and professional qualities which endeared him to his friends and aroused the respect of his colleagues. In all of his work he exhibited meticulous care and a high degree of skill. He was modest and unassuming, yet helpful, particularly so to the younger members of the staff. Endowed with uncompromising integrity and loyalty and displaying an admirable forthrightness at all times, his life was beyond reproach.

Retirements

Pauline A. Merchant, Secretary in Forestry Department, April 1, 1945.
E. M. Bailey, Ph.D., Head of Analytical Chemistry Department, October 1, 1945.
C. E. Shepard, Chemist in Analytical Laboratory, October 1, 1945.
B. H. Walden, B. Agr., Entomologist, October 1, 1945.

Resignations

Jean M. Royce, Secretary in Genetics Department, May 11, 1945.
P. P. Wallace, Assistant in Entomology, July 31, 1945.
L. M. Roberts, Ph.D., Technician in Genetics, September 15, 1945[1].
G. A. Gries, Ph.D., Assistant in Plant Pathology, September 30, 1945.
Wanda D. Ginter, B.S., Research Technician in Biochemistry, October 8, 1945.

Appointments

F. H. Butterfield, Superintendent of Buildings and Grounds, February 1, 1945.
H. A. Fisher, Ph.D., Acting Head, Analytical Chemistry, October 1, 1945.

Returned from Military Service

R. R. Nichols, Sampling Agent, September 16, 1945.

PLANT IMPROVEMENTS AND NEW EQUIPMENT

Spectrograph

A spectrograph was purchased for the use of the Analytical Chemistry Department and is proving extremely useful in the analyses of various agricultural materials. In using the spectrograph, samples to be analyzed are burned with an arc or spark and the rays given off are photographed. Lines on the film, which represent the various elements present, are identified according to wave length and the intensity of each line is measured to determine the amount of material present. The advantages of spectrographical over chemical analysis are great: the saving in time is enormous and the ability of the spectrograph to detect unsuspected elements which may be present results in a much more complete analysis.

Improvements to Buildings

The apartment of the Superintendent of Buildings and Grounds was completely renovated. A new cottage for the Foreman at the Tobacco Substation at Windsor was constructed, utilizing, to a large degree, materials from an old laboratory building which was torn down.

Thaxter Laboratory was shingled and painted. A new roof was put on Johnson Laboratory.

[1] On military leave since May 24, 1942.

PROGRESS OF THE STATION'S WORK

Entomology

INSECTICIDE RESEARCH

During the past year, one of the main projects of the Entomology Department has been the development of insecticides. This included not only a study of the insecticidal properties of organic and inorganic preparations but, also, the development of new methods of applying these chemicals and the effect of adjuvants such as dust diluents, stickers and spreaders.

Certain studies have been carried on concerning the relationship of chemical constitution to toxicity to insects. A series of compounds of known composition prepared by the Eastern Regional Research Laboratory has been assayed using aphids as the test insect. Only a few of the compounds, which were prepared from nicotine, were as toxic as nicotine sulfate on the basis of nicotine content. In general, the fatty acid radicals affected toxicity in the same order as the toxicity of the fatty acids themselves.

The toxicity of the same series of compounds injected into milkweed bugs was considerably different than when sprayed on aphids. Apparently, the materials were more toxic when injected into the body cavity of the insects. This injection procedure offers a more rapid response *per se*. Of course, any toxic material, when injected directly into the body cavity, should result in a greater degree of mortality than when applied by spraying.

In cooperation with the Department of Plant Pathology and Botany, certain factors which affect the efficiency of dusts were studied. Laboratory tests of diluents for dusts containing rotenone demonstrated definite and marked differences among diluents having similar physical characteristics. A series of samples of diatomaceous earths from the same source prepared by different methods also resulted in differences in the effectiveness of rotenone. One of these was found to be excellent. None of the highly effective diluents was of fine particle size.

The tenacity of the materials was also determined in the laboratory. High tenacity was of relatively little importance in dusts containing rotenone, but was of value in cryolite dusts. Field tests indicated that the diluents performed in the same order as in the laboratory.

Laboratory studies of the tenacity of dusts deposited on wet surfaces were made. The percentage remaining after washing decreased as the amount deposited was increased. Preliminary tests indicated

that dust diluents varied in the speed with which they were removed by successively increasing amounts of washing. In other words the amount of washing would determine which material had better tenacity.

The factors affecting the toxicity of DDT residues to houseflies have been investigated to some extent. The deposition of DDT on the surface was greatest when this insecticide was used in the form of water suspension. The deposit was less when the DDT was dissolved in comparatively non-volatile solvents such as kerosene. The diluent used with DDT in making water suspensions had a marked effect on the toxicity of these residues. Initial toxicity differed very little, but residues of formulations contained pyrophyllite, Fuller's earth and flaky talc retained toxicity better than those made with various clays. Wood flour was also a highly effective material.

In general, suspensions performed better than emulsions initially, but the emulsion residues retained toxicity longer than those from suspensions.

Suspensions were more effective than kerosene solutions on screen, glass and painted wood. The kerosene solutions were more effective on unpainted wood.

Adhesives for Standard Spray Mixtures

In spraying fruit orchards it is very frequently essential that the insecticides adhere to the foliage of the trees for long periods of time, in order that insect control may be effective. This adherence is attained by adding so-called adhesives or "stickers" to the spray materials.

The results of considerable research on such materials have been published (Bulletin 485, August, 1945). It has been found that aluminum gels, including bentonite, act as safeners for both oil and lead arsenate, preventing foliage burn, and also are good insecticide deposit builders. This is of particular importance to the orchardist, especially in regard to the possible reduction in the number of applications necessary to produce clean apples. The reduced schedules appear to give improved control of European red mite and apple maggot and to result in less spray russet, foliage burn and fruit drop, as well as saving labor, materials and wear on machinery. The mixtures used are somewhat complex, and the control of curculio is rather poor when this insect is unusually abundant. Supplementary treatments may be necessary in certain years. Although we have had no difficulty in controlling the codling moth, we do not yet recommend the reduced schedules when this insect becomes a threatening factor in the orchard, nor has the method been tested sufficiently in wet years for use with scab-susceptible varieties.

In 1945 the reduced schedules gave promising results on Baldwin, Rome and Delicious varieties. Eighty-two to 98 per cent clean fruit was produced and russet was not unusually severe. On McIntosh, Duchess and Staymen Winesap, the results were not entirely satisfactory. The McIntosh trees produced fruit which varied in scab infection from 8 to 46 per cent. Increasing the Fermate from 1.5 to 3 pounds per 100 gallons decreased the amount of infection, but not sufficiently.

New Methods for Dispersing Insecticides

We have been interested for some time in apparatus for dispersing insecticides, particularly those in concentrated forms, in small amounts per unit of area. During the past year we cooperated with the federal Bureau of Entomology and Plant Quarantine in determining the practicability of helicopters and mist blowers.

The helicopter used was provided by the Coast Guard and was available during much of the growing season. It was equipped with a pump which forced the insecticide through a series of nozzles on a boom. The only insecticide applied with it was a solution of DDT in xylene and kerosene, that is, one pound of DDT to one quart of xylene and three quarts of kerosene. This was distributed at the rate of one gallon per acre (one pound of actual DDT) for the control of several pests. On potatoes the control of flea beetles was quite satisfactory, and that of leaf hoppers very promising. Against aphids the applications had some merit, although the control was not outstanding. The seventeen-year locust in fruit orchards was not affected by the insecticide to any appreciable degree nor were large caterpillars of the striped oak worm in forested areas. The control of cankerworms in forested areas was fair to good and that of the gypsy moth excellent.

The helicopter was also used for the control of adult mosquitoes with great success. Through the cooperation of Yale University and the New Haven Orchestra Association, Inc., we treated the Yale Bowl in order to eliminate mosquitoes during symphony concerts held there this summer. One application at the above mentioned rate kept the Bowl free of mosquitoes for from five to seven days. The helicopter may prove to be a very useful instrument in dispersing insecticides, for it does not require a large landing field and can be driven at relatively slow speeds. It has some disadvantages which are possessed by all aircraft when used for this purpose, and the model we used had a very small carrying capacity, that is, about 30 gallons of the mixture.

The use of concentrated insecticides in small amounts for the control of certain pests of forest and shade trees would be of great practical importance if methods of dispersion of the insecticide could be perfected. They may also have some use in the treatment of field crops and fruit orchards. Through the courtesy of the John Bean Manufacturing Company and the Niagara Sprayer and Chemical Company, Inc., we secured two pieces of apparatus for experimental

use during the past season. The principle of these so-called mist blowers is simply that of atomizing and projecting the spray in fine droplets by a strong air draft with a large volume of air per minute. It was found that such a mist could be blown into the tops of trees up to 100 feet in height, and concentrated solutions of DDT as mentioned above could be used effectively. One pint of such a DDT solution containing approximately two ounces of actual DDT, could take the place of 15 to 20 gallons of lead arsenate spray as ordinarily used. The saving in time and labor with such concentrates is quite obvious. We secured excellent control of many leaf-feeding caterpillars and beetles, including the gypsy moth, fall webworm, the eastern tent caterpillar, the elm leaf beetle and cankerworms. Such a mist blower was also used very effectively in keeping adult mosquitoes away from areas for a considerable length of time. In one experiment a block of residences 12 acres in extent was treated with a total of 13 gallons of the mixture and no mosquitoes were present in the area for from 10 to 14 days. The development of this apparatus will be continued during the coming season.

In cooperation with the Bickford Research Laboratories of Avon, Connecticut, we carried out certain preliminary investigations on the practicability of dispersing DDT in buildings for the control of household pests by employing an impregnated fuse cord, known commercially as "Toxicord". The smoke from such a fuse not only killed houseflies present in a laboratory chamber at the time of treatment, but left a residue which was quite effective against these insects for some time. Practical trials in houses demonstrated its promise in the control of blowflies, houseflies and bedbugs.

VEGETABLE PESTS

The Control of the European Corn Borer

Our corn borer control investigations have been limited to a study of the effect of the presence of tillers, the relation of tassel development to survival of larvae, and the merits of Ryanex, an insecticide prepared from a tropical plant.

Studies of the effect of tillers on infestation and survival of the European corn borer showed: (1) that plants with tillers received more eggs than those without tillers, (2) that the rate of survival was higher on plants with tillers, (3) that the number of larvae in stalks and ears was greater when there were no tillers, (4) that the *percentage* of larvae killed by treatment was the same whether tillers were present or not, and (5) that control of larvae in the ears was better in ears from plants with tillers because there was a lower *number* of larvae surviving treatment.

A comparison of genetic stocks of field corn having sparse and bushy tassels, and fertile and sterile pollen, failed to show any consistent effect on survival of larvae. The failure may have been caused

by the relatively late appearance of the tassels in the period of oviposition. Stocks of corn which have shown low breakage received fewer eggs than those rated as breaking easily. Surviving population was substantially greater in plants showing high breakage.

Dosage tests comparing DDT with Ryanex, prepared from *Ryania speciosa*, indicated that 1 per cent DDT dust was as effective as 50 per cent Ryanex. Both provided a high degree of control.

The Biology and Control of the Eastern Field Wireworm

One of the most serious problems in growing commercial potatoes in Connecticut involves the control of the Eastern field wireworm, as these larvae cause a certain amount of damage to the tubers annually. It has been necessary to study, not only the possible utilization of certain insecticidal preparations in controlling this pest but, also, to investigate certain biological aspects rather carefully in order to supply a foundation for control operations.

Limited experiments in the greenhouse indicate that the use of dichloropropane-dichloropropylene (D-D) as a soil fumigant may not be practicable in the field. In order to secure a penetration to a depth of two inches in the soil, where most wireworm larvae are present in early spring, it would be necessary to apply 400 gallons of dilute emulsion per acre.

In a field experiment 600 gallons of a D-D emulsion (400 pounds of crude D-D) per acre failed either to kill wireworms or deter them from feeding on the roots of rye. The soil may have been too wet for the fumigant to exert its maximum effect.

Calcium cyanide (Cyanogas), which is used in some parts of the country for wireworm control, was found to have no effect on the sprouting of potatoes nor on the subsequent crop when placed in bands as close as eight inches from the seed pieces. Surface treatments of up to 100 pounds per acre of a 3 per cent DDT dust had no effect on earthworms. A recently developed insecticide called Gammexane (hexachlorocyclohexane) was found to be very toxic to wireworms when mixed with the soil in very small amounts per acre.

Laboratory tests in 1944 indicated that an application of 3 per cent DDT dust to the soil surface during the flight period would kill a high percentage of wireworm adults. This was tried in the field in 1945, but frequent rains following treatment not only suppressed the activities of the beetles to a marked extent but also washed the dust into the soil. In general, the field trials supported the laboratory tests. Under ideal conditions 50 pounds per acre should be effective but, if the flight period should be prolonged over three or four weeks, or if rains should be frequent, then 100 to 200 pounds would be necessary. The surface of the soil should not be disturbed during the flight period.

The control of larvae by using poisoned baits offers some promise of success. A 3 per cent DDT dust was mixed with wheat cereal at the rate of one-fourth to one-half gram of actual DDT per pound. Irregularity in the feeding of the larvae caused some variation in the results obtained, but the method is certainly worth trying in the field in the spring.

The wireworm injury in 1945 in field plots which have been under observation for six years was one-third that observed in 1944. This is presumably due to population fluctuations.

In the laboratory the feeding activities of the eastern field wireworm were observed under various conditions. Wireworms incubated in soil containing no organic matter, soil fortified with additional leaf mold, and soil containing sprouting grain showed neither molting nor mortality trends which could be associated with the feeding situations provided during the three months of observation. Wireworms incubated under these conditions seem to require growing plants if they are to gain in weight, and it is doubtful if organic matter present in the soil is utilized to any appreciable extent in maintaining metabolism. Under the conditions provided, the feeding pattern of wireworms is almost a random one, affected neither by the temperature nor the food differences used. There was a definite tendency, though not invariable, for a period of fasting to precede a molt, and there was a suggestion of a tendency for a period of feeding to follow shortly after the time of molting. This was not consistent enough, however, to explain much of the mass feeding pattern observed in the field. The wireworm as a pest of tobacco is discussed on pages 50 and 51.

JAPANESE BEETLE INVESTIGATIONS

Although the Japanese beetle has been present in Connecticut for a number of years and methods of controlling it have been developed by many investigators in this country, certain aspects still need some attention.

A study was made of the influence of temperature upon the mortality of third instar Japanese beetle larvae in soil treated with known amounts of lead arsenate. The soil was treated at the rate of 5, 10, 20 and 40 pounds of lead arsenate to 1,000 square feet of surface area mixed to a depth of three inches, and then placed in four-inch flower pots, infested with four grubs each. There were four series of treated soil and one control, each series consisting of 24 pots containing 96 grubs, subjected to each of the four temperatures, 57°, 67°, 77° and 87° F. The first readings of mortality were made on the third and the seventh days. All of the other readings were made at weekly intervals until 100 per cent mortality was recorded for each of the treatments.

The logarithm of dose to kill third instar larvae at the temperatures tested varies inversely as the logarithm of exposure time.

For any given length of time, twice the amount of lead arsenate is required to kill 75 per cent of the larvae at 67° F. as is needed at 77° F. Likewise, at 57° F. twice the amount required at 67° F. is necessary to kill 75 per cent. There is only a slight difference in the effect of dosage and the length of time of treatment between 77° F. and 87° F., indicating that the optimum effect of treatment is near, and yet only slightly higher than, that at 77° F.

Parasites

Insect parasites of the Japanese beetle continue to multiply and spread in localities in which they have been colonized, and are exerting significant control in certain areas. *Tiphia vernalis*, the spring *Tiphia* parasitic on the grubs of the beetle, was sufficiently abundant at three colony sites in Fairfield County and one each in New Haven and Hartford counties to permit collection of the species for redistribution purposes. Sixteen colonies of 200 females each were provided by the federal Bureau of Entomology and Plant Quarantine and released at 14 places in the State. *Tiphia popilliavora*, the fall *Tiphia*, is multiplying rapidly in Bridgeport and vicinity. Material was collected at Seaside Park, in that city, and released in the Town of Shelton, an area of rapidly rising Japanese beetle infestation. A new strain of *T. popilliavora* was sent into Connecticut by the Bureau of Entomology and released in Waterbury, in an area of extensive grub damage. *Centeter cinerea*, a fly parasite of adult Japanese beetles, has multiplied sufficiently along the Connecticut River in Hartford to allow collection of a considerable quantity of parasitized beetles. Two colonies were provided from the material and releases made along the Farmington River in Farmington and Windsor.

"Milky" Disease

The results of biological studies on the milky disease of Japanese beetle larvae have been published in Station Bulletin 491.

A new method of processing the bacterial spores which cause milky disease is being developed for use in disseminating the bacteria in the field. At present the spores are incorporated in a talc carrier. A method has been developed for incorporating the spores in a soluble carrier, the mixture then being pressed into tablet form. The spore content of the tablets can be very concentrated so that one tablet can be used for a spot treatment. These tablets will be readily broken up by soil moisture or dew and hence the bacteria can quickly be carried into the soil. Tests have not been completed on the potency of spores processed in this way, so at present it cannot be stated whether or not the infectivity of spores in tablet form is equal or superior to spores in the dust preparation.

Studies are in progress on the infectivity of Type B milky disease as compared with Type A. The bacteria causing these diseases are mutually antagonistic in the host and the mode of infection is ap-

parently different in the two cases. The Type B milky disease organism does not offer much promise as an agent in the biological control of Japanese beetle grubs.

Because of the drought of 1944 no grubs could be found in many experimental milky disease field plots. However, a high incidence of disease continues to occur in certain parts of the State, especially in Hartford County. It appears that the trend in infection of Japanese beetle grubs where the disease has been applied has been progressive for the past several years. In 1940, an average of 3.1 per cent disease was recorded for all experimental plots in the State; in 1942, 10.7; in 1943, 19.6; in 1944, 46.5 and, in 1945, 19.6, a slight drop explained by drought conditions of the previous year.

FRUIT PESTS

The control of pests of fruit orchards will always offer some difficulty, due to the necessity of producing fruit which is not only edible but which is also perfect in appearance. Also, generally speaking, the orchardist attains very good results by adhering to spray programs employed at present. The effect of such spray programs can be improved.

Apple Maggot

Among our orchard pests the apple maggot still presents a serious problem for many reasons. In 1944 good control of this insect on the Cortland variety was obtained by applying four 3 per cent DDT dusts, but three 5 per cent dusts applied in 1945 were much less successful. The percentage of apples infested with maggot was much too high. The reduced spray schedule, where the last application (containing lead arsenate) was made June 7 gave much better maggot control. In the Burton orchard, maggot control was satisfactory where a late July dust of DDT was applied, but not entirely satisfactory in the more heavily infested Westwood orchard where no such late treatment was given. In view of the conflicting results obtained during the past two years, the usefulness of DDT for control of the apple maggot is questionable.

Oriental Fruit Moth

The number of oriental fruit moth larvae going into hibernation in the fall of 1944 was estimated to be the lowest of any year since control measures had been undertaken. There was a high parasitism of field-collected larvae during the summer, very little if any larval injury to twigs of young trees in August, and approximately 5 per cent or less average fruit injury in peach orchards at harvest time.

A potentially dangerous situation apparently exists, from the point of view of biological control. Years of mass liberations had built up parasite populations which might now be cut to a minimum by lack of suitable hosts necessary for survival. Conditions favorable

to the fruit moth during 1945 would mean a recurrence of the original increase of early infestation of fruit unless control was attained. The imported larval, pupal and cocoon parasites released and reared some years back through cooperation with the U. S. Department of Agriculture were not recovered in 1945. The Moorestown laboratory sent us surplus supplies of the parasite *Macrocentrus ancylivorus* at various intervals during the summer, and these, in addition to those reared in our own laboratory, were released throughout the orchards in Connecticut. However, the injury to fruit at harvest averaged about 25 per cent, as compared to 5 per cent in 1944.

DDT may have a place in fruit moth control in peach orchards if a schedule can be developed which will not be deleterious to the parasite population in the orchard. Our experiments during 1945 gave results of sufficient promise to warrant a continuation of this investigation. This insecticide also gave promising results when applied to quince trees for fruit moth control.

Codling Moth

The unusual weather conditions in 1945 apparently spread out the emergence of the first generation of adults over an unusually long period. This, accompanied by the unfavorable conditions for oviposition by the moths which emerged earlier in the season, resulted in the delay of the peak of oviposition and subsequent hatching of larvae to such an extent that larval entrance into fruits occurred later than is commonly found and planned for in spraying for codling moth control. Late hatching of a significant part of the first brood larvae has probably been much more frequent in the past than has been generally realized, as we have had low population levels of the insect for a number of years, and this phenomenon has consequently escaped notice. An examination of past temperature records in Connecticut and nearby regions indicates that the hatching of at least one-third of the first generation larvae may have occurred as late as July in 13 out of the last 27 years. This implies that more attention be devoted to insecticide applications throughout June and July.

The question of increased resistance of codling moth larvae to arsenate of lead is important. However, the fact that we have an increase in larval population at the present time may not be due to this but rather to conditions of temperature more favorable to the insect in recent years. In three orchards under close observation in 1945 where normal spray schedules were used, the usual low level of codling moth injury occurred in two cases, and the injury in the third orchard was significantly less than for the last several years. In orchards where codling moth injury has been relatively severe of late, there has been, in general, a slight lapse in one or more details of control operations. At the present time it seems just as reasonable to attribute an increase in codling moth population and subsequent injury to this factor as to assume that the codling moth is developing

a resistance to lead arsenate in this State. This latter possibility, however, should not be discarded.

Comstock's Mealybug

Observations on mealybug infestations in Connecticut during the fall of 1945 indicate reductions, in the areas where parasites have been established, of migrating adults and in the number of egg masses found under bark scales. The infested fruits were fewer in number and not so heavily attacked as in previous seasons. There were very few immature mealybugs feeding late into the fall and early winter this year, and these few were absent after the first week in December.

It has been noticed during 1944 and 1945 that spread of the parasites to uninoculated trees any appreciable distance from sites of release is slow. Release of parasites at three locations, two in Wallingford and one in Wilton, demonstrated the need for careful distribution at the time of release.

New infestations of mealybugs have been found on fruit in 1945 at Wilton, Milford and East Wallingford. Infestations in certain orchards in Milford, New Canaan, Guilford, Wallingford and New Haven are very low and will require some time to build up to damaging proportions, and in many other orchards fruit infestations are not serious. In a few cases the infestation is dangerously high.

The 1945 releases of mealybug parasites (*Pseudaphycus*) were made at orchards in Milford, Wilton, Guilford and Wallingford, totalling 13,000 parasites. This insect is also a pest of nursery stock and its control is discussed on page 22.

Miscellaneous Fruit Pests

One of the problems involved in the use of DDT in apple orchards is increase in the abundance of the European red mite following applications of this chemical. In an experiment conducted in cooperation with Dr. Kerr of the Naugatuck Chemical Division of the United States Rubber Company, promising results were obtained by the use of the special agent 72 E with DDT. The addition of 72 E to DDT markedly reduced the number of adult female mites on the leaves.

In our peach orchard at Mount Carmel the use of a mixture containing basic lead arsenate and wettable sulfur for early sprays demonstrated the desirability of using this arsenical for plum curculio control. The combination of these early sprays and late applications of 5 per cent DDT dust gave a gratifying production of clean fruit.

A combination of oil, Fermate and DDT on quinces gave excellent control of quince curculio, oriental fruit moth and fruit spot diseases.

DDT is not very effective in controlling the pear psylla. In cooperation with the federal Bureau of Entomology and Plant Quarantine, a solution of nicotine alkaloid in kerosene was applied to pear trees in October, using special mist blowers. Applications of 5 to 10 ounces per tree gave 95 per cent mortality in a number of separate tests. This mixture also destroyed a large proportion of fifth instar nymphs.

HONEY BEES

Honey bees are much more important to agriculture than most people realize. The production of honey and wax is of little significance as compared to the role of honey bees as pollinizers. In Connecticut we face two serious problems in apiculture, one of which is a disease which annually takes an enormous toll of our bee colonies and, secondly, the poisoning of honey bees by sprays for harmful insects.

Those chemicals commonly employed to kill insect pests will also kill those insects that are beneficial. The possible use of an antidote for arsenic to offset poisoning in the field is being investigated, although our results to date have not been any too promising. Our laboratory studies indicate that there is a cumulative or progressive poisoning brought about when bees are fed sub-lethal doses of arsenic and that death may occur after a few days of such feeding. This work will be continued during the coming season.

About a year ago the successful control of American foul brood by the use of sulfathiazole was reported from the Missouri Agricultural Experiment Station. This was confirmed by our own experiments during the past season. It was found that feeding a syrup containing 0.5 grams of sulfathiazole per gallon weekly throughout the summer gave excellent control of the disease. There was some sulfathiazole found in the honey at the end of the season, as we expected, but it amounted to only 9.07 milligrams per pound, which appears to be absolutely innocuous to human beings.

PESTS OF TREES AND SHRUBS

The Spruce Gall Aphid

An experiment was carried out which supported the belief that this gall is formed through stimulation by the salivary secretion rather than by mechanical stimulus of the stylets. Salivary glands were dissected from fundatrices and macerated in glycerine solution. This extract was injected into the apical part of spruce twigs by means of micropipettes. At the same time pipettes containing only glycerine solution were employed as checks. When the buds burst, five twigs showed swollen needle bases. Egg masses were attached to these twigs and the emerging crawlers entered the buds. Incipient galls formed on three twigs and one of these developed into a small, complete lateral gall. The difficulty of placing the tip of the pipette in the proper tissue layer probably accounts for the minimum of successful results. In no case did the checks show a positive reaction.

Folic acid was injected into gall-bearing twigs to determine whether or not it would inhibit further development of the galls. No positive results were obtained with this material which has shown some promise in treatment of cancer.

Qualitative tests were made on both galled and normal tissues for starch, proteins, sugars, lignin, aldehydes and fats, and certain differences were obtained. The concentration of nutrient materials around the base of the bud may account for survival of the fundatrix in this region, and its death when fixed lower down on the stem.

Control of Borers in Nursery Trees

One of the principal pests of peach trees in both orchards and nursery plantings is the peach tree borer. Our experiments on nursery stock during 1945 indicate that one application of DDT at the rate of 3 pounds of actual DDT to 100 gallons of water applied in late June gives a satisfactory control of this pest. Although the evidence is not quite so conclusive, it appears that if 1½ pounds of DDT plus 1½ pounds of bentonite are used the control may be satisfactory. We have also carried on a series of experiments with flat-headed and round-headed borers in other species of nursery trees, but the results to date are not quite so clean-cut as the above. The work will be continued during the coming season.

Comstock's Mealybug

Comstock's mealybug is a serious pest of several species of Taxus in nurseries at times. The insect causes a loss of foliage and a stunting of the growth of the shrubs. It was found that applications of a mixture containing lime sulfur with a wetting agent, the dilution of lime sulfur being one part to 39 parts of water, would kill about 85 per cent of the insects present, including eggs, and that, at a dilution of one part to 19 parts of water, the kill was complete. Lime sulfur causes a certain amount of injury to Taxus, particularly to new growth, but at a dilution of one to 19 the injury is very slight and the plants recover readily. Presumably, a late fall application would be advisable for the control of this pest, because the residue left after spraying lime sulfur discolors the foliage for several weeks.

Insect Survey of Connecticut

Some progress is being made in the publication of a series of bulletins on the insects of Connecticut. Dr. W. E. Britton, former State Entomologist, started this series in 1911 under the general title "Guide to the Insects of Connecticut". To date, the first five parts and the first section of Part VI have been published by the Connecticut Geological and Natural History Survey. Part VI deals with the Diptera or True Flies. The second section of this, dealing with the mosquitoes of Connecticut and written by Professor Robert Matheson of Cornell University, has been published as Bulletin 68 of the Geological and Natural History Survey.

One of the most interesting entomological features of the year was the appearance of Brood II of the periodical cicada, which last appeared in this State in 1928. The insect was very abundant in that part of the State between Branford and Avon, Cheshire and Middletown, that is, about the same area of distribution as occurred previously.

CONTROL AND SERVICE

Inspection of Plants and Plant Products

During the summer of 1945, a total of 299 nurseries, representing 4,243 acres of nursery stock, was inspected. The usual number of pests was found, but none of them was serious enough to warrant the destruction of any great number of plants. Section 2137 of the General Statutes requires nurserymen who fail to register before July 1 to pay the cost of inspection. A total of 19 nurserymen failed to register on time and paid $95.00 which has been turned over to the State Treasury.

Federal quarantines for gypsy moth and the Japanese beetle require that plants and plant material be inspected and certified as being free from these pests before they may be shipped out of the quarantined area. This required inspection and certification by the federal Bureau of Entomology and Plant Quarantine and this office of 646,298 plants for the Japanese beetle and 5,582,027 plants and 3,008 pieces of stone and quarry products for gypsy moth.

Some of the states still maintain a quarantine against products that might harbor larvae of the European corn borer. This required the inspection and certification of 465 shipments of plants and seed corn.

One hundred and forty-six duplicate nursery certificates were issued to Connecticut nurserymen so that they might ship their stock to other states which require filing of duplicate certificates with their state entomologists. Stores and individuals who sell nursery stock but do not grow it were issued dealers' permits. There were 66 of these issued. A total of 70 package certificates were issued for private individuals who wished to ship plant material.

The export seed business is increasing in Connecticut. Most of this is consigned to South and Central American countries. A total of 316 certificates was issued for this purpose.

Four hundred and five blister rust control area permits were issued.

Seventy-four complaints of insects causing damage to homes and crops were investigated. Thirty-four of these were for termites causing injury to buildings. This is a serious matter and we can often save householders large sums of money by giving information about control and reconstruction methods. We also attended to 27 calls to de-

termine whether or not elm trees were infected with Dutch elm disease fungus.

Inspection of Apiaries

This summer our three bee inspectors visited 2,589 apiaries and inspected 13,353 colonies of bees. There was a slight decrease in the amount of American foul brood found this season. Winter mortality accounted for a loss of 21.6 per cent of the bee colonies. This was very much higher than for the winter of 1943-44 when the loss was slightly more than 5 per cent. Wet and cold weather in early summer prevented the bees from gathering the usual amount of honey but later in the season conditions improved and they gathered a fair amount of honey from late summer and fall flowers. The total cost of inspection was $3,136.86 and the cost per apiary was $1.21. The cost per colony was $.235. The average number of colonies per apiary was 5.15.

Control of the Gypsy Moth

Gypsy moth control work in 1945 consisted of mapping areas to determine susceptibility of stands to gypsy moth infestation and present extent of this infestation as a basis for control operations; a survey to determine the extent of defoliation caused by the larvae; a survey of certain towns to determine whether or not the gypsy moth was present, using a material attractive to male moths; scouting to determine the presence of egg masses in certain areas; an estimation of the percentage of eggs which hatched in the spring, and control by using insecticides.

The forest stands in Mansfield, Somers, Vernon and Winchester were mapped. During the summer a survey for defoliation was undertaken in all towns in New London, Hartford, Tolland and Windham counties and in some towns in Middlesex, New Haven and Litchfield counties. Very little defoliation was found, and much of that occurred on individual trees in the north central part of the State. On eleven acres, 25 to 75 per cent of the foliage was destroyed, and on five acres the trees were completely stripped of leaves. This is in contrast to conditions in Massachusetts where on 299,521 acres 25 to 75 per cent of the foliage was destroyed and on 157,313 acres the trees were completely stripped of leaves. (The area of Massachusetts is 8,029 square miles and of Connecticut 4,820 square miles.)

A survey was conducted in cooperation with the federal Bureau of Entomology and Plant Quarantine, using an extract of the tip of the abdomen of virgin female moths to attract males to a trap, in the following towns: Bridgewater, Brookfield, Middlebury, Monroe, Newtown, Oxford, Roxbury, Shelton, Southbury and Woodbury. A total of five male moths were caught. In Sharon the federal Bureau caught 165 males. During the winter several towns in the central part of the State were scouted, particularly in and around nurseries and in areas where a heavy infestation occurred in 1944.

The abundance of gypsy moth larvae depends to some extent on the percentage of eggs which hatch in the spring, so we determine this each year. Athough the weather during the 1944-45 winter was not unusually severe, and the egg masses were large, only 58.5 per cent of the eggs in 115 egg masses collected hatched. This is low.

Spraying operations were somewhat limited. Thirty-eight individual trees and areas were sprayed from the ground with mixtures containing DDT, cryolite or lead arsenate. The DDT was applied by a mist blower, the other materials by standard ground machines. The mist blower, using a solution of 1 pound of DDT to 1 gallon of a xylene-kerosene mixture, was very efficient. For example, a large oak tree, which would require about 20 gallons of a lead arsenate spray, was treated with 1 pint of the DDT solution with excellent results.

Four infested areas were treated with a DDT solution mixed as above, using a helicopter for application. One area contained five acres; one, 10 acres; one, 20 acres; and one, 24 acres. Excellent results were obtained in the first three areas, but an increase in the population was noted in the 24-acre area. This particular plot may have been improperly treated.

The federal Bureau of Entomology and Plant Quarantine carried out control work in 22 towns in Litchfield and New Haven counties. A total of 60,672 acres was scouted by this Bureau and 46 infestations were sprayed. We are indebted to Mr. R. A. Sheals, Chief of the Division of Gypsy and Brown-tail Moth Control, and to Assistant Chiefs C. S. Crossman and H. L. Blaisdell for their splendid cooperation in this work.

Rearing and Distributing Parasites of the Oriental Fruit Moth

The mass rearing of the larval parasite, *Macrocentrus ancylivorus*, for distribution to the peach growers of Connecticut was carried out during 1945. Orders for parasite colonies from fruit growers were received through the Connecticut Pomological Society as usual. Parasite breeding was accomplished by use of laboratory-reared oriental fruit moth and potato tuber moth larvae as hosts.

The June twig infestation of fruit moth larvae was negligible in orchards under observation, and over 10,000 parasites were released during this month in Connecticut. Sixty-five thousand were sent to Massachusetts and Rhode Island. During the entire season we released 59,700 *Macrocentrus*, divided into 241 colonies to 95 growers.

Dutch Elm Disease Control

This disease was very destructive to elms, particularly in Fairfield and New Haven counties. Some of the towns and cities carry on a program of removing diseased trees as soon as found. This retards the spread of the disease locally. New Haven, known as the Elm City, has lost many of its elms in parks and on streets in residential areas.

During 1945 the disease has spread rapidly to the east and was found for the first time in 16 hitherto uninfected towns, those farthest east being, New London, Montville, Norwich, Lisbon, Windham, and Chaplin. These new locations were found by scouts of the federal Bureau of Entomology and Plant Quarantine. Diseased trees are reported to the Station and we, in turn, notify the town authorities, urging them to remove and burn these trees before bark beetles emerge.

In 1942 we established five observation plots, each one-fourth square mile in area, in each of four towns, Greenwich, Stamford, Darien and Norwalk. Each year since, the number of diseased trees has been determined in each plot. Although the trend has varied among plots from year to year, the total number of diseased elms in all 20 plots increased from 60 in 1942 to 209 in 1944 and then dropped to 188 in 1945. In these four towns, which represent the oldest infested part of the State, it is estimated that approximately 3.5 per cent of the elms were diseased in 1945 and that approximately 10 per cent of the elms have become diseased in the last four years.

Plant Pathology and Botany

FUNGICIDES

Fungicide research during the past year included a study on synergism between disodium ethylene bisdithiocarbamate (Dithane) and zinc sulfate and lime—a mixture which has shown considerable promise in the field. As zinc sulfate and Dithane combine, sodium sulfate is liberated into the medium. This seems to increase permeation of the toxicants into the cell. The increased permeation can be antidoted by the proper concentration of calcium sulfate.

One new foliage fungicide seems to have some promise, 2, 2′–dihydroxy–3, 5, 6–3′, 5′–6′–hexachloro-diphenyl methane (G4). The material was developed for mildew-proofing of army material. It may also be useful for agricultural purposes. Another mildew proofer, a quaternary ammonium salt of pentachlorophenol, proved to be too phytotoxic, probably because of the pentachlorophenol part of the molecule.

POTATO SPRAYING

The Station is doing active research on the use of the fungicide Dithane on potatoes. Data obtained from six growers' fields using Dithane show in three cases an increase in yield over Bordeaux mixture, in two cases, a decrease in yield, and no difference in the other case. In all the Dithane plots the growers used DDT to control insects. At the Station farm where a serious outbreak of late blight occurred on Katahdin potatoes, spraying with Bordeaux mixture increased the yield 75 bushels per acre, while spraying with Dithane increased the yield 100 bushels per acre. The increased yield of Dithane

over Bordeaux was not due to better blight control but to less injury to the plants. The Dithane-sprayed plants had both larger tubers and more tubers per hill than the check while the Bordeaux-sprayed plants had larger tubers but no greater number than the check.

CONTROL OF VEGETABLE DISEASES

In the program to develop new fungicides, beans and celery are used as test crops. Experimental data show the fungicide Dithane used with zinc sulfate and lime to give exceptional control of anthracnose (pod spot) on beans. A reduction in the percentage of infected pods from 95 per cent in the untreated to 19 per cent with the Dithane, zinc sulphate, lime combinations was noted. In the same test, Fermate gave a reduction of the disease to 35 per cent and Bordeaux mixture to 41 per cent. A study of the synergistic system of Dithane and sodium sulfate was made in the field on beans and gave results closely analogous to those in the laboratory. Of the other compounds tested, Puratized was outstanding but not commercially practical on vegetable crops because of the mercury in the molecule.

The question of whether the newer organic fungicides require more frequent applications than the old standby, Bordeaux mixture, has largely remained unanswered. Experimental data at the Mt. Carmel farm on the control of celery blight (*Cercospora apii*) with biweekly and weekly sprays of Dithane and Bordeaux show weekly sprays to be much better. Our data show biweekly sprays of Dithane and Bordeaux were about equal in the control given, but much less satisfactory than weekly sprays. Of the other new fungicides tried on celery, Puratized and Phygon were satisfactory.

APPLE SPRAYING

The work on the effect on deposit and scab control of high and low gallonage per tree with equal amounts of sulfur per tree was continued in 1945. Apple scab was particularly severe during the past season and, under these conditions, it was found that dosages of 1 lb., ¼ lb., 1 oz. and ¼ oz. of sulfur per tree gave better scab control when applied with 5 gallons than with 20 gallons of water. The difference in control between high and low gallonage decreased with decreasing doses and was approximately zero at the lowest dosage.

The year, 1945, was the third season of this work. In 1943, a year of normal scab incidence, high gallonage gave better control at the higher doses and poorer at the lower doses than low gallonage. In 1944 with the scab incidence below normal, high and low gallonage gave approximately the same control. We believe that these variations are due to the environmental factor of weather and not to chance heterogeneity. It was also found that the deposit of sulfur was in the order of 2.5 and 20 times the expected for the three lower doses.

Experimental plots on small McIntosh apple trees showed that certain of the newer organic chemical fungicides give far better control than the standard wettable sulfur sprays. Puratized N5E gave excellent control without injury to the trees at concentrations as low as 1/20 lb. per 100 gallons of water. Some question arises as to the use of the compound because it contains some mercury in the molecule.

Dithane, an organic fungicide developed at this Station, gave good control of scab, but injured the trees.

CHEMOTHERAPY

Work on chemotherapy of plant diseases was carried on during the year on the following plants and diseases: apple, apple scab; tomato, tobacco mosaic; elm, Dutch elm disease, and peach, X disease. All of this work was attended with some degree of success as will be seen in the detailed reports on the several projects.

Apple

Eight and 12 gallons of Dithane at concentrations of 2, 1, ½ and ¼ lb. of active ingredient per 100 gallons were put on the soil around five-year-old McIntosh trees at regular intervals over a period of six and eight weeks beginning April 12. The highest concentration reduced scab infection to 11 per cent of the leaf area as compared to 39 per cent on untreated trees. The 1-100 concentration was not effective but the ½-100 and ¼-100 concentrations showed appreciable reduction of scab infection. On account of the time lag before the tree absorbs an effective quantity of material, it is believed earlier applications would have been more effective.

Tomato

Injection and watering of tomato plants with various chemicals for the inactivation of tobacco mosaic virus have been continued. This virus is more stable than the X disease virus and the attempts at inactivation have not been as successful as with the peach virus. Two sulfa compounds, *p*-toluenesulfonamide and *p*-aminobenzenesulfonamide have so far been the only materials showing much promise, with *p*-toluenesulfonamide giving the better results. On the X virus the ratings of these two materials were reversed. It was found that the materials were more effective if applied after inoculation, the same as was found true in the work on peaches.

Elm

The tree plots of two-inch elms were treated with water solutions of oxyquinoline benzoate at concentrations of 1, ½, ¼ and ⅛ parts per 1,000 for control of Dutch elm disease. The solutions were applied before and after inoculation of the trees at the rate of 10 gallons per tree, half the plots receiving the 10 gallons in one application and the other half getting the same amount in five applications of two gallons each. The highest concentration used gave 80 per cent control of symptoms consistently, irrespective of time or method of application. The lower concentrations gave better control than the checks but the results were not uniform. The checks showed 80 per cent of evident symptoms. Inasmuch as the causal fungus was isolated from as many of the treated trees as from the checks, it appears that the action of the oxyquinoline benzoate was to antidote or prevent the formation of the toxins causing the wilting rather than being either fungicidal or fungistatic.

Peach

The work on X disease has been continued but with a change of method of application of the various materials used. It appeared evident that injection of orchard size trees could never be practical or successful, because of inability to get satisfactory distribution of the materials in the tree and the mechanical difficulties attendant on injection. For these reasons, applications of solutions on the soil have been used the past season with apparent success. Several of the materials when watered on the soil have produced the same characteristic reactions in the trees as occurred when the same materials were injected into the trees. This shows that these chemicals can be absorbed through the roots as well as by top injections. To date, the therapeutic value appears to be equal to that obtained by top injections. Calcium chloride and zinc sulfate, which are cheap and easily obtainable, show promise of being effective when watered on the soil and may have value for field use.

VASCULAR DISEASES

The year 1945 was a banner year for plant diseases, especially diseases of foliage. Frequent rains from spring throughout the year favored the inoculum. It was striking, however, that Alternaria on tomato was the lowest by all odds since 1939 at least, probably because the plants vegetated so freely that the fungus was discouraged.

The research on vascular diseases lagged because of personnel shortages. However, with the help of the Entomology staff, we obtained data on the Dutch elm disease in the towns of Greenwich, Stamford, Darien and Norwalk.

It is noteworthy that the disease in those four towns is developing steadily at about the same rate as before. A recent study of the spread of the disease across the State showed that it is advancing about 5.5 miles per year. If it continues at the same rate, it should be in Boston in about 10 $\pm$ 2 years.

ROOT ROT

The work on calcium-potash balance for potato scab and clubroot of cabbage was continued. The evidence now seems irrefutable that the effect is polymodal, i. e., the amount of scab waxes and wanes

as the Ca/K ratio increases. It seems that the peaks and valleys of the curve are separated by a factor of about 30 fold along the Ca/K axis. No clear reason for this is apparent. The position of the peaks seems unaffected by seasonal conditions (at least for two seasons) or by absolute amounts of Ca or K applied. It is affected by the anion for K. It requires three times as much $CaSO_4$ for a given peak for K_2SO_4 as for KCl. The position of the peaks is also related to soil type. Mt. Carmel and Windsor do not react alike.

We now need information on Ca/K ratio in soils of the State that have potato scab and soils that do not. Perhaps from these data we can draw some practical conclusions about what a farmer can do for scab.

The effects of mulches on strawberries, reported last year, were confirmed.

Genetics

FIELD CORN

The 1945 season was unusually favorable for corn production. Yields both at Mt. Carmel and Windsor were obtained that surpass any obtained previously. Not only are better varieties with higher yielding capacity being obtained, but the enormous production indicates that present fertilization and cultural practices are reasonably satisfactory.

Inbreeding Program

New inbreds from eastern varieties of field corn (developed under a fellowship with the Eastern States Farmers Exchange and mentioned in the past three reports as being outstanding) have been more adequately tested during the 1945 season. Several promise to be of definite importance to breeders in the Northeastern area. Four of these inbreds are now numbered and will be released in 1946—1016-188 as C102, 1016-215 as C103, 1012-7 as C104, and 1069 as C105.

C102 is a tall, dark green Lancaster inbred with good stalk characters and a very long ear. General combining ability is good as indicated by the fact that C102×Indiana 608 was the highest yielding cross in our observation test.

C103 has been favorably mentioned for its excellent stalk and root qualities. The plant is light green in color and has a very good ear. The kernels are orange in color with good quality showing none of the cracking or moulding so prevalent in other Lancaster inbreds. Crosses grown here show that its remarkable stalk and root qualities are inherited by single crosses containing C103. Yield ability on a par with other good Lancaster inbreds is evident from the 1945 yield results where (540×Hy) C103 significantly out-yielded other good

hybrids. Experimental hybrids made with C103 are significantly superior in resisting stalk breakage and root lodging.

C104 is a line of Long's Champion derivation. It is tall with a sparse tassel, and stalk qualities are not particularly good. Kernels are reddish and coarse, and the cob has perhaps the largest diameter of any field corn inbred. The ear is very slow-drying and it is not anticipated that this inbred will be of importance in grain corn hybrids. However, its hybrids are remarkably fast-growing and stalks attain a large size so that this inbred may be of use in hybrids made exclusively for silage.

C105 is an early inbred (slightly earlier than A158) which comes from a cross of a purple popcorn by Ohio 25. It is very short with excellent stalk and root characteristics. The kernels are flinty and slightly orange in color.

Lancaster line 1016-154, 1003-26, 1008-3, and 1027-32 are all very promising lines which should be carefully observed.

Yield Testing

Perhaps the outstanding feature of the yield tests grown this year was the uniform, cooperative, double cross test of the U. S. 13 season which was organized and conducted in several states. The results were later analyzed here at the Connecticut Station. It is interesting to note that the experimental hybrid (Wf×P8) (I159×40), which is a prediction from the 1944 all-combination, is the best hybrid in this test. It ranked fifth or better in every test, displaying a consistent high yield not equalled by any other variety being tested. As to moisture, breaking and lodging features, it is comparable to any other variety. Next in order are the single cross Wf×40 and Ohio 3143. Ohio 3143 is one of the blight-proof Ohio varieties that was outstanding in the observations of 1943 and hence was included in the test this year. It would appear to be worthy of continued testing.

Rather surprising was the consistently poor performance of Illinois 448. It did not yield well at any location. The grain was coarse and wet while stalk breakage was very bad.

With next year's test in view, we at Connecticut have a series of double crosses made with (Ohio 40B×C103) for a similar trial. These may have yield ability equal to the best of the commercial hybrids and should certainly have excellent stalk and root characteristics.

An all-combination comprising the following inbreds was grown this past season—W35, W27, A, Ohio 28, L317, Ohio 40B, Wf, B164, 540, P8 and I159. The yields for the predicted combinations have been compiled. Two facts are noteworthy: (1) The ability of I159 to impart yield to these hybrids; 164 of the total of 234 have I159 and all the highest yielding hybrids have this inbred. (2) The remarkable similarity in predicted yields of the three possible hybrids which could be made from any four inbreds.

During the past summer two all-combination tests were made, as agreed upon at the first Northeastern Corn Conference. The first is of U. S. 13 season and made up of L317, 07, P8, Wf, Hy, Kr, N. J. 30, N. J. 47, 40B and I159. The second all-combination is of Iowa 939 season and comprises Wf, Ohio 28, M14, A, I205, CC10, CC24, CC28, NC and Ohio 51A. This seed is available for cooperative testing in 1946.

The early and mid-season yield tests at Windsor were remarkable chiefly for the excellent yields. Results of these tests are given in the annual grain corn report.

The observation trial this year consisted of test crosses of new inbreds by Indiana 608. Each cross was replicated three times and yield is given as an average of the percentages of that of the checks on either side of the rows in question. The check is U. S. 13. On this basis a number of inbreds appear to be rather good. 1016-188 has already been numbered for release as C102. None of the other inbreds in this test is considered ready for release. The crosses of these (and more) inbreds with a good double cross made last summer will be more completely observed in 1946.

SWEET CORN

Sweet corn breeding work in 1945 proceeded along lines of previous years in which a succession of sweet corn hybrids was developed. Since there is such a great range in maturity in sweet corn, it is possible to develop a series of hybrids that, if planted at one time, will ripen in succession over a period of a month to six weeks. Some seedsmen have put up sweet corn collections, packaging six or eight different hybrids separately, but selling the whole collection as a unit. It was designed primarily for the home gardener and many such gardeners are enthusiastic about the collection which includes the following varieties that ripen in the order listed: Spancross, Marcross, Carmelcross, Lincoln, Golden Cross and Wilson. The last two varieties can be planted about three weeks after the regular planting to extend the season further. Market gardeners use some such series of hybrids but buy them separately since they usually want different amounts of the hybrids ripening at different times.

The succession series given above is not quite an ideal collection. An ideal series should have the first hybrid ripening as early as any sweet corn and should have each variety following in succession at about four-day intervals. This will allow time for a second and final picking of one variety before the next is ready. Also, each variety should possess the best quality if it is to be grown by the home gardener who is in a position to harvest corn and cook it quickly, thereby retaining as far as possible, all the good quality present.

Our efforts are now being directed toward getting an earlier variety for the succession, improving the quality of some of the varieties now used, and securing one or two very late hybrids to extend

the season further. Also, there is too great a time lapse between Carmelcross and Lincoln; we are working on a hybrid for this season.

Sweet corn quality is the most important problem of sweet corn breeders. Better methods of testing quality are needed. It is possible to get a fairly accurate estimate of pericarp toughness by means of the puncture test. A low puncture reading indicates tender pericarp. This method is more objective than the practice commonly followed of chewing either the raw or cooked ears. However, the puncture test method requires more time and attention to conduct a trial and for this reason is not used as widely by sweet corn breeders as the method of chewing the corn to estimate pericarp tenderness.

Another attribute of quality, sweetness or sugar content, can be determined chemically, or a good estimate can be obtained by eating either raw or cooked ears. The ease of testing makes the second method more widely used. The third factor in quality, flavor, can only be determined, for the present at least, by tasting the corn.

More tests on sweet corn quality made by plant breeders are made on corn freshly picked. What is equally, and perhaps more, important is whether some varieties are more likely than others to maintain their original quality upon keeping for several hours or days after picking. Clearly, more information is needed on methods of testing sweet corn quality, not only of corn freshly picked and after standing several hours, but also the quality of canned and of frozen corn. Perhaps this is a problem more for home economists than for sweet corn breeders. More progress might be made by a laboratory not primarily interested in sweet corn breeding.

A quality test card has been used at New Haven since 1942 with fairly good results. The following items are mimeographed on a 4×6 card.

SWEET CORN QUALITY TEST

Name of Tester _____ Date _____

Varieties Tested

1 _____

2 _____

3 _____

RATING

	Best	2nd	Poorest
Tenderness			
Sweetness			
Flavor			
General Rating			

Remarks _____

These cards are given to various members of the farm crew ("testers") along with two or three samples of sweet corn for testing. The test-

ing time covers a period of about six weeks of the summer when green corn is being picked. Comparisons are always made between varieties maturing in the same season. Often several testers try the same two varieties. There is usually good agreement among different testers so this method has some merit. It has enabled us to discard hybrids on the basis of such tests alone.

The quality angle in sweet corn is further emphasized by the recent trend in sweet corn marketing. Until recently it took several days for green corn to reach the ultimate consumer after picking. With little or no refrigeration, the good quality was lost rather rapidly and all corn was mediocre to poor when eaten, even if first class in quality when picked. Improved marketing methods will shorten very substantially the time between picking and eating with the corn refrigerated during this period. Different experiments in marketing were conducted in 1945 with great success. More will undoubtedly be tried in 1946. With improvement in marketing, quality will assume a more important place in the sweet corn breeding program.

Considerable hybrid vigor is obtained when two sub lines of Purdue 39 are crossed. It is possible to make use of this increased yield in the corn breeding program. The line cross P39-1×C30, when crossed by an unrelated inbred C42, gives a hybrid as productive as either 39×42 or 30×42 and no more variable than the single crosses. Since 39-1×C30 yields at least 25 per cent more than P39, its use in seed fields is suggested. Similar line crosses could be used, as pollinators at least, in field corn hybrid seed production making three way hybrids instead of the double crosses now in use.

Another product of the sweet corn breeding project is a sweet-dent silage made by crossing one of several western F_1 field corn hybrids by C95, our latest sweet corn inbred. Sweet-dent silage gave good results in farmers' trials in 1944 and 1945. Preliminary reports indicate that cows show a preference for this type of silage. Trial lots are available in 1946. This is of interest primarily to dairy farmers.

VEGETABLE BREEDING

In spite of the scarcity of labor, a rather vigorous squash, pepper and sweet corn program has been carried on. Other investigations have been reduced or eliminated for the present.

Tomatoes

In 1916 this Station reported the results obtained from first generation hybrid tomatoes which showed that appreciable increases in yield as well as other valuable characters could be obtained. Within recent years several agricultural experiment stations, as well as commercial seed companies, have done considerable work on the production, testing and utilization of first generation hybrid tomatoes which has resulted in the introduction of several highly productive hybrids.

Only limited observational tomato trials were planted in 1945 in which twenty hybrid lines were compared with twenty commercial varieties. While these trials were purely of an exploratory nature and the results cannot be taken as final, they did demonstrate that some of the F_1 hybrids have possibilities of becoming important in Connecticut and perhaps replacing some of the standard varieties.

Peppers

Reports from several growers and institutions where Charter Oak peppers have been grown indicate that this variety—as yet not released to the seed trade—has earliness and productivity, as well as a thick heavy wall. Inasmuch as increased stocks of Charter Oak show more off-type plants than is desirable, seed will not be released until this situation can be corrected.

Twenty-one 1944 selections from mosaic-resistant lines were grown in 1945 with disappointing results. For some unexplained reason, all these lines showed extreme susceptibility to tobacco mosaic although they were not inoculated with the virus. It is thought that a new strain of virus may account for this phenomenon. Only further experimentation can determine this point. New lines of peppers that are resistant to two different strains of viruses will be used to incorporate resistance in the susceptible Charter Oak variety in future breeding projects.

Squash

Considerable attention is being given to the development of inbred lines which combine to give superior hybrids. As yet no combination of inbreds has been found that is any earlier or more productive than Yankee Hybrid, although some hybrids have better color.

The foot rot disease which destroyed many inbred lines in 1941, 1942 and 1943 did not reoccur in 1944 or 1945. Whether this was due to weather, better cultural methods or to the use of two-year-old seed in 1945 is not known. Certainly, its failure to appear this year gives us hopes of being able to continue with the breeding of squash.

Forty-seven lines of butternut squash are being inbred and selected for uniform productive types of good quality. Many of these are outstanding in these characteristics and will be released just as soon as their superiority has been established. This variety has been well received by everyone who has used it and many repeat calls, wherever it has been offered for sale, are indicative of its popularity. Several managers of stores and roadside markets are of the opinion that butternut may eventually replace acorn and other winter types.

Pink banana, a winter squash grown extensively in California for its excellent quality and rich reddish-yellow color, was grown at Mt. Carmel for the first time in 1945. It was enthusiastically received by

nearly all who tried it. Growers who have a steady outlet for winter squash might find that this variety would be a popular item.

Three varieties of winter squash of the moschata species, that Dr. L. C. Curtis found growing in the oasis of the Sahara Desert in North Africa, produced an excellent crop at Mt. Carmel in 1945. These are too large for Connecticut markets but they do have certain characteristics that will be valuable as breeding material.

Naked Seed

For more than sixty years squashes have been grown in the Balkan countries and Austria for their seed as a source of oil. According to published reports, this squash seed oil is considered by those people as ranking next to olive oil in desirability as a liquid cooking oil.

The particular type of squash that has been used for this purpose is one containing a seed that has no hull. So far as can be determined only two people have attempted to utilize this naked seed squash in America. Dr. A. F. Yeager, while at the North Dakota Experiment Station, published a short account of the possibilities of utilizing this seed. Also, Mr. R. E. Young at the Waltham Field Station grew this variety for a number of years.

Seed of this variety was obtained from the Massachusetts Experiment Station in 1940 and it has been used in various combinations with the idea in mind that, if sufficiently large yields of seed could be obtained, the seed could be used as a source of vegetable oil for the United States.

In 1945 several naked seeded lines produced at the rate of more than 1,000 pounds of cleaned seed per acre, based on small plots. An inexpensive simple method has been worked out so that the seed is obtained in a pearly white condition. All those who have eaten the normal squash seed—by cracking away the hull—know what a delicious nut it is. Naked seed is equally good and the bothersome separation from the shell is eliminated. Furthermore, when these seeds are cooked in oil and salted, they equal any similarly prepared nuts in quality and flavor.

In consideration of the facts that these seed can be harvested in the field by mechanical methods, that a yield of 1,000 pounds per acre may be obtained, that the oil content of squash is double that of soybeans and about equal to that of peanuts, we have every reason to believe that squash seed can be produced in New England, not only as a nut crop, but as a source of oil.

Potatoes

Within recent years, many new varieties of potatoes have been developed with outstanding disease resistance and attractive color,

shape and shallowness of eyes. A few of these varieties compare favorably with Green Mountain and Irish Cobbler in table quality. Some of the most productive will undoubtedly be grown but, unfortunately, the quality of these is so much inferior to the standard varieties now grown that the demand for potatoes may be unfavorably affected. In tests covering the past two seasons, one very dry, the other moist and cool, Mohawk seems to have the best eating quality of the newer sorts. It has uniform size and shape, attractive appearance and shallow eyes. Teton, Sequoia and Pawnee are equally attractive in appearance and somewhat higher in yield, if planted early and grown to full maturity, but not as good in quality.

On a light sandy soil in Hamden, potatoes were planted on April 4 last year and dusted three times for leaf hoppers and aphis. Out of six varieties grown, Green Mountain was the most productive with 388 bushels per acre but was the most variable in size and shape. By early planting, it may be possible to produce satisfactory yields of Green Mountains in an area where this variety cannot be grown without thorough spraying.

Strawberries

The strawberry growing season of 1945 was characterized by above normal rainfall in May with low temperatures and high humidity. It was a generally favorable season for this fruit following a dry season in which the plants made an unusually poor growth. However, many varieties showed much mildewed fruit and poor color. The new varieties, Midland, Fairpeake and Redstar, compared well with standard varieties such as Premier, Pathfinder and Catskill in size, color and general appearance. While not as productive as these varieties, they have the same fine flavor and eating quality as Dorsett and Fairfax. They are especially fine for the home garden, for quality markets and for freezing. These three varieties ripen in the order named. Redstar is the latest to ripen and is one of the best in this season. Starbright is most attractive in size, color and general appearance but is low in yields.

GENETIC PRINCIPLES

Degenerate types originating as mutations in inbred strains of maize have shown a surprising amount of hybrid vigor when crossed back to the parental line from which they came and from which they differ by what seems to be a single gene. These results have been published and are attracting much interest. Further study is being made to establish the genetic nature of the change and the bearing of these findings on the problem of hybrid vigor.

The variant types were outcrossed to unrelated inbreds and these crosses were compared with the same combinations made with the normal line. No significant differences in yield were obtained, showing that there is no detrimental effect of the degenerate variation in combination.

Induced reciprocal chromosomal translocations in a uniform inbred line of maize have been tested for possible alterations by crossing with recessive gene markers. In Drosophila, cases have been found whereby a normal gene is modified by chromosome relocation in such a way that a recessive gene is allowed to have a visible effect in the heterozygous condition when normally it is completely covered. One case in this corn material has been found which behaves the same way. Translocations involving the long arm of Chromosome #1, when crossed by fine stripe, show the fine stripe condition on first generation heterozygous plants. Second generation plants from these recessive plants selfed give some normal plants showing that no deletion of chromatin is involved. This is the first direct evidence for a position effect in maize.

Electric Potential Results

Mr. O. E. Nelson has been working on the electric correlates of genetic strains of maize for the past three years. This work is now ready for preliminary publication in collaboration with Dr. H. S. Burr of the Yale Medical School. However, two features of this work may be reported here because of their interest to plant breeders and seedsmen.

After soaking seeds in water for approximately twelve hours, they are placed on a turntable and the E. M. F. in mill volts measured by a vacuum tube potentiometer. Two readings are possible: (1) the first potential recorded when the electrodes touch the seed, and (2) an equilibrium potential attained sometime later, presumably as a result of the equilibrium between the seed and the sodium chloride solution used as a conductor. Both these potentials apparently have correlates in the later growth of the plant and must be taken. The first potential seems to be correlated with seed quality and as such will be of great interest to the seedsmen.

A five by five lattice square test using U. S. 13 as the test variety was grown in 1945. The five entries were high, medium and low potential (divided on the basis of their first potential) and two untested lots. The total number of seeds planted for each entry was 135. The following number of plants survived to maturity for each group — low potential 85, medium potential 107, untested (1) 112, untested (2) 115, high potential 125. The just significant difference is 23 on the .01 level.

This difference naturally reflects itself in the yield totals which are low potential 211, medium potential 242, untested (1) 269, untested (2) 271 and high potential 277, with a just significant difference of 55. Thus, we have been able to pick out lots of seed of greater yield ability because of their superior viability.

If the first potential presages seed quality, the second potential seems to be correlated with genetic constitution. Seed from an F_1 cross of Wf×Hy has been followed through four generations. The

F_2 seed was tested by an equilibrium potential and divided into high, medium and low potential. In 1945 the difference between the F_3 stocks of high, medium and low potential was marked and significant, with high plants being much more vigorous and desirable and medium plants being better than low. The F_4 seed from these rows was then tested and the E. M. F. are still highly correlated with the E. M. F. of the F_2 seed.

If further investigations bear this work out, we have at hand a potentially powerful tool to use in plant breeding since it offers a means of segregating superior genetic constitutions without ever seeing the plant.

Soils

FURTHER STUDIES ON PLANT TISSUE TESTING

To obtain more information on the value of plant tissue testing as an aid in the diagnosis of nutrition problems, greenhouse studies were made on six crops (sweet corn, snap beans, pasture grass, tobacco, potatoes and ladino clover). Fertilizer treatments were varied to provide both favorable and unfavorable nutritive balance. The tests were carried out essentially as described in Dr. Morgan's soil test bulletin 450, but with some modification in the preparation of the extract, in anticipation of possible use of the test in the field.

It was found that differences in nutritive balance could generally be detected in the tissue tests and also in soil tests, but that the stage of growth had an extremely important effect on the results. The tests must be made on identical portions of the plant and on the same day, and even at the same hour if possible, in order to make reliable comparisons between normal and abnormal plants.

Very low calcium values are obtained unless pains are taken to slice the material very finely, or to crush it.

The direct test method patterned on the Purdue procedure, in which the reagents for any given test are added directly to the plant sample, was found to be useful in certain instances and could be readily performed in the field. The method is slow, however, and not very practical if many tests are to be run. The sulfanilic acid-alphanaphthylamine powder mixture developed at the Illinois Station was found to be preferable to the usual diphenylamine-sulfuric acid reagent for detecting nitrates in the direct test.

Soil Testing

The number of soil samples tested during the year totaled 1,809, which is 100 more than were tested last year but is about 100 less than the record of 1942-43.

FERTILIZER VALUE OF DIGESTED SLUDGE

Further trials to test the fertilizer value of digested sewage sludge were made and they showed variable results. Celery yields were significantly increased by 7 to 29 per cent in one case, and not increased in another. Beet and carrot yields were definitely less in one case and unaffected in another. Potato yields in the garden where sludge was used were about the same as those without sludge, but in a dry season sludge caused the vines to remain green for a longer period.

The conclusion, based on these trials and upon work done elsewhere, is that immediate increases in crop yields can hardly be expected under all conditions and with all crops. Undoubtedly, occasional or frequent use of sludge is beneficial to the soil in the long run, and the sandier the soil and the lower the fertility, the greater will be the likelihood of beneficial effects. Sludge is in no sense a balanced plant food and it needs to be supplemented with potash. For the first crop, supplementary application of nitrogen also may be advantageous.

SOIL EROSION

In breaking down the data obtained in a soil type and erosion survey of the Muddy River and Farm River watersheds conducted several years ago, it was found that nearly half of the 21,300 acres had suffered moderate erosion, meaning that 25 to 50 per cent of the surface soil had been removed. About 31 per cent had been slightly eroded (less than 25 per cent removed). All but 15 per cent of the area is of sufficient slope to cause erosion if not protected. Gully erosion affected only 316 acres.

At the time the survey was made, it was found that nearly half of the area was fully stabilized (protected against erosion), and about a quarter was partially stabilized. A good deal of land now protected by forest, brush, or grass was previously cultivated and subject to erosion at that time.

Break down by land use is the next step, and that angle of the problem is now being explored.

SOIL SURVEY OF POTATO SECTION

The chief potato-growing section of the State is centered in the area northeast of Hartford, consisting of Enfield, Somers, East Windsor, Ellington, South Windsor, Vernon, East Hartford and Manchester. Last fall considerable progress was made on a survey of soil types, slopes and kinds of crops in these eight towns. This work is to provide a basis for further studies to be made by the Station on various problems of potato growing.

GREEN MANURES IN THE MARKET GARDEN

How to maintain an adequate humus supply in the soil and at the same time obtain good yields is the object of this field experiment at

Windsor. Initiated in 1940, the first rotation cycle of the three staggered rotation systems has been completed. The following trends are evident up to this point:

The plots top dressed with additional nitrogen appear to be maintaining nitrogen and organic matter better than those not so treated.

On those plots in which onions are followed by buckwheat, the nitrogen and organic matter content of the soil tends to be slightly higher than on the plots where lettuce is followed by beets.

Millet seems to be the most effective so far in maintaining nitrogen and carbon, followed in order by soybeans, animal manure, and millet plus extra nitrogen.

In some cases tomato yields (Pritchard) were slightly less where extra nitrogen was applied.

In general, extra nitrogen resulted in about 12 per cent higher yields of Ebenezer onions. There was an average of 27 per cent onion rot in the field.

The lettuce crop (Geneva 456) was disappointing due to the lack of uniformity in heads and in date of maturity. At the time of harvest only 56 per cent of the heads were marketable. The extra nitrogen treatment produced 11 per cent greater yield than the standard treatment.

Extra nitrogen was likewise beneficial to spinach (Long Standing Savoy), producing a 12.5 per cent greater yield. The largest yields were produced on those plots where millet receiving extra nitrogen was plowed under as green manure. Poorest yields were from the plots receiving stable manure in the spring previous to seeding the crop.

OTHER SOIL STUDIES WITH VEGETABLES

On the acid (pH 4.8), phosphorus-deficient soil in the soil frames at Mt. Carmel Farm, both onions and the succeeding celery crop, showed marked response to phosphorus and to lime but none to magnesium. In fact, the celery was practically a failure without lime. The celery yields were considerably larger where borax was applied in addition to lime.

In 1945 yields of carrots, beets and cabbage on the Windsor organic plots were generally in line with those obtained in previous years. That is, the use of such materials as peat moss, dried cow manure, ground tobacco stems, a treated peaty muck and sheep manure gave better results than did commercial fertilizers alone. Of these five organics, dried cow manure, tobacco stems and peaty muck tended to be somewhat more effective than either peat moss or sheep manure, but the differences between them are by no means consistent.

Forestry

SMALL CHARCOAL KILNS OF THE CHIMNEY TYPE

The experimental work on the development of the cinder-concrete kilns, mentioned in the Director's last report, has been completed and is described in Bulletin 494. The two kilns have a nominal capacity of one and two cords, respectively, and are designed for four-foot wood. They may be increased in capacity by 25 per cent by increasing the width to accommodate five-foot wood.

The results obtained with a kiln of three-cord capacity (for four-foot wood) were not entirely satisfactory. This kiln was not as easy to operate as the smaller sizes and the yield was somewhat lower.

The ratio of kiln length to kiln height appears to be quite important. In the one and two-cord kilns, which operated successfully, the ratio was 96 inches to 64 inches and 128 inches to 80 inches, respectively, or about 1.5 to 1 in each case. The ratio of length to height in the three-cord kiln was 208 inches to 80 inches or about 2.5 to 1. There are indications that better results would have been obtained with a three-cord kiln with a length-height ratio of 144 to 96 or 1.5 to 1.

If the manufacture of charcoal is to be done on a fairly large scale, it is recommended that increased plant capacity be attained by battery operation of small kilns (one or two-cord) rather than by increasing the size of kiln. The former will require a somewhat larger initial investment, but they are much easier to operate and the timing is such that most of the labor required can be performed within the limits of the average work day. Moreover, the monthly output of a battery of small kilns will be greater than the monthly output of a large kiln of equivalent cubic capacity.

REVIEW OF EIGHTEEN YEARS OF WORK IN WOOD PRESERVATION

During the early part of the century woodland management in Connecticut and other eastern states was essentially the management of chestnut. The wood of this species was used for a wide variety of purposes but, because of its natural resistance to decay, was of especial importance as a post and pole material.

By about 1910 the ravages of the blight had increased to such proportions that the supply of posts, poles and other products cut from living trees was fast dwindling and by about 1920 had become practically non-existent. There were still vast numbers of dead trees in the forest. The wood of these trees remained sound for many years and, until about 1935, dead trees constituted a large reservoir on which to draw for posts and poles.

However, it was obvious that the supply of dead material could not last forever and that the quality was rapidly declining. Some substitute had to be found, and in 1928 the Station began a study of substitute materials. This study was confined to round sticks under 10 inches in diameter and 13 feet in length. Larger sized poles, such as are used by utility companies, were excluded.

The principal users of posts and small poles were:

(1) The State Highway Department for railing and property posts.
(2) The tobacco growers for construction of shade tents.
(3) Farmers for general use.

The study was based on the premise first, that wood was a satisfactory material for the above conditions and would continue to be used, if it possessed the desired physical properties and could be made resistant to decay and, second, that local woods, of which there is a vast supply, should be used wherever possible to increase the outlet for native products and thereby to promote better forestry.

The project has, for the most part, been carried on cooperatively with the State Highway Department, the State Forester's office, the Yale School of Forestry and other institutions and individuals.

The strictly experimental phases of the work have been confined to the treatment of native woods with creosote by the open tank method and with zinc chloride by the sap stream method (tire-tube). In addition, strength tests were made on native grown and imported woods to determine their suitability for specific uses. Durability tests are being made to determine the decay resistance of different kinds of treated and untreated wood in contact with the soil.

Following are the highlights of the investigation:

(1) The *untreated sapwood* of most native grown woods will become unserviceable in contact with soil in from two to five years.
(2) The *untreated heartwood* of all native grown woods except red cedar, white cedar, locust and white oak in contact with the soil will become unserviceable in three to ten years.
(3) Round posts (with sapwood intact) of oak and pine, are readily treated with creosote by the open tank method with good absorption and penetration of preservative. Service tests indicate that, if these woods are given a *full length treatment*, they may be expected to remain serviceable for 15 years or more.

Maple, birch, elm, tulip, ash, hickory and aspen are less easily treated than the species mentioned above. The distribution of creosote within the post is rather poor and these species should probably not be subjected to open tank treatment unless incised over the ground line area. Squared or split posts are not recommended for open tank treatment.

The untreated tops (portion above ground) of posts of native grown woods, except red cedar, white cedar, locust and white oak will become unserviceable in less than ten years.

(4) Posts pressure-treated commercially with creosote by a reliable processor probably will remain serviceable for 25 years or more. One lot of posts including white and pitch pine, maple and birch have been in the ground 18 years and show no signs of decay.

(5) Posts pressure-treated commercially by a reliable processor with copper sulfate, zinc chloride or sodium fluoride, either as such or in mixture with other chemicals, and also with zinc metarsenite (ZMA) may be expected to give good service though not as long as creosote. Of the preservatives mentioned, only zinc metarsenite, applied under pressure, has been tested for durability by the Station. Posts treated with this material have been in service 12 years and show no deterioration except a slight softening of the wood at ground line.

(6) Posts treated under pressure may be either round (with sapwood mostly intact) or squared. Since sapwood absorbs preservative more easily than heartwood, the penetration of preservative will be deeper in a round post than in a squared post which is all heartwood. The distribution of preservative in a squared post containing both sapwood and heartwood will be uneven. This may be corrected by incising and a reliable processor will incise to insure a good penetration of the heartwood.

(7) *Sap-stream process.* This is a displacement process. It consists of replacing the sap contained in the conducting tissues of the sapwood (vessels or tracheids) with a solution of a water-soluble salt poisonous to decay organisms.

The process may be accomplished in a number of ways, but it is always carried out on freshly-cut wood and peeling is unnecessary. Some forms of the process are particularly well adapted to use by the small operator because little equipment is needed.

Experiments have been conducted by the Station using sap-stream methods on many species. It has been found that maple and birch can be treated very satisfactorily. Conifers with thick sapwood take treatment well, but more slowly than the hardwoods. Oak, ash, hickory and other species with a relatively thin sapwood are not recommended for this type of treatment.

Service tests on posts and poles treated by sap-stream processes indicate a serviceable life of ten years or more.

The results of the Station's work in wood preservation are not easy to measure, but it is felt that a reasonable amount of credit can be taken for the following:

(a) The adoption by the Highway Department of a sound policy for procurement of treated guide rail posts. This will eventually mean a substantial saving to the taxpayers of the State.

(b) The acceptance by the tobacco growers of the fact that their recent procedure in procuring tobacco tent poles is not only costly, but dangerous.

There is an increasing tendency at present on the part of the growers to purchase poles which have been properly treated. This policy is sound and will appreciably lessen their costs for replacements.

The prospects for the use of native woods are not too promising. Many of them can be treated satisfactorily, but the obstacles to the development of a going business in treated native woods are very difficult to overcome.

RECENT EXPERIMENTAL WORK IN WOOD PRESERVATION

A patented pressure apparatus for injecting water-soluble preservatives into freshly-cut wood was given a brief trial. The device appears to have considerable merit for the treatment of posts and poles on a quantity basis. The distribution of preservative was no better than that attained by the gravity tire-tube method, but time required to treat was shortened from hours to minutes.

STRENGTH TESTS OF CONIFEROUS WOODS

This project comprises some 7,000 tests and measurements made on the wood of conifers used for reforestation in Connecticut.

Material progress has been made during the past year in developing the data to a point where they can be subjected to statistical analysis.

Preliminary analyses indicate that the wood laid down during the first 20 to 25 years of the life of a forest plantation is of low quality. Its strength properties are below that of wood from the same species grown in natural stands and it tends to warp and twist in seasoning unless carefully handled. After the stands have closed and the rate of diameter growth has slowed down, the quality and strength of the wood improves. Some special tests made on the wood of red pine indicate that wood of satisfactory quality and strength is laid down when diameter growth is reduced to approximately two-tenths of an inch per year.

CONTROL AND SERVICE

White Pine Blister Rust Control

Blister rust has been brought under control througout the State. The European black currants have been eliminated and other ribes have been initially eradicated on all control areas, except for a few zones surrounding recently established pine stands. Many old cankers are still in evidence, but there are very few cankers of recent origin to be found. This control can be maintained only if the pine areas and surrounding 400 to 900 foot zones are kept ribes-free. Such maintenance work is being supervised by the Connecticut Agricultural Experiment Station and is financed by state, federal and town funds.

It is estimated that the cost of the maintenance will amount to 5 per cent of the value of the annual growth of the pine.

Twenty towns are now cooperating with the Station in the maintenance of blister rust control areas. In most cases the town makes an annual appropriation to a town sinking fund that is allowed to build up until it is required for further control work.

During the past year the control areas in Salisbury, Sharon, Killingly and Sterling were checked and the wild ribes eradicated. There were 44,215 wild ribes and 15 cultivated ribes destroyed on the 21,947 acres examined at a cost of $.27 per acre. Three nursery sanitation zones were re-examined and made ribes-free. There were 47,805 acres of pine and control area remapped at a cost of $.06 per acre.

Tree Protection Examining Board

Section 784e of the 1939 Supplement to the General Statutes, provides that the botanist, entomologist and forester of the Connecticut Agricultural Experiment Station, ex-officio, with two other members appointed by the Governor, shall constitute a Board whose duty is to examine all persons who contract, solicit or advertise to do tree improvement work of any kind. If such persons are found qualified, they are granted a license to do tree improvement work.

The purpose of the law is to protect the public by preventing inadequately trained and inefficient tree workers from operating within the State. The Board has no police power.

The forester of the Station has acted as Secretary-Treasurer of the Board since it was first organized under Chapter 181, Public Acts of 1919.

Tobacco Substation at Windsor

SHOULD TOBACCO LAND BE PLOWED?

In order to see whether plowing has an advantage over merely stirring the surface of the soil with a harrow in preparation for planting, a two-acre field was divided into 32 plots, half of which were plowed and the other half disced. Half of the plowed plots and half of the disced plots received a full ration of our regular fertilizer mixture. On the other plots the application was reduced to a three-quarter ration. The field was planted to Havana Seed tobacco and all cultural operations other than those mentioned above were the same throughout the season. The results of the first two years follow:

1. No consistent differences in growth in the field were observed when plowed plots were compared with disced plots.

2. The plowed plots with a full dose of fertilizer averaged only nine pounds more cured tobacco to the acre than the harrowed plots and 23 pounds on the reduced fertilizer plots. Both differences are too small to be statistically significant.

3. At both levels of fertilization, the grading of the cured tobacco was higher on the harrowed than on the plowed plots, but the differences were too small to be statistically significant.

4. Reducing the quantity of fertilizer to a three-quarter ration decreased the yield by 119 pounds on the plowed and 133 pounds on the harrowed plots. This is a significant difference and there is no indication that harrowing alone has reduced the need for fertilizer.

As far as one can judge from the first two years of the experiment, it makes little difference whether the land is plowed or only harrowed to fit it for setting. It is possible that a longer period of years under the same treatments may show a difference.

PLOWING DOWN THE FERTILIZER

The object of this field test is to compare two methods of applying fertilizer: (1) broadcast and harrowed into surface soil after the land is plowed, and (2) broadcast on soil surface before plowing.

Each treatment has been applied on quadruplicate plots for three years on Merrimac sandy loam soil. Havana Seed tobacco was grown on this field. Average acre yield for three years on the plowed-under plots was 1,944 pounds as compared with 1,932 pounds for the plots fertilized after plowing. The average grade index was .366 for the former compared with .383 for the latter. When the results of the three years were analyzed statistically, the differences in yield or grading were found to be not significant.

During the first year, the "stand" of plants was not so good on the plots where the fertilizer was applied after plowing and more restocking was necessary. Probably more plants were killed by proximity of the fertilizer under this system. In the last two years, however, this injury was not evident.

From results up to the present, we may conclude that it makes no difference which one of these methods of incorporating the fertilizer into the soil is used.

IMPROVEMENT OF SHADE TOBACCO BY BREEDING AND SELECTION

This experiment has been continued for six years, in cooperation with the Shade Growers' Association. The objects of the test are to develop strains of Shade tobacco with: (1) leaves of better quality (color, shape, elasticity, taste, etc.), (2) higher acre yields, and (3) resistance to diseases and insects.

The tobacco strains are grown in the tents of the Shade growers and, after curing and fermenting, are sorted by experienced workers in a commercial warehouse under expert supervision.

Many old strains have been tested and new ones developed. None of the old strains appears to be sufficiently superior to the ordinary strains grown to warrant further work on them. Three of the new strains have proved to be superior to the old ones in grading (percentage of higher-priced leaves) and in acre yield. There is, however, a difference of opinion among the dealers and manufacturers as to taste, some considering it just as good as that of the regular strain, others rating it as less desirable. Three strains that have rated highest in our tests, have met with most favor from growers and have been selected until they are quite uniform and apparently "fixed" are:

1. *Connecticut 15.* Taller plants than the ordinary producing 20 to 25 marketable leaves as compared with 15 to 18 by the regular, of lighter and more uniform color, and better shape. Average grading for two years was 34 per cent above the ordinary Shade. Growers who have tried this strain on a small scale of a few acres report increases of 25 to 50 per cent in yield. Very highly resistant to black rootrot and can be grown on "sick" land where ordinary Shade is a failure. Suffers less from dead-blossom leaf spot and some growers report less flea beetle injury.

Connecticut G4. This strain is very similar to Connecticut 15 in grading, color, leaf shape and yield but is superior in having a smaller, less conspicuous vein. The taste is rated as better than Connecticut 15 by some of the "experts" on this elusive quality. Preliminary trials indicate that it is resistant to rootrot.

Connecticut 17. Developed for its light uniform color by the Tobacco Station fifteen years ago, this strain has been preferred by some of the growers. In grading and yield it approaches the other two but the leaf shape is not so good. The leaves are too pointed and do not keep the shape from bottom to top as is the case with the other two. This plant does not produce as many marketable leaves.

AMMONIUM NITRATE IN FERTILIZATION OF TOBACCO

Field experiments with ammonium nitrate as a source of nitrogen for tobacco were carried out in 1944 and 1945. In the dry season of 1944, with no leaching of nitrogen, it was shown that 150 pounds of nitrogen per acre from this new source was comparable in effect to 200 pounds of nitrogen in cottonseed meal. In the relatively wet season of 1945, however, nitrogen in ammonium nitrate leached to the extent that the results from *200 pounds* of nitrogen from this source was not sufficient to match those from 200 pounds of nitrogen in cottonseed meal.

When 200 pounds of nitrogen in ammonium nitrate was applied in fractions (the equivalent of 40 pounds N before planting, at the time of planting, and the balance at 10-day intervals), the effect was similar to that of cottonseed meal.

Most satisfactory results with ammonium nitrate were obtained when it was used in a mixture of commercial grade.

From our own observations as well as from reports by some growers, it appears that ammonium nitrate is a very satisfactory side dressing material.

BORON IN TOBACCO FERTILIZATION

The assumption that sufficient boron would be carried incidentally in the great bulk of organic materials used in our tobacco fertilizer needs a modification, according to our recent findings. To be sure, the organics and other materials furnish some boron, but this *per se* would not be sufficient to maintain the boron level in the soil. It is indicated that the nitric acid produced in the nitrification of the organics (usually equivalent to 200 pounds N per acre) will liberate boron from minerals in the soil. Moreover, the liberal use of potassium for Connecticut tobacco has a tendency to hold boron in combinations with this element. This would sustain boron in a more active form than calcium which is usually the most abundant base in agricultural soils. Thus the *method* of fertilizing Connecticut Valley tobacco helps to maintain the boron status in the soil.

When additional boron (as borax) is furnished, the quality of tobacco is improved. Results from experiments with the use of 10, 15 and 20 pounds of borax per acre suggested that an optimum improvement in grading of 10 per cent was obtained at the 15 pound rate, although more than 12 per cent better grading was shown at the highest rate. Since separate applications of small amounts of borax are impracticable, it is recommended that the material be added at the rate of 5 pounds per ton of fertilizer mixture. Larger amounts of borax should not be used without preliminary soil tests and consultation with the Experiment Station.

CHLORPICRIN STERILIZATION OF SEED BEDS

In recent years experiments with chlorpicrin as a soil fumigant at this Station have been supplemented by trials on a commercial scale where tobacco growers have tried chlorpicrin and steam sterilization in comparative tests. The results corroborate our own, that weeds and weed seeds can be controlled with this gas treatment about as well as with steam. It follows that insects and soil-borne fungi are destroyed as well. Keeping the surroundings of the beds free of weeds helps to prevent re-infestation. This is important since the fumigation is made early in the fall. A minimum soil temperature of 55° F. is required for proper distribution of the gas.

A motor-driven continuous-flow applicator of chlorpicrin has been introduced in the Valley. By this means, one acre of bed space can be treated in one day which is a great saving in time as compared with steaming.

Detailed directions for soil preparation, chlorpicrin applicator, and treatment of beds after fumigation are given in the Tobacco Substation Report for 1945.

FURTHER STUDIES ON POLE ROT

This investigation, which has been pursued intermittently for the last 10 years, has been largely a study of the life history of the fungi that cause pole rot. Studies in 1945 are confined to the species *Sclerotinia sclerotiorum*, one of the two fungi responsible for our worst epidemics of pole rot, with especial reference to infection of stalk-cut tobacco.

It has been demonstrated in this study that, contrary to previous belief, infection of the plants may occur while they are still standing in the field. Inoculations with ascospores failed to infect healthy green leaves under any conditions. But when bruised or broken stems or leaves were inoculated and kept for a few days in a moist atmosphere, the rot became established. It made no difference whether the injured leaves were still in the field or had been removed. Incidence of Sclerotinia rot depends on (1) tissue injury, (2) presence of the spores on the injured surface, and (3) a surrounding moist atmosphere. If the bruised surface dries rapidly, no infection occurs.

The rot does not spread from plant to plant in the shed except by direct contact. Simultaneous outbreaks of pole rot in all parts of the shed, common in bad years, result from a general previous field infection of injured plants or the presence of spores on the leaves when brought into the shed.

Sclerotinia is essentially a parasite of green leaves and is unable to attack cured leaves.

Cross inoculations show that the Sclerotinia on hollyhock is capable of producing pole rot. The same is probably true of this same fungus on many other hosts.

These findings suggest some modifications in our present control methods:

1. Avoid topping and suckering during rainy periods.
2. Don't let the blossoms mature in the field.
3. Avoid bruising during harvesting.
4. Allow the plants to mature fully before harvesting since this hastens the cure.
5. Fire the sheds while the leaves are still green instead of waiting until the leaves are turning color.

CONTROL OF WIREWORMS BY USE OF A RYE COVER CROP

Some growers have observed that wireworm injury is rarely serious where a heavy rye cover crop is plowed under in the spring before tobacco plants are set. This general observation was confirmed by

actual counts of plants showing wireworm injury in adjacent fields with and without rye cover. It was checked further by counting the wireworms in potato seed pieces on parts of a field with and without rye.

The explanation is that when the hungry hibernating worms come to surface soil as it warms up in the spring, they find an abundance of green food in the rye plants. Having gorged themselves, they stop eating for a period which corresponds to the setting period for tobacco and the young plants are thus allowed to become established without molestation. By the time the worms get hungry again and the rye has rotted, the tobacco plants have become so large and strong that feeding of the worms on the roots is of little consequence.

"YELLOW PATCH" IN THE SEED BEDS

This seed bed trouble is characterized by starved looking patches of plants in the early seed bed period. The plants lose color and stop growing or die. An investigation of many such spots in the beds in 1945 revealed that they may be due to any of the three following causes:

1. Leaching of the nitrogen due to excessive water dripping from the sash or settling in low spots. Corrected by sprinkling with a weak nitrate of soda solution.
2. Destruction of the feeding roots by the fungus *Pythium debaryanum*. Not so easily corrected but nitrate of soda gives some relief.
3. Excess ammonia in the soil due to the use of too much nitrogenous fertilizer material or seeding too soon after steaming. Can be prevented by avoiding these practices. Drenching the beds with a dilute solution of calcium chloride caused marked improvement.

Analytical Chemistry

WORK OF THE DEPARTMENT

Much of the work of the Department of Analytical Chemistry is prescribed by special statutes, namely, the fertilizer, feeding stuffs, food, drug and cosmetic, dairy and insecticide laws. Under these laws, the Station is charged with the registration, sampling and analysis of fertilizers and feeding stuffs; with giving advice to, and analyzing foods, drugs and cosmetics submitted by the Dairy and Food Commission; with the analysis of insecticides and fungicides, and with the certification of Babcock glassware and dairy thermometers. Since it is the only general State chemical laboratory, a considerable amount of analytical and consulting service is also rendered to other State and Station departments, including the Departments of Agronomy and Animal Diseases of the Storrs Experiment Station, the Commission on Domestic Animals, the State Purchasing Agent, the Bureau of Preventable Diseases of the State Department of Health, the State Police,

the U. S. Geological Survey, State Humane Society, and local Boards of Health and Police Departments.

In the past year analyses or other examinations have been made of 451 fertilizers; 1,271 feeding stuffs and fodder materials, including biological specimens examined for poisons; 1,397 official and other samples of foods, drugs and cosmetics; 1,023 miscellaneous materials, and 3,178 pieces of Babcock glassware and thermometers.

A spectrograph has recently been added to the department's equipment. The use of this instrument for the accurate quantitative determination of the elements has not yet been so thoroughly explored in the agricultural field as it has in the metallurgical industries, but experiments already conducted indicate that in many cases determinations can be made by this method in much less time than by chemical methods, without loss of accuracy. This instrument promises to be of considerable value in the study of the occurrence of the minor elements in soils and plant materials.

INSPECTION OF FERTILIZERS

For the 1944-45 season, war restrictions still modified the normal fertilizer picture in the same manner that was noted last year: there was increased tonnage consumption with a marked decrease in the number of grades and brands.

Fertilizers used in Connecticut amounted to 81,663 tons, an increase of 9 per cent over the previous year and of approximately 30 per cent over the 5-year average immediately prior to 1942. Forty-four firms registered 229 commercial brands.

Guaranteed analyses were well maintained. Our analyses show that 91 per cent of all guaranties were substantially met or exceeded; this is the same percentage shown in the 1943-44 inspection.

INSPECTION OF FEEDING STUFFS

The number of firms registering feeding stuffs and the number of brands registered have remained fairly constant during the last five years. For the past year, 1944, there was a decline of 14 per cent in the number of brands as compared with 1943, 180 firms registering 1,058 brands of feed, including vitamin D carriers.

The difficulty in obtaining certain ingredients has made it necessary for manufacturers to change feed formulas and revise guaranties rather frequently, but guaranties have been well maintained. Results of the 1944 inspection show that for feeds 94 per cent of the guaranties were substantially met; for vitamin D carriers the corresponding percentage was 91.

In addition to the commercial feeding stuffs, 50 samples of native seeds and berries known to be eaten by wild birds were analyzed for the State Department of Fisheries and Game, and 220 samples of pasture grasses were examined for the Storrs Experiment Station.

INSPECTION OF FOODS AND DRUGS

Under the Connecticut Food, Drug and Cosmetic Act, it is the duty of the Station to analyze samples submitted by the Dairy and Food Commission and report whether the samples violate the law; also to give technical advice to the Commission. The Station is jointly responsible with the Commission for regulations issued under the law. In addition to the official samples analyzed for the Dairy and Food Commission, the department also examines some foods and drugs submitted by the State Purchasing Agent, local boards of health and private citizens.

In the past year, emphasis in inspection was placed on four classes of foods: (1) those contaminated with filth or decomposed, (2) those deceptively packaged, (3) incubated eggs, and (4) those that contained or might have contained poisonous ingredients. One hundred and four official samples were examined for evidence of filth or decomposition, and 66 of these, or 63 per cent, were condemned. Seventy-four samples were examined for deceptive packaging, that is, for being slack-filled, and 26, or 35 per cent, were condemned.

Until the law was amended by the 1945 session of the General Assembly, a special section of the General Statutes (Sec. 2453) permitted the sale of incubated eggs for food provided they were labelled "incubated eggs". These eggs are the eggs that are rejected by hatcheries as infertile after they have been incubated for as long as 18 days. There was considerable sale of these eggs for food purposes, almost exclusively to bakeries. Such eggs, while they do not have an offensive odor, are addled eggs and unfit for consumption. During the past year many of these eggs were examined for the Dairy and Food Commission, which proceeded against them under the Food, Drug and Cosmetic Act, charging that they were unfit for food purposes. Thousands of dozens were condemned and destroyed.

The foods examined for the possible presence of poisonous ingredients included 106 samples tested for lead and arsenic residue from spraying; in no case were the tolerances for these elements exceeded. Two cases where foreign poisonous ingredients were encountered were: (1) the accidental substitution of boric acid for dextrose in a feeding formula at a New London hospital, which caused several infant deaths, and (2) the serving in a restaurant, by mistake for ginger ale, of a sterilizing preparation, "Roccal".

Of the 1,221 official samples of foods and drugs submitted for examination, 27 per cent were found to be adulterated, misbranded or otherwise objectionable. This is somewhat higher than the 1940-1943 average of 20 per cent, but the increase is too small to be of positive significance. In any case these percentages are not representative of

the quality of the food and drug supply of the State as a whole, because samples usually are taken only when there is reason to suspect a violation of the law.

CALIBRATION OF BABCOCK GLASSWARE AND THERMOMETERS

The law requires that all Babcock milk and cream bottles and pipettes, and all dairy thermometers, be calibrated by the Station before they may be used. The number of pieces so tested in 1944 was 3,178.

ANALYSES OF INSECTICIDES AND FUNGICIDES

The work on insecticides during 1944 was confined mostly to determining the composition of new insecticides submitted by the Station Department of Entomology, and to preparing compounds for study that were not commercially available. The use of organic compounds for insecticides and fungicides in place of arsenicals, fluorides, copper compounds and sulphur is increasing, and has brought with it numerous analytical problems.

ANALYSES OF SPECIAL AND MISCELLANEOUS FOODS

Since the advent of insulin, special foods have ceased to play the part they once did in the diet of the diabetic. Few "diabetic" foods were found on the market last year. There is a growing tendency on the part of manufacturers to declare vitamins in their foods. Many of the vitamin claims are no more than appeals to the hypochondriac, but dietiticians and plant breeders are legitimately interested in the vitamin content of natural foods. The department has made a limited number of vitamin determinations on foods; more extended work must await the establishment of a microbiological laboratory. One vitamin-containing food that is regularly inspected is Vitamin D milk; 108 samples were examined in 1944; 93 per cent of these met their guaranties.

COLLABORATIVE STUDIES OF ANALYTICAL METHODS

The department head served as chairman of the editorial committee of the new (6th) edition of Methods of Analysis of the Association of Official Agricultural Chemists, which is to be published shortly. This book contains the official methods for the analysis of fertilizers, feeds, foods, drugs and cosmetics, and is used by federal, foreign and state control officials; it is recognized by name in the statutes governing the fertilizer and feed inspection in this State, and is generally recognized as authoritative in federal and state courts.

The department has continued to collaborate with other laboratories in an effort to improve the method for the assay of vitamin D in carriers for poultry feeds. Considerable evidence has been accumulated that the assay may be shortened by determining ash in the toes

of the chicks instead of in the tibiae; work on an improved diet is also in progress.

EXAMINATION OF BIOLOGICAL SPECIMENS IN CONNECTION WITH SUSPECTED POISONING OF LIVESTOCK

One hundred and nine biological specimens were examined in connection with suspected poisoning of domestic animals and poultry. In 37 of these, poisonous substances were found in sufficient quantity to suggest probable causes of death. The poisons found were: arsenicals, cyanide, lead, nitrates, yellow phosphorus and strychnine.

The spectrograph is becoming increasingly useful in these examinations.

Biochemistry

SOYBEAN PROTEINS

During the war years, many changes in the national diet were advocated by nutrition authorities. One of the most important of these was a policy of replacing the highly esteemed proteins of animal origin to as great an extent as possible with proteins derived from plants. Relatively few sources of plant proteins are produced in quantities sufficient to play a significant role in such a program but of these few the soybean occupies a dominant position.

The soybean has long been known to possess excellent nutritive properties. Scientific experiments have shown the proteins of this bean to compare favorably with those of wheat flour and to be only slightly less effective in nutrition than the proteins of milk. The traditional use of the soybean by large populations in the Orient as the main source of protein other than the cereals is additional evidence of its high quality. As a consequence, the Food and Nutrition Board of the National Research Council early in the war advocated a substantial increase in the acreage devoted to the soybean in America. In addition, every effort was made to increase the popularity of this food material. A broad program of scientific study of the soybean was also initiated and contributions to this program were invited from many laboratories.

The share taken by the Department of Biochemistry was described in some detail in the Director's Report for 1944 (Bul. 484). The fulfillment of the Department's task may be briefly described as follows. A large sample of glycinin, the main globulin of the soybean, was prepared from one of the varieties (Illini) widely grown in the middle western states and distributed to collaborators for analytical studies of the amino acid content by the recently developed methods of microbiological analysis. These methods have the advantage over the previously employed chemical methods in that results for all of the amino acids known to be essential in nutrition can be obtained with remarkably little expenditure of either time or material. Further-

more, in the hands of qualified specialists, the new techniques have been shown to give results of great accuracy.

The combined data from the cooperating laboratories, together with a few trustworthy values from other sources, were assembled into a table of the composition of soybean glycinin which accounts for well over 85 per cent of this protein. Glycinin is now, therefore, one of the most completely analyzed of the seed proteins. The only amino acids for which analytical results could not be obtained are some that are not essential in the nutrition of animals.

In addition, it was established that, as a first approximation, the composition of the main globulin, which makes up about one-half of the total proteins of this seed, can be used without serious error to compute the amino acid composition of the total proteins of this seed. Thus, a simple and sufficiently accurate basis for completing soybean diets is now available.

It was demonstrated that the main deficiency of the proteins of the soybean is the amino acid methionine. This substance is present in small proportion. Accordingly, in devising diets that are to furnish a complete and adequate supply of the essential amino acids, a richer source of this particular amino acid must be included.

HISTIDINE

A new method for the gravimetric determination of the proportion of histidine yielded by proteins was described last year. This method has been applied to a series of the more important proteins used in the standardization of methods of this type. In addition, through the cooperation of Professor Wyman of Harvard University, the method has been applied to specimens of hemoglobin prepared from the blood of the cow and also to hemoglobin prepared from that of the unborn fetus of the cow. It has been suspected for some time that the hemoglobin of the fetus must differ in certain respects from that of the mother; otherwise it would be difficult to account for the fact that the fetus can derive its oxygen from the hemoglobin in the maternal blood stream during intrauterine life. Determinations of histidine in these two kinds of bovine hemoglobin demonstrated a difference in composition with respect to the proportions of this important amino acid. Through cooperation with Professor Brand, of Columbia University College of Physicians and Surgeons, differences with respect to other amino acids have also been established. Accordingly, it can be concluded that the hemoglobin of the blood of the fetus is in general a protein of different amino acid composition from that of the mother.

ISOCITRIC ACID

A thorough study of the synthetic preparation of isocitric acid has been completed. As was mentioned in last year's report, this substance has assumed an extremely important position in recent years in theoretical explanations of the respiration of both animal and plant tissues. Isocitric acid contains two asymmetric carbon atoms. Therefore, synthetic preparations should contain four optically active isomers which separate from solution as two optically inactive pairs of substances, each of which is composed of an optically active isomer and its mirror image or enantiomorph, as it is technically called. These two pairs, or diastereoisomers, differ from each other only in the geometrical arrangement in space of the four different groups or radicals around the two asymmetric carbon atoms. This small difference is sufficient to endow the two substances with different physical and chemical properties. However, the differences are not great so that the separation of diastereoisomers is frequently a difficult operation. This was found to be the case with synthetic isocitric acid. When prepared by the method of Fittig and Miller, the mixture contained isocitric acid and allo-isocitric acid (literally the "other" isocitric acid) in a ratio of about six to one. As a result of this fortunate circumstance, it was possible to prepare the desired isomer in good yield and in a high state of purity. The observation accounts for the fact that other investigators who have employed this method were able to obtain synthetic material exactly half of which consisted of the optically active isocitric acid that occurs in nature and which is attacked by the enzyme aconitase.

It was also possible to secure a small yield of allo-isocitric acid from the synthetic material and to characterize it by means of chemical derivatives. This substance was isolated for the first time.

A second synthetic method for isocitric acid, that of Wislicenus and Nassauer, was also studied. This yielded the two diastereoisomers in far more nearly equal proportions and, although both isocitric acid and allo-isocitric acid could be obtained from the mixture, the separation was found to be extraordinarily difficult and the yields were small. This method of synthesis is therefore inferior to that of Fittig and Miller when interest is confined to the preparation of the substance that occurs in nature.

Progress has also been made in the development of a convenient method for the preparation of optically active isocitric acid from the leaves of *Bryophyllum calycinum*. It has been found that the organic acids can be conveniently precipitated with lead acetate from extracts of the dried leaves and esterified after liberation from the lead salts. The time consuming extraction of the free acids with ether is thereby avoided. It is hoped that moderate supplies of this extremely rare organic acid can shortly be made available for research.

THE METABOLISM OF NARCISSUS BULBS

A series of bulbs of the common paper white narcissus was grown a few years ago in darkness and also in continuous light with nitrogen supplied as nitrate, with nitrogen supplied as ammonium salts, and without extraneous nitrogen. At the time that bud formation began

to assume importance, the tissues were separated into fractions that represented the residual bulb, the roots and the tops. Analyses of these samples of tissues have now been completed and the results have been fully described in Station Bulletin 496. A detailed study was made of the carbohydrates, the proteins and the organic acids in the bulbs at the start and of the fate of these components during growth. The object of this experiment was to obtain data from a plant that can grow under normal conditions to maturity, at least with respect to the initiation of the reproductive phase, without nutrition from the outside. Bulb plants alone are provided with sufficient stores of food material to support the plant for a significant part of this period without access of nutriment from the soil or culture solution. The isolation of the system under study can therefore be more effectively accomplished with such plants than with plants that reproduce from seeds. By comparison of the behavior of the plants that had no outside source of nitrogen and of those that received either nitrate or ammonium salts, an illustration was obtained of the manner in which the plant makes use of the nitrogen that is available to it. In addition, comparison of the respective behavior with nitrates and with ammonium salts showed how these two main sources of nitrogen affect the metabolism.

The contrast between growth in light and the abnormal growth of the plants in darkness provided evidence on the effects of the supply of the products of photosynthesis. Nevertheless, inasmuch as this plant contains a rich store of starch in the bulb, this contrast was far less marked than is observed in the case of ordinary seed plants.

A striking and unexpected result of the culture upon ammonium salts was the failure of this species to become enriched in the amides, asparagine and glutamine. The narcissus plant thus differs widely in this respect from such plants as the tomato.

Detailed discussion of these results may be found in Bulletin 496. Perhaps the outstanding observation was that, when grown with no outside source of nitrogen, the narcissus plant loses a small but significant proportion of its nitrogen in the course of development of the leaves. This confirms observations made in England some years ago with detached leaves of an allied species and brings up difficult problems regarding the chemical mechanism whereby the plant can transform organically bound nitrogen into elementary gaseous nitrogen.

THE PROTEINS OF PLANTS

At the invitation of the editors of *Physiological Reviews*, a comprehensive review of the literature of the proteins of plants was prepared. On the one hand, this term is ordinarily understood to comprise the proteins of seeds that serve as the source of nitrogenous nutriment during the initial stages of growth of the plant and, incidentally, are the primary source of protein in the nutrition of both man and animals. On the other hand, it covers the proteins of the green leaves

and other fleshy tissues of plants. The classical experiments of Osborne carried out at this Station during the last decade of the 19th century are still the foundation of our knowledge of the plant proteins of the first category, while the experiments of Chibnall, some of the most important phases of which were carried out while he was a guest of this Department some twenty-five years ago, provide the foundation of our knowledge of the proteins of leaves.

CHITTENDEN MEMOIR

A biographical memoir of the late Professor Russell H. Chittenden was prepared at the request of the president of the National Academy. Chittenden was one of the outstanding students of Professor Samuel W. Johnson, the first Director of this Station, and in 1875 established at Yale University the first laboratory in America for the study of physiological chemistry. He subsequently became one of the great leaders of this branch of science and was especially noted for his contributions to nutrition.

NUTRITION

The rapid normal rate of growth of the albino rats of the Connecticut Station strain has become well known in recent years. Following the report by Mendel and Hubbell in 1935 in which this enhanced rate was compared with that in earlier years, questions have frequently been asked concerning the change, especially whether it was due entirely to the difference in food, or was brought about at least in part by the selection of larger animals for breeding. It has also been suggested that the rapid rate of growth recorded in 1935 was attained as the result of improved nutrition during several generations. This implies that the animals available for experimental use during that period were not satisfactorily uniform.

It has seemed of interest, therefore, to record data that have a bearing on the questions raised. Two groups of breeding rats are maintained in the colony. In one, the so-called "regular stock", the rats are fed according to the procedure described by Mendel and Hubbell, in which the basal diet of a commercial calf starter is supplemented at all times with yeast and with wheat germ and, during nursing and early growth subsequent to weaning, with a paste food in addition. This paste food consists of approximately equal parts of whole milk powder, casein, lard, and wheat germ. The other group of breeding rats is maintained for the production of animals for vitamin D assays and may be referred to as "rickets stock". The food for the animals of this group is the well known Bills diet, a mixture of grains, whole milk powder, and inorganic salts. No supplements are used.

The animals in the "rickets stock" colony are all first generation material derived from the regular stock and their growth and repro-

ductive behavior therefore reflect an immediate rather than a cumulative change in dietary treatment.

Data that show a comparison of the reproductive behavior of animals in the two groups for the last seven years are presented in the table.

	Stock diet	Bills diet
Number of females mated	1,755	2,329
Percentage of litters cast	81.1	79.8
Average number of young per litter	9.3	9.5
Percentage of litters weaned	88.9	89.2
Average number of young weaned per litter*	6.7	6.7
Average weaning weights (21 days)		
Females	46.6	38.1
Males	48.0	39.3

* All litters were arbitrarily reduced to 8 young at birth.

It will be noted that the only significant difference is in the weights of the young at weaning. In the "regular stock" colony the average weight of the 8,395 young was more than 20 per cent greater than that of the 10,425 young in the other group. That this difference is not due to excessive consumption of the concentrated paste food by the young rats of the regular stock colony during the last days of nursing is indicated by data that have been obtained in recent months. These observations show that the higher weights of the young rats are evident even during the early stages of nursing, namely, at 4 days of age, and also at 17 days, when the period of active nursing is almost completed.

Biometry

Agricultural experiments are subject to so many variable factors that clear-cut results depend upon the care with which they are planned and the skill with which they are interpreted. Special designs and methods of analysis have been devised by statisticians to meet these needs. As the specialist in this field, the Station biometrician has acted as a consultant to staff members throughout the year. Conferences have included the design of both laboratory and field experiments, the analysis and interpretation of data from all departments in the Station and the critical review in their statistical aspects of many manuscripts and published reports. The results have been reported by the several departments, usually without the statistical details upon which they were based. The biometrician has given similar assistance to staff members from other Experiment Stations in New England and to special committees of the United States Pharmacopoeia on the standardization of drugs.

The biometrician has also carried on research on statistical techniques of use in biological investigations. These included a study of the accuracy of the cylinder-plate assay for penicillin from the data of a collaborative experiment, conducted under the auspices of the U. S. Pharmacopoeia in twenty different laboratories throughout the United States. This analysis was issued in mimeographed form and aided in determining the sources of error in the assay and their magnitude. As one result, a revised and simplified technique has been proposed.

Another project concerned the comparison of tibia and toe ash in the chick assay of vitamin D from data obtained at the Experiment Station over a period of years. The relation between dosage and response was found to be relatively stable in successive assays and potency could be assayed with as great precision from the toe ash as from the tibia ash. As part of the collaboration by the Station in a study of the effect of two experimental diets upon the chick assay sponsored by the Animal Vitamin Research Council, the analysis of the results were supervised from the biometrician's office. In another project, the calculation of confidence limits for biological assays was reduced to a systematic form. A major project continuing throughout the year was the preparation of a book on the biological measurement of potency.

The Library

During the year ending October 31, 1945, the Station Library had approximately 240 additions. These consisted of 170 bound periodicals and bulletins (received as separates) and 70 single books. The total number of volumes on hand is now approximately 27,950.

The Library subscribes to about 100 sets of scientific journals. It receives 20 sets of farm journals in exchange for the publications of this Station. United States Department of Agriculture publications and Experiment Station publications of all states are received regularly. These are not included in the volume count until bound.

Approximately 80 microfilms and photostats were obtained in place of inter-library loans, mainly from the U. S. Department of Agriculture Library in Washington.

Duplicates of six incomplete sets of journals were contributed to the American Library Association Committee on Aid to Libraries in War Areas.

Accessions and library information are listed in the mimeographed "Library Notes", issued to the staff.

The list of "Scientific Journals and Serial Publications", which lists our holdings, was revised this year.

Recataloguing is still in process; the classification has been revised and brought up-to-date according to the latest edition of the Dewey classification scheme. Cutter numbers have been added to books to facilitate both filing and finding.

LIST OF PROJECTS

Active in 1945-46

Analytical Chemistry

1. Inspection of fertilizers.
2. Inspection of feeding stuffs. (Including biological assays of vitamin D supplements for poultry feeds.)
3. Inspection of foods and drugs. (Including biological assays of vitamin D milk.)
4. Calibration of Babcock glassware and thermometers.
5. Analyses of insecticides and fungicides.
7. Analyses of special and miscellaneous foods.
8. Collaborative studies of analytical methods.
9. Examination of biological specimens in connection with suspected poisoning of livestock.

(Nos. 2, 3 and 5 are in cooperation with the Dairy and Food Commissioner.)

Biochemistry

1. Cell chemistry.
   a. A detailed examination of the chemical composition of plant tissues with special reference to the changes that occur during culture under various conditions, and to the metabolism of the various components. The development of methods suitable for the accurate determination of the components of plant tissues.
   e. Investigation of the organic acids of plants with special reference to their detection, analytical determination and to their metabolism.
2. Protein chemistry.
   Investigation of the properties of proteins and amino acids with special reference to the development of methods for their preparation and analytical determination.
3. Nutrition investigations.
   Investigations of the relation of certain constituents of the diet, especially the mineral salts, to growth.

Entomology

9. Insect survey of Connecticut.
17. The control of the Oriental fruit moth, including parasites. (In cooperation with the U. S. Dept. Agr.)
31. The biology and control of the European pine shoot moth. (Inactive.)
37. Substitutes for lead arsenate in orchard sprays for apple maggot control.
40. The control of the European corn borer.
43. The spruce gall aphid.
44. Bark beetles of the elm.
45. Investigation of parasites of the Japanese beetle.
49. Adhesives for standard spray mixtures.
51. Soil and grassland insect investigations.
52. The biology and control of the eastern field wireworm.
53. Rodent control. (In cooperation with the U. S. Fish and Wildlife Service.)
56. Investigation of the factors affecting the efficiency of dusts. (In cooperation with the Dept. of Plant Pathology and Botany.)
57. The biology and control of Comstock's mealybug on pears and apples.
58. Investigations of diseases affecting scarabaeid larvae.
60. The biology of the codling moth in Connecticut.

61. Control of insects by means of chemicals absorbed by plant tissues. (Inactive.)
62. Control of the borers in nursery trees.
63. Investigations into the poisoning of honey bees in the control of plant pests.
64. Control of American foulbrood of bees.
65. New methods for applying insecticides.
66. Relation between chemical constitution of insecticides and toxicity to insects.

Control and Service

10. Inspection of orchards and nurseries.
11. Control of the gypsy moth. (In cooperation with the U. S. Dept. Agr.)
13. Inspection of apiaries.
19. European corn borer and Japanese beetle inspection. (In cooperation with the U. S. Dept. Agr.)
27. Rearing and distributing parasites of the Oriental fruit moth. (In cooperation with the Conn. Pomological Society.)
29. Dutch elm disease control. (In cooperation with the U. S. Dept. Agr.)
67. Control of white pine blister rust. (In cooperation with the U. S. Dept. Agr.)

Forestry

1. Experimental plantations on a sandy tract at Rainbow.
   a. Comparison of many species of conifers and hardwoods, in pure stands and in combinations, as to growth and habits.
   b. Methods of management for those species that have survived.
6. Studies of forest plantations throughout the State.
   a. Growth and yield of several species in relation to site.
12. The utilization of native grown woods.
   a. Use of preservatives.
   b. Portable charcoal kilns.
   c. The properties of the wood of several of the important species. (In cooperation with the Yale Forestry School.)

Control and Service

8. Tree Protection Examining Board.

Genetics (Plant Breeding)

1. A genetic and cytological study of hereditary characters in plants.
2. The effect of inbreeding and crossing upon seed and vegetatively propagated plants.
3. Methods for the improvement of naturally cross-fertilized plants by selection in inbred lines.
4. Methods for the improvement of naturally self-fertilized plants.
5. A genetic and physiological study of variation and the effects of selection in vegetables and fruits.

Plant Pathology and Botany

5. Plant disease survey of Connecticut.
27. Vascular diseases of plants—Dutch elm disease; maple wilt; wilt diseases of tomato and eggplant.
31. Virus diseases of plants—X-disease of peach; mosaic diseases of vegetables and ornamentals.
34. Fungicides, new and old. An examination of the action of fungicides, old and new, and of their use on vegetables, fruits, shade trees and ornamentals.
36. Artificial immunization and chemotherapy in plant disease control.
37. Root rot diseases of plants.
38. Interrelations between physiology and pathology of plants, using as material tip-burn on potatoes, defoliation diseases of tomatoes, blossom-end rot of vegetables, deficiency diseases of plants.

Control and Service

12. Seed testing. (In cooperation with the Commissioner of Agriculture.)
25. Spray service. (In cooperation with Extension Service, University of Conn.)

Soils

2. The physical and chemical characteristics of soils representing important types and cultural uses in relation to the nutritive responses of tobacco and other indicator crops in pot trials.
3. Nutrient requirements of vegetable crops on important soil types used for market gardening in Connecticut.
4. The relation of soil conditions to growth and composition of natural and planted forests.
5. Lysimeter studies of the drainage losses and other changes that occur in soils under heavy fertilization as practised for tobacco and vegetables.
7. The improvement of the nutritional status of unproductive forest soils.
8. The agronomic application of rapid chemical tests for estimating the nutritional factors of soil fertility.
10. Nitrogen relationships in soil maintenance by green manures in vegetable cropping systems.

Tobacco Substation

1. Fertilizer experiments.
   - ea. Ammonium nitrate as a source of nitrogen for tobacco.
   - r. Plowing under the fertilizer.
4. Tobacco nutrition studies.
   - b. Boron fertilizer experiments.
   - d. Symptoms of food element deficiency.

5c. Improvement of Havana seed strains.

7aa. Improvement of Shade tobacco by selection and breeding. (With Genetics Dept. and in cooperation with the Shade Tobacco Growers Agricultural Association, Inc.)
   - e. Open field wrapper improvement.

13. Preservative treatment of shade tent poles. (See Forestry No. 12.)

17aa. Study of tobacco pigments.

19. Investigation of various tobacco diseases.
   - a. Damping-off.
   - c. Pole rot.
   - e. Breeding for mosaic resistant Broadleaf.
   - f. Control of downy mildew.
   - i. Sclerotinia and Botrytis diseases of tobacco.
   - j. Breeding for mosaic resistant Havana seed.

20. The biology and control of insects that attack tobacco. (See Entomology No. 52.)
22. Irrigation of tobacco.
26. Chlorpicrin for sterilizing tobacco beds.
32. Plowing *versus* discing as preparation for tobacco.
33. Effect of shade tent on atmospheric conditions and developments of tobacco.

PUBLICATIONS

July, 1944 to July, 1945

BULLETINS OF THE STATION

No. 480. Commercial Feeding Stuffs. Report on Inspection. 1943. E. M. Bailey.

No. 481. Connecticut State Entomologist. Forty-Third Report. 1943. R. B. Friend.

No. 482. Report on Food and Drug Products. 1943. E. M. Bailey.

No. 483. Commercial Fertilizers. Report for 1944. E. M. Bailey.

No. 484. Report of the Director for the Year Ending October 31, 1944.

CIRCULARS OF THE STATION

No. 161. The Law Concerning Concentrated Commercial Feeding Stuffs and Regulations Pertaining Thereto.

JOURNAL PAPERS

Barratt, R. W. Intraseasonal advance of disease to evaluate fungicides or genetical differences. Phytopath., **35**:657. 1945.

Beard, Raimon L. The susceptibility of Japanese beetle larvae to *Bacillus popilliae*. Jour. Econ. Ent., **37**:702-708. 1944.

Bliss, C. I. A chart of the chi-square distribution. Jour. Amer. Statistical Assoc., **39**:246-248. 1944.

———. A simplified calculation of the potency of penicillin and other drugs assayed biologically with a graded response. Jour. Amer. Statistical Assoc., **39**:479-487. 1944.

———. Relative potency as applied to the assay of penicillin. Science, **100**:577-578. 1944.

———. Review of "Statistical Tables for Biological, Agricultural and Medical Research" by R. A. Fisher and F. Yates. Science, **98**:346-347. 1943.

———. Review: "Statistical Analysis in Biology" by K. Mather with a foreword by R. A. Fisher. Science, **102**:161-162. 1945.

———. The U. S. P. collaborative cat assays for digitalis. Jour. Amer Pharm. Assoc., **33**:225-245. 1944.

Bliss, C. I., and Allmark, M. G. The digitalis cat assay in relation to rate of injection. Jour. Pharmacol. and Expt. Ther., **81**:378-389. 1944.

Bliss, C. I., Fitzhugh, O. Garth, and Nelson, Arthur A. The chronic oral toxicity of selenium. Jour. Pharmacol. and Expt. Ther., **80**:289-299. 1944.

Fisher, H. J. Report of Committee on Revision of Methods. Jour. Assoc. Official Agric. Chemists, **28**:36. 1945.

Friend, Roger B. Entomology, The American Year Book. 1944. pp. 800-807.

———. The gypsy moth in Connecticut. Proc. Conn. Acad. Arts and Sciences, **36**:607-629. 1945.

———————. New insecticide material (DDT). Amer. Scientist, Vol. 32, No. 4, p. xiv. October, 1944.

———————. The timing of insect control operations. Plants and Gardens (Brooklyn Botanic Garden Record), **1**:113-115. 1945.

GARMAN, PHILIP. Further studies of apple spray schedule reduction. Jour. Econ. Ent., **38**:341-343. 1945.

———————. Report on parasites, 1944. Conn. Pom. Soc. Proc., **54**:86-87. 1944.

———————. Seventeen-year locust or periodical cicada, with a few notes on other insect pests. Pomol. Pointers for Conn. Fruit Growers. June, 1945.

———————. The season's insect situation. Pomol. Pointers for Conn. Fruit Growers. April, 1945.

———————. Trends in insect control. Conn. Pom. Soc. Proc., **54**:29-34. 1944.

GARMAN, PHILIP, FRIEND, R. B., and GOWDY, C. H. Insects of 1944. Conn. Pom. Soc. Proc., **54**:81-82. 1944.

GRIES, GEORGE A. Juglone: The active agent in walnut toxicity. Northern Nut Growers' Assoc. Proc. 1943, **34**:52-55. 1944.

GRIES, GEORGE A., and HORSFALL, JAMES G. Balance of calcium and potassium in relation to club root of cabbage and potato scab. Phytopath., **34**:1001. 1944. (Abstract.)

GRIES, G. A., HORSFALL, J. G., and JACOBSON, H. G. M. The balance of calcium and potassium in relation to club root of cabbage and potato scab. Phytopath., **34**:1001. 1944.

GRIES, G. A., HORSFALL, J. G., and TURNER, N. Polymodal response curves in biological research. Phytopath., **35**:654-655. 1945.

HORSFALL, J. G. Synergism and antagonism. Plant Disease Reporter. Suppl. **157**:162-166. 1945.

———————. Quantitative biossay of fungicides in the laboratory. Botanical Review, **13**:357-397. 1945.

HORSFALL, J. G., and BARRATT, R. W. An improved grading system for measuring plant diseases. Phytopath., **35**:654-655. 1945.

HORSFALL, J. G., and ZENTMYER, GEORGE A. Fungicidal action of reagents for amino acids, amines, aldehydes, and other reactive cell constitutents. Phytopath., **34**:1004. 1944. (Abstract.)

JONES, D. F. Biographical memoir of Edward Murray East, 1879-1938. Proc. Natl. Acad. Sciences, **23**:217-242. 1945.

———————. Growth changes in maize endosperm associated with the relocation of chromosome parts. Genetics, **29**:420-427. 1944.

———————. The importance of degenerative changes in living organisms. Science, **102**:209. 1945.

LUNT, HERBERT A. Response of hybrid poplars to nitrogen. Proc. Natl. Joint Comm. on Nitrogen Utilization, 1944. pp. 103-104.

———————. Soil organic matter. Rural New Yorker, **104**:4. 1945.

———————. Wood ashes for fertilizer. Conn. Woodlands, **10**:18-20. 1945.

LUNT, H. A., and JACOBSON, H. G. M. The chemical composition of earthworm casts. Soil Science, **58**:367-375. 1944.

SINGLETON, W. RALPH. Noyes Darling, first maize breeder. Journal of Heredity, **35**:265-267. 1944.

STODDARD, E. M. Immunization of peach trees to X-disease by chemotherapy. Phytopath., **34**:1011. 1944. (Abstract.)

STODDARD, E. M., GRIES, G. A., and PLUMB, G. H. Red spider control with disodium ethylene bisdithiocarbamate. Phytopath., **35**:657. 1945.

TURNER, NEELY. The coverage factor in the application of dusts. Jour. Econ. Ent., **38**:359-364. 1945.

VICKERY, HUBERT BRADFORD. Biographical memoir of Russell Henry Chittenden, 1856-1943. Natl. Acad. Sci., Biographical Memoirs, **24**:59-104. 1945.

———————. The histidine content of adult and fetal bovine hemoglobin. Jour. Biol. Chem., **156**:283-287. 1944.

———————. The proteins of plants. Physiological Reviews, **25**:347-376. 1945.

VICKERY, HUBERT BRADFORD, and WINTERNITZ, JANE K. The determination of histidine with the aid of 3, 4-dichlorobenzenesulfonic acid. Jour. Biol. Chem., **156**:211-229. 1944.

ZENTMYER, GEORGE A. Inhibition of metal catalysis as a fungistatic mechanism. Science, **100**:294-295. 1944.

ZENTMYER, GEORGE A., and WALLACE, PHILIP P. Factors influencing the development of *Ceratostomella ulmi* in elm trees. Phytopath., **34**:1014. 1944. (Abstract.)

ZENTMYER, GEORGE A., and WALLACE, PHILIP P. New research on the Dutch elm disease. Proc. 20th Natl. Shade Tree Conf., 1944. pp. 115-119.

ZENTMYER, GEORGE A., WALLACE, P. P., and HORSFALL, J. G. Distance as a dosage factor in the spread of Dutch elm disease. Phytopath., **34**:1025-1033. 1944.