Bulletin 484 March, 1945

REPORT OF THE DIRECTOR

For the Year Ending October 31, 1944

Connecticut
Agricultural Experiment Station
New Haven

CONTENTS

DR. M. F. MORGAN

(Lt. Colonel, U. S. Army)

As this Report was being written, we were shocked and saddened to receive word that Dr. Morgan, chief of our Soils Laboratory, had lost his life while on active military duty.

A captain of infantry in the last war, Dr. Morgan was keenly interested in military matters. He maintained an active contact through membership in the Officers Reserve Corps, and when it became clear that we would be drawn into this war, put his affairs in order. He reported for active duty in March 1942, and after several assignments, was ordered to the Philippines in November 1944. On January 15, 1945, he was killed by Japanese troops while leading his unit on Leyte Island.

But proud as we are of Dr. Morgan's part in the war, it is as scientist, colleague and friend that we will remember him best. For twenty years he led our researches in Soil Science, with imagination, resourcefulness and energy. His contributions not only served Connecticut's agriculture, but earned recognition throughout the world.

Perhaps he is best known for the "Morgan" method of soil testing, but his work covered a much wider range of agronomic matters. His thorough knowledge of the field and his sound judgment were widely recognized. Not only in Connecticut but throughout the region and the country, farmers, scientists and industrialists sought his counsel and guidance.

Dr. Morgan possessed to an unusual degree those qualities that make for ideal public service—character, ability and energy. His loyalty to the Station and its interests was sincere and complete. We of the Station Staff mourn his loss and cherish his memory.

REPORT OF THE DIRECTOR

FOR THE

YEAR ENDING OCTOBER 31, 1944

To the Board of Control of the
Connecticut Agricultural Experiment Station:

Although we are still on a "war footing", and will continue so for some time, the work of the Station is going forward satisfactorily. The year brought us many difficult situations, but in this respect we merely shared the lot of all.

Because of our depleted staff, reduced transportation and shortage of supplies and equipment, certain less urgent and critical activities may have been laid aside for the present. On the other hand, all research and service that makes for greater efficiency on our farms has been carried on with added vigor.

There follows a brief account of the year's accomplishments and activities.

THE STAFF

The Station has suffered two great losses in the deaths of Mr. W. H. Dietrich and Mr. G. E. Graham.

William H. Dietrich

Mr. Dietrich came to the Station as Assistant Treasurer in 1939 after 10 years in the accounting office of the State Highway Department. Efficient and tactful, he soon won the friendship and respect of the entire staff. His sudden death on February 27, 1944, came as a great shock to his colleagues and friends.

George E. Graham

The Superintendent of Buildings and Grounds at the Station holds a unique and difficult position. His task includes not only the maintenance and care of the plant, but many services for the staff, who are in constant need of special devices and facilities. For over 20 years, Mr. Graham fulfilled these varied requirements to our complete satisfaction. He did this quietly, efficiently and economically. Loyal and faithful, the Station was always his first consideration.

Military Leaves

Sixteen members of the staff are now serving in the Armed Forces. During the Station year the following leaves have been granted:

Herbert Harriman, June 30, 1944
Florence MacWilliam, August 11, 1944

Other Leaves of Absence

Dr. L. C. Curtis was granted leave on May 1, 1944, to take part in the food mission to North Africa for the Foreign Economic Administration.

Dr. H. B. Vickery returned to full time status on July 1, 1944, after spending part time for two years as Associate Director of the Plasma Fractionation Laboratory at the Harvard Medical School.

Retirements

Louise M. Brautlecht, Librarian, January 1, 1944.

J. T. Ashworth, Deputy in charge of Gypsy Moth Control, July 1, 1944.

Resignations

Alice Dustan, M.S., Editor, January 1, 1944.

Jeanne Emerson, secretary, May 15, 1944.

Mrs. Ruth Smith Yatrells, secretary, June 17, 1944.

Dr. Stuart B. LeCompte, Jr., Assistant Plant Physiologist, Tobacco Substation, July 31, 1944.

Dr. George A. Zentmyer, Assistant Plant Pathologist, August 11, 1944.

Elinor Fitzgerald, secretary, October 15, 1944.

Appointments

Amanda Quackenbush, B.Litt., Editor, February 1, 1944.

Wanda D. Ginter, B.S., Research Technician in Biochemistry, January 1, 1944.

Gilbert H. Ahlgren, Assistant Treasurer, June 1, 1944.

Dolor LaBelle, Acting Deputy in charge of Gypsy Moth Control, July 1, 1944.

Helen L. Kocaba, B.S., Research Technician in Analytical Chemistry, July 1, 1944.

Jean F. Royce, secretary, July 1, 1944.

Mary C. Frederiksen, secretary, July 1, 1944.

Emily V. Jensen, secretary, July 10, 1944.

Jeannette J. Hubert, secretary, Gypsy Moth Headquarters, September 1, 1944.

EVENTS AT THE STATION

In normal times, the Station holds one meeting of its own each year—The Field Day or Open House. This is usually at our Experimental Farm in Mt. Carmel, but occasionally at the Laboratories on Huntington Street, New Haven. The attendance runs from 400 to 700 guests. Recently, this has been omitted.

However, each year, the facilities of the Station are used by many agricultural organizations and related groups. Britton Auditorium, completed in 1940, makes an especially suitable meeting place.

Federated Garden Clubs' Day

To compensate partially for the curtailment of garden club talks by staff members, due to wartime conditions, a second annual "Day at Your Experiment Station" for the Federated Garden Clubs of Connecticut was held in Britton Auditorium on March 8. More than 130 delegates from garden clubs throughout the State attended the session.

At the morning meeting, the visitors heard talks on care of soil for the home garden, the fungicide and insecticide outlook for the coming season, and the development of new and improved vegetable varieties. Ten members of the staff participated in an "Information Quiz", a question-and-answer session on problems most frequently encountered by the home gardener. The afternoon program was devoted to a tour of the Station's laboratories and greenhouses, where the delegates saw demonstrations and exhibits of the latest research developments at the Station.

Connecticut Dairy and Milk Inspectors

The annual summer meeting of the Connecticut Association of Dairy and Milk Inspectors was held at the Station on June 27. The members heard talks by Mr. Henry B. Mosle, State Food Administrator for the Connecticut War Council, on the work of his organization, and Mr. Neely Turner of the Station Staff, on insect and rodent control in food establishments. The inspectors were also taken on a tour of the Station during which the work of various departments was explained and demonstrated to them. Particular emphasis was given to the work of the Analytical Chemistry Department, where demonstrations on the testing of food and dairy products were conducted.

Other Station Events

On February 11, an all-day meeting of Connecticut fruit growers, arranged by the New Haven County Farm Bureau and the Connecticut Pomological Society, was held at the Station. The meeting was attended by more than 100 fruit growers, representing every county of the State.

A meeting of New Haven County vegetable growers was held at the Station on February 16. Mr. Martin Myers, regional director of the OPA, and Dr. James G. Horsfall of the Station staff were the speakers.

The Annual Field Day of the Connecticut Beekeepers' Association was held at the Station on June 25. Francis W. Gravely, New York City representative of the A. I. Root Company, Ohio bee supplies concern, was the principal speaker.

The Connecticut Pomological Society held its annual summer meeting at the Mt. Carmel farm on August 23.

The annual meeting of the Federated Garden Clubs of Connecticut was held here on October 11. Dr. William B. Terhune, founder and medical director of the Silver Hill Foundation in New Canaan, discussed the benefits of gardening from a psychiatrist's point of view and the part that gardening may play in rehabilitation of ex-service men and women. The morning session was devoted to annual reports and election of officers.

The Connecticut pest control operators held several meetings at the Station during the past year.

WAR GARDENS

In cooperation with other agencies in the State, the Station continued its work in the war garden program during the past year. Several staff members gave talks on garden subjects to various groups, and others served on local and State committees. Circular 159, "Controlling Pests of War Gardens", a revision of Circular 155, proved particularly popular with victory gardeners. Twenty-five thousand copies were distributed on request. A series of 21 home gardening articles was prepared and distributed to newspapers throughout the State during the summer months.

Progress of the Station's Work

ENTOMOLOGY

Japanese Beetle Infestation Decreases

In general, the Japanese beetle infestation in Connecticut was less intense in 1944 than in 1943. Although the adults were injurious to the foliage of many plants in some areas, a decline in abundance was noted in many places, particularly in the southwestern part of the State. In the Naugatuck Valley and in northeastern Connecticut an increase in population was noted, but in the latter region the infestation is not serious. In southern Connecticut, when the summer drought was severe, a marked decrease in larvae was noticeable as compared to previous years.

"Milky Disease" of Japanese Beetle

The "milky disease" organism has been distributed in all heavily infested parts of Connecticut and the effect of this bacterium on the grub population is becoming noticeable. In one golf course in Fairfield County approximately 90 per cent of the grubs in the soil in late June were infected. It usually takes two to three years from the time of inoculation of the soil for the development of an appreciable incidence of disease, but under certain conditions some effect may be observed in one year.

Studies have been continued on the biological aspects of the "milky disease" and its effects on Japanese beetle larvae. These studies, details of which are to be presented in another Station publication, have been directed toward an understanding of the mode of infection and the spore dosage required to cause disease, the pathogenicity of the disease organism against the grub, the transmission of the disease from grub to grub and factors favoring its spread, and the environmental factors affecting the potency of bacterial spores. Also, some attempt has been made to find an artificial medium for the production of the disease organism, so far without success.

The "milky disease" organism has been found to be of low virulence, requiring large doses to infect Japanese beetle larvae and exerting few pathogenic effects when established in the host. The disease does not cause prompt death of the grub, and infected grubs may continue feeding until they become moribund. The disease does prevent molting and metamorphosis, although grubs may become infected in one stage and successfully molt to the next if the disease has not developed sufficiently.

The effect of the organism upon field populations of grubs is largely influenced by three factors: temperature, dosage of the organism

and population of the host. Favorable temperature and adequate doses of bacteria are required for the initial infection of individual grubs. Favorable temperatures and heavy grub populations are required for a rapid spread of the disease among grubs and a build-up of the spore content of the soil.

Japanese Beetle Parasites

The insect parasites of the Japanese beetle are also important. We are particularly interested in three species. *Centeter cinerea*, a tachinid parasite of adult beetles, has survived in large numbers in Hartford. This parasite shows considerable promise and in another year will be recolonized in other sections of the Japanese beetle-infested areas of the State. The progress of *Tiphia vernalis* and *Tiphia popilliavora*, larval parasites of Japanese beetle grubs, was followed throughout the season. Ten new colonies of *Tiphia vernalis* were released at the rate of 200 females per colony in various sections of Fairfield, New Haven and Hartford counties. Recoveries of healthy cocoons of this species were made at 21 out of 55 of the oldest colony sites. This is convincing evidence that the parasite has, to a certain extent, achieved the purpose for which it was released. Owing to an unprecedented dry season, *Tiphia popilliavora*, which emerges in August, was missing this year at most of the colony sites where its abundance was noted in former seasons.

Adult Japanese beetles are pests of soybeans, seriously defoliating the plants when abundant. Experiments on controlling the insect by spraying the leaves with certain insecticides were not very successful, as the beetle population in the test plots was too low to affect the crop yield significantly. Sprays of varying concentrations of lime and aluminum sulfate, lime and Kolofog, and DDT were applied three times to the foliage of field grown edible soybeans (var. Hokkaido) in late July and August. Leaf samples taken to record the percentage of defoliation gave individual plot variations from 0.80 per cent to 12.50 per cent, while the totals for the different series varied from 2.65 per cent to 6.75 per cent. The lime-Kolofog sprays did not give any improvement over the check. The DDT sprays were not conclusive, as the results were confounded because of insufficient concentrations in the first applications. In the lime-aluminum sulfate sprays, a concentration of 30 pounds of lime and 10 pounds of aluminum sulfate gave results which were significantly better than the standard containing 20 pounds of lime and 3 pounds of aluminum sulfate. However, upon an analysis of the crop yield, there were no significant differences between the sprays.

New Research on Insecticides

In the control of insects affecting truck and vegetable crops, the main reliance is placed on insecticides. Research in this field involves the determination of the toxicity of materials, the proper doses to use

in the field, the method and timing of applications, and the use of diluents, adhesives, and other adjuvants.

For the control of the oriental fruit moth spray tests were conducted with DDT[1] on quinces and peaches. Results both in the laboratory and in the field are promising, but the field infestation on peaches was so low that no conclusions can be drawn this year. On quinces receiving the higher concentrations of DDT, there was a decided reduction in the infestation at harvest.

Work this year with insecticides for apple maggot control has been confined to tests with DDT in the laboratory and in the field. Laboratory cage tests are quite promising and one field experiment gave indications of fair reduction in infestation by the use of four applications of 3 per cent dust.

Spray Schedule Reduction

Any reduction in the number of spray applications or the amount of material necessary to control orchard pests would be of distinct benefit to the grower. Extensive experimentation in the field with adhesives for standard spray mixtures demonstrated again the value of reduced schedules for disease and insect control. In all tests during 1944 the three-spray schedule employing certain stickers, equaled in effectiveness the seven-spray schedule commonly recommended in the spray calendar. There is continued evidence to support the idea that these reduced schedules, as employed during the last two years, will give fair to satisfactory control of scab, European red mite, curculio and apple maggot. This year samples of fruit and foliage were analyzed by Mr. Shepard of the Department of Analytical Chemistry. It was found that the heavier applications resulted in residues over tolerance, but residues from the seven-spray schedule (standard) were also over tolerance. In these tests 3, 6 and 9 pounds of lead arsenate per 100 gallons were used. In the reduced schedule plots only those treated with 9 pounds of arsenate of lead per 100 gallons gave residues over tolerance. The seven-spray schedule using 3 pounds per 100 gallons was, as stated, also above tolerance in some instances because of the dry summer.

Dusts vs. Sprays

The investigation of insecticidal dusts has yielded some significant results in the field of vegetable pest control. The relative efficiency of dust and spray applications was studied by using dosage series of cryolite on beans to control the Mexican bean beetle. In general, a pound of cryolite applied in the form of a dust was more effective than in the form of a spray. This is contrary to the general belief that spraying is more efficient than dusting in terms of material used. DDT, derris and cryolite dusts diluted with pyrophyllite were compared for the control of flea beetles on potatoes and tomatoes. On

[1] 2, 2—bis (parachlorophenyl) 1, 1, 1—trichloroethane.

potatoes, 0.5 per cent DDT, 1 per cent rotenone in derris and 50 per cent cryolite provided the same degree of control. On tomatoes, the DDT was much more effective than cryolite. On leafhoppers infesting late potatoes, DDT was much more effective than Bordeaux mixture spray. One per cent DDT dust provided about the same control of tipburn as 4-2-50 Bordeaux mixture spray. Further studies of diluents showed that use of an alkaline talc reduced the effectiveness of cryolite substantially as compared with a neutral pyrophyllite.

Dusts for European Corn Borer

The effect of applying dusts to certain parts of the corn plant and the relative efficiency of various insecticides on corn and potatoes were studied in relation to corn borer control. Dusts were applied directly to tassels and ears and to the entire corn plant by means of a suitable hood arrangement. In all cases direct application was substantially more effective. In terms of dosage for equal control, twice as much nicotine was required when a hood was used as with direct application to tassels and ears. In a test of different dust materials, nicotine bentonite, derris, and DDT, all diluted with pyrophyllite, and dual-fixed nicotine, diluted with clay, were applied in a dosage series. Approximately 2 per cent DDT was required to equal in effect 1 per cent rotenone in derris dust. Nicotine bentonite with pyrophyllite was more effective than the dual-fixed nicotine with clay. Eight per cent nicotine was required to provide the same control as 1 per cent rotenone or 2 per cent DDT. The number of eggs hatching on treated plants was substantially higher than on untreated plants. Furthermore, both the DDT and derris dosage series showed more eggs hatching for higher dosages of material.

On potatoes, DDT dust was somewhat more effective than derris or cryolite dusts in controlling the European corn borer. In terms of dosage for equal control, 0.5 per cent DDT equaled 1 per cent rotenone in derris and 50 per cent cryolite dust.

The Codling Moth

The codling moth is not nearly the pest of apples in Connecticut that it is in most other parts of the country. However, an increase in infestation has occurred during the past five years, and although the situation is by no means serious as yet, it merits attention. As far as climate is concerned, there appears to be no reason why large areas in Connecticut should not be favorable to the insect, particularly in the south-central and southwestern parts of the State.

The life cycle of the insect was investigated in the orchard and insectary. In general it is very similar to that which occurs in the neighboring parts of Massachusetts and New York. There are two generations a year, but the second is not complete. This year in our orchards the infestation by the first generation was light, presumably because of low temperatures during the flight period of the moths.

In most cases where an increase in codling moth infestation has occurred in Connecticut orchards, this can be attributed to some phase of management, either in the spray program or in general orchard or packing house sanitation. This was apparently the case in the single instance of severe damage reported to us this year. The standard spray program appears to be adequate to cope with normal infestations in most of the State. In southwestern Connecticut, where the insect has been increasing in recent years in spite of thorough spraying, conditions are of greater concern.

Parasites of Pests of Fruit

Considerable experimentation has been carried on with the fruit moth in order to increase production of its parasites (Macrocentrus) in our laboratories. We have substituted the potato tuber moth as the host and have been interested in more efficient procedures for handling the oriental fruit moth for the same purpose. By using cellophane for obtaining eggs, we have succeeded in changing over our egg production from the greenhouse to the laboratory. Between March and July of this year we produced 98,177 parasites, of which 65,000 were liberated in various peach orchards. Considerable new equipment has been constructed for handling the potato tuber moth, its production has been developed, and we are prepared to increase its use substantially in 1945. This work is carried out in cooperation with the Connecticut Pomological Society.

A new parasite of Comstock's mealybug, a pest of pears and apples, has been imported from Virginia and has taken hold well in several localities.

The Relation of the Survival of the Corn Borer to the Corn Plant

The relation of tassels and of ears to the survival of corn borer larvae was studied by the use of special stocks of corn furnished by the Genetics Department. All the abnormal characters were segregated and were compared with normal plants of the same stock. The tassel abnormalities used were (1) tassels which formed no pollen, (2) tassels on which kernels developed, and (3) "wild" plants which remained in the whorl stage throughout the season. Tassels are of primary importance in corn borer survival, chiefly when the borers begin to hatch during the early tassel stages. In 1944 the extreme drought delayed the oviposition of the borer and consequently the plants had passed the important late whorl and early tassel stages before the eggs hatched. As would be expected under such circumstances, the tassel abnormalities did not affect the survival of larvae.

Ear abnormalities included (1) ears without silks, (2) barren plants with no ears or ear shoots and (3) "wild" plants with neither ears nor tassels. The silkless plants did not affect the survival of larvae. Survival in plants with no ears was 2.25 larvae per hatching egg mass, and the same stocks with ears showed a survival of 2.9 larvae per

egg mass. In "wild" plants, 1.75 larvae survived as compared with 4.4 on normal plants. This demonstrated conclusively the effect of ears and ear shoots on survival, and points to the special necessity of treating ears with insecticides in any schedule of treatment to control the corn borer.

A study of the distribution of larvae in plants and the effect of tillers on the infestation showed that the total number of larvae per plant and proportion of larvae in the tillers increased as the number of tillers per plant increased. The number of larvae in ears and ear shoots decreased as the number of tillers increased.

Wireworm Investigations

Wireworms, the larvae of elaterid beetles, are very injurious to potatoes, eating holes in the tubers, and are at times harmful to tobacco, eating the roots of the plant. Field observations and small scale pot experiments on larval development and feeding habits, life history studies, and control methods with some of the newer organic insecticides were carried out during the past season. The recording of injury on potatoes grown in rotation with various green manure crops, begun in 1940, was continued in an effort to obtain more definite information on the relation of these rotations to wireworm abundance and injuriousness. The development and habits of the insect have received emphasis, at this time, because of their close relationship to control efforts. Of the newer organic insecticides, DDT appears to offer promise in wireworm control when applied to kill the beetles (the adult stage), thus preventing reinfestation of the soil.

Borers in Trees

Investigation of the biology of the dogwood borer has been completed. The application of this information is essential to control. Extensive tests of various tree wound dressings have demonstrated that at least two common materials are quite effective in preventing infestation if carefully applied at the proper time. Clear shellac is entirely satisfactory and presents a good appearance but should be renewed once during the summer. This is not a particular disadvantage, since the trees must usually be examined and treated at regular intervals. A tree paint consisting of asphaltum and linseed oil is also an effective repellent. This material is black, forms a tough coating over wounds and requires only annual renewal. Both materials appear to influence better callus formation than no treatment.

The peach tree borer, well known as an orchard pest, is also of importance in nurseries. In an experiment with DDT, satisfactory control of this insect was obtained by applying a low concentration to the base of the young peach trees in late June. The effectiveness and practicability of applications of two other insecticides to young trees in the nursery have also been investigated.

Spruce Gall Aphid

The parasite-host relations involved in the formation of the twig gall on Norway spruce by the action of the aphid, *Adelges abietis*, are being investigated. This involves not only a study of the secretory action of the aphid but also of the development of normal and infested spruce buds to determine what plant tissues form the gall. The extent of the gall around the twig depends in part on the number of aphids surviving at the base of the buds. Some Norway spruce trees are immune to gall aphid attack, and this study may throw some light on the phenomenon.

Gypsy Moth Control

The abundance of the gypsy moth increased in Connecticut in 1944 as compared to 1943, but the amount of defoliation by the insect was negligible. Single trees were stripped in some localities, but the total of completely defoliated areas throughout the entire State amounted to only five acres. The general increase in infestation was indicated, not only by the increased number of egg masses found in the winter of 1943-44, but also by the large number of eggs per mass and the high percentage of hatching which occurred this spring.

Our spraying operations were confined to Torrington, where a large section was treated with lead arsenate in order to prevent an outbreak which threatened in that city.

In cooperation with the Federal Bureau of Entomology and Plant Quarantine, 655 traps for moths were set out in southwestern Connecticut in the Barrier Zone, using a material attractive to males. No male moths were captured.

The work of mapping the types of forest growth to determine those areas susceptible to gypsy moth outbreak was continued and six towns were completed.

The Federal Bureau of Entomology and Plant Quarantine continued its usual work within the Barrier Zone in Litchfield and New Haven counties and sprayed 10 infested areas with cryolite.

Dutch Elm Disease

This disease has increased rapidly in New Haven and Fairfield counties. Many of the cities and towns in this part of the State have difficulty in disposing of their diseased trees because of a shortage of manpower, particularly among the climbers who are needed to cut branches, overhanging wires and buildings, which must be removed before a tree can be felled.

The U. S. Department of Agriculture men examine a zone outside of the quarantined areas for diseased trees and report them to this office. We notify the town officials of these and urge their removal. In most cases the officials dispose of the trees as quickly as possible.

The Connecticut State Highway Department has also been very cooperative in the removal of diseased trees on state highways.

The disease has been spreading eastward and was found in 1944 for the first time in 16 new towns, many of them east of the Connecticut River. A proposed change in the Dutch elm disease quarantine will probably include all towns west of the Connecticut River and one tier of towns east of the River, from the Massachusetts boundary south to the town of Portland.

The European elm bark beetle, which transmits the fungus causing this disease, has been found as far east as Preston, although it is not abundant there.

The defoliation on elms has been studied in relation to its effect on the vigor of the trees, their susceptibility to bark beetles, etc. Elms will stand considerable defoliation and still survive. Trees defoliated completely twice a year for two successive years showed a marked retardation in growth. Extensive die-back occurred during the winter and some during the growing season. No bark beetle attack occurred. Observations on elms defoliated by cankerworms, in collaboration with the Department of Plant Pathology and Botany, indicated that such trees may be more susceptible to the Dutch elm disease.

The Imported Long-horned Weevil

Studies of the life history, habits and control of the imported long-horned weevil (*Calomycterus setarius*) have been completed and the information has been published in Station Bulletin 479.

During the past season the drought apparently delayed the emergence of the adult insects and hence the development of the season's brood of adults. They were not very numerous until early July and then most of them were observed around the base of plants. Although weekly diggings were made from the last week in June on, no larvae were found until September 30.

Inspection and Quarantine

During the summer of 1944 a total of 297 nurseries representing 4,343 acres of nursery stock were inspected. No unusual pests or diseases were found.

The sugar shortage was reflected in an increased interest in beekeeping. During the year there were a number of new apiaries started, mostly by amateurs. The summer of 1944 proved to be a poor season for honey production, as the serious drought prevented many plants from blooming profusely and those that did produced very little nectar. The apiary inspectors visited and inspected all known apiaries in the State. American foul brood has decreased slightly this year. Fairfield and New Haven counties still have the highest percentage of foul brood.

Because of the Federal Japanese beetle and gypsy moth quarantines, large amounts of plant and other material must be inspected and certified before being allowed to move out of the quarantined area to the uninfested parts of the country. This required the inspection and certification of 1,568,702 plants on account of the Japanese beetle and 4,411 because of the gypsy moth quarantine.

Since the federal quarantine on the European corn borer was abolished, many states have their own regulations. At present only a few inspections need to be made on this account. In 1944, 309 certificates were issued and most of these were for shipments of shelled seed corn. Only one person in Connecticut ships corn on the ear, and this corn must be heat treated under our supervision before certificates are issued.

Connecticut seedsmen export large quantities of seeds to foreign countries, mostly to South and Central America. During the past year 458 shipments of seeds were inspected and certified to fulfill export regulations.

A total of 333 package certificates were issued to individuals who wished to ship miscellaneous plant material.

Miscellaneous Insects

The Department cooperated with the Federal Bureau of Entomology and Plant Quarantine in making the annual survey of the abundance of the European corn borer in Connecticut. The infestation in 1944 was noticeably less intense than in 1943. The average number of borers per 100 corn plants in Hartford, Middlesex and New Haven counties was 811.5 in 1943, 178.7 in 1944. In five counties in 1944 (Litchfield and Fairfield in addition to the above) the average was 162.6. This survey was made in the early fall for the second generation of borer.

The Federal Bureau of Entomology and Plant Quarantine made a survey of the State to determine whether or not the golden nematode and the potato tuber worm, both pests of potatoes, were present. No specimens of either species were found.

During the year 434 samples of insects were received with requests for information about their identity, injuriousness, and control. Amateur entomologists sent in about 60 species for identification.

Rodent Control[1]

During the past year studies were continued on the population fluctuations of the meadow mouse (*Microtus pennsylvanicus*) and the testing of various rabbit repellent mixtures. This spring a prelimin-

[1] Investigations carried out by Mr. Francis B. Schuler of the U. S. Fish and Wildlife Service, Division of Predator and Rodent Control, in cooperation with the Connecticut Agricultural Experiment Station, New Haven, and the University of Connecticut, Storrs.

ary study was initiated, in cooperation with F. W. Southwick, Department of Horticulture, Storrs Agricultural Experiment Station, on the effectiveness of methyl bromide as a fumigant for controlling rodents in cold storages.

The October *Microtus* census indicates that the mouse population is definitely low this fall. This condition is probably related to the downward trend of the population, which was noticeable last fall, after the high year of 1942. The lack of abundant food and cover due to the drought of the past two growing seasons was undoubtedly a further check on the population.

Fourteen repellent mixtures were tested on penned cottontail rabbits during the past winter. Due to the high mortality among the experimental animals, this work was curtailed.

From the control point of view, methyl bromide is an effective fumigant for the control of rats and mice in cold storages. Further studies are necessary, however, to determine its effects on the flavoring and ripening of the fruit, particularly the effects on apples. Also a practical method of application in the storage has yet to be worked out.

PLANT PATHOLOGY AND BOTANY

Vascular Diseases of Trees

Research on Dutch elm disease and Verticillium wilt of elm and maple during the past four years seems to indicate that the most promising method of control for such vascular diseases is the introduction of chemicals into the plant before infection so that the plant will not "take" the disease. Although this internal chemotherapy work has not yet reached the practical stage, it is a promising approach.

In the case of Dutch elm disease, three significant steps have been made toward practical control. The major symptoms of Dutch elm disease are caused by a toxic by-product of fungus growth. The research has indicated: first, that this toxin may be inactivated by such chemicals as 8-hydroxyquinoline sulfate; second, that pre-infection treatments with such chemicals as 8-hydroxyquinoline benzoate may impart some immunity to the trees; and third, that post-infection treatments may cure infection if not too long delayed. None of these results has yet reached the stage of commercialization but they are significant signposts in the direction of ultimate control of vascular disease of trees by internal chemotherapy.

The local spread of Dutch elm disease has been investigated, and it has been found that the probabilities of infection are very low at distances beyond five hundred feet. It has also been found that pruning of infected wood may be valuable in the saving of individual trees.

The most significant advance in 1944 was the discovery that canker-worm defoliation increased markedly the summer-time susceptibility

of elms to infection, presumably by lengthening the period of spring wood formation. Researches on Dutch elm disease will be published in a Station bulletin.

Fungicide Research

The most significant development in the fungicide research was the introduction to the trade of a new chemical, disodium ethylene bisdithiocarbamate, which had its inception and development at this station in collaboration with the manufacturer. With the introduction of this chemical, we embark on a new approach to the control of plant diseases by protective fungicides. Heretofore, all protectants have been insoluble. This compound is soluble in water but dries on the foliage to become insoluble. It could, therefore, be applied with a sprayer without the usual agitator, if desired.

Moreover, it has been accidentally discovered that plants can be "immunized" against attack by certain insects and diseases simply by watering the chemical on the ground so that the roots take it up.

As a result of our over-all research on fungicides, we were invited by the National Research Council to participate in a symposium in Washington on the use of fungicides for epidermaphytosis in the armed services. We also participated for several months as a member of the Science Committee of the National Defense Research Committee on Tropical Deterioration of Military Material. Since the cancellation of the Science Committee, we have participated informally in the development of research in this important field.

Considerable progress has been made in understanding the mechanism by which the fungicides act, and it has now been shown that new chemicals can be picked on the basis of their ability to inhibit the action of certain cell components like amines, amino acids, metals, sugars, etc. We have also made considerable progress in the relation of structure of organic compounds to their fungicidal potency, and in the investigation of synergism and antagonism, that is, the inter-action of two or more poisons acting jointly.

Chemotherapeutic Inactivation of X Disease of Peach

Seedling peach trees were injected by the top injection method with various chemicals, both before and after inoculation with X disease by budding with diseased buds. The results of this work confirmed the results of last year in respect to the immunization of the trees to X disease by *p*-aminobenzenesulfanilamide, as well as the partial antidoting of the injury to the tree by this material by the addition of a 2 per cent solution of maltose or dextrose. *p*-Aminobenzenesulfanilamide injected after inoculation gave 100 per cent control. Trees treated similarly in 1943 remained healthy through 1944. Hydroquinone, zinc sulfate, dextrose and maltose each gave some measure of control.

Spray Coverage on Apples

The spray coverage experiment on apples was a duplication of the 1943 work. This year's data did not show a cross over of the curves of high and low gallonage when plotted as per cent control vs. dosage per tree. This year the curves were parallel with the low gallonage curve displaced to the right. Foliage infection of scab was heavier on the outside of the tree than on the inside in all treatments and the checks, with about the same relative differences on the sprayed and check trees.

Fungicide Tests on Apples

The fungicide tests were made against apple scab on small McIntosh trees and were largely tests of Dithane and TMTD as Thiosan. These materials were used in dosage series both alone and in various combinations with other materials. Dithane gave good control of scab at 4 and 2 pounds per 100 gallons in the early part of the season but lost its efficiency later. The higher dosages produced severe foliage injury. The addition of zinc sulfate and lime increased the efficiency of Dithane and reduced the injury. TMTD maintained its efficiency throughout the season and showed increased efficiency by the addition of arsenate of lead. Cankerworms were controlled as well by TMTD alone as when combined with lead arsenate.

Root Diseases

In general the investigations on root diseases carried on during the past year were continuations and extensions of problems already under study. Three main fields were pursued: (1) Effect of cation (especially Ca and K) balance of the soil on root and tuber diseases, (2) Toxic plant decomposition products as factors in root diseases, and (3) Studies on the factors affecting the incidence of the foot rot disease of summer squash.

The most interesting results obtained have come out of the studies on the Ca and K nutrition in relation to scab of potatoes and club root of cabbage. It was observed that as the ratio of available Ca to available K in the soil was shifted progressively from a "high Ca" soil to a "high K" soil, the response of the two diseases was of a periodic nature. Thus, instead of the plotted data (disease on the ordinate and Ca/K on the abscissa) giving either a mathematical or geometric progression or a normal distribution curve, multiple minima and maxima were observed giving a cyclic or periodic curve.

A search of the literature reveals this type of response to be not uncommon in physico-chemical and biological reactions. It has not however been studied in sufficient detail in the biological fields to be explained in all of its interesting implications.

Studies on toxic plant decomposition products have shown most strikingly that the results of greenhouse experiments (previously re-

ported) are equally applicable under field conditions. Five plant products used as mulches on strawberries grown in a location with poor drainage varied in their harmful effects on the crop as measured by the incidence of the black root disease, number of surviving plants, and the weight and number of berries produced.

Timothy and rye mulches applied early in the fall and allowed to decompose considerably before the ground froze were most prone to yield toxic products as measured by the above mentioned criteria. Soybean refuse gave the most satisfactory results as a mulch, while red clover and excelsior were intermediate. The order of toxicity noted above follows closely that of the previously reported greenhouse experiments in which the plant tissues were decomposed in crocks and the extracts applied to water cultures. In the greenhouse experiments it was thought that a state of anaerobiosis was essential to toxin formation. The mulching experiments tend to discredit this view since the decay of surface vegetation can hardly be considered as occurring under anaerobic conditions. It is possible to explain this by assuming that nontoxic products may have been leached from the mulches only to be further reduced and hence increased in toxicity below the soil level under reduced oxygen concentrations.

Limited experiments in the greenhouse in which green manure species were "plowed under" in the soil have also indicated that timothy and some other grasses are more prone to produce toxins than certain other non-graminicolous species as measured by the incidence of black root symptoms.

Squash foot rot is apparently on the decline in Connecticut. This may be attributed largely to two factors: (1) The knowledge (and resulting practice) of seedsmen that seed infection "dies out" during two years of storage, and (2) The inability of the fungus in the soil to thrive (and possibly to survive) during the drought conditions of the past two summers.

Data has been gathered to substantiate the theory that seed infection results from a direct soil to fruit invasion of the fungus rather than through the plant from a diseased vine. Surface-borne "seed infection" comes largely from the spread of the fungus spores in the fermentation vats.

It has been shown that squash seed may be freed of the fungus by a hot water treatment. This method seems impractical on a commercial scale and has not been publicized since it is believed that the two year storage of seed is a more practical method of controlling seed infection.

GENETICS

Field Corn

The preliminary estimate of the 1944 field corn crop for the country indicates a new record high production. The increased use of hybrid seed, as well as better cultural practices and favorable weather,

has had an important part in this large yield at a time when it is most needed. This emphasizes the value of continuity in scientific research since it was during the last war that the double cross method of seed production was being worked out—the method that now makes hybrid field corn possible.

The average Connecticut growing season varies from 140 frost-free days in the towns of Salisbury, Canaan, North Canaan and Norfolk in the northwestern part of the state and Griswold, Sterling and Voluntown in the east central part to 190 days along the Sound from Milford to Stonington. To fit these widely varying maturity regions, many varieties of corn are needed to produce satisfactory crops of grain and ensilage.

Nearly all seed corn planted in Connecticut is grown outside of the state. This means that the varieties grown here must also be useful in other parts of the country having similar growing conditions since the local demand is hardly sufficient to justify the production of special varieties exclusively for this region.

The increasing damage from corn borers has made necessary the development of varieties that will show less stalk breakage. The most promising now in production were tested during the past season for their ability to yield, to stand erect and to remain free from stalk breakage, especially below the ear. These tests included 25 late, 25 midseason and 30 early hybrids. In addition, 30 varieties were grown solely for ensilage in an observation test to determine their general adaptations and stalk breakage.

As an indication as to which would be most satisfactory, 45 single crosses, representing all combinations of ten standard inbreds, were grown. From these results the most promising double crosses can be predicted. Additional seed for a repetition of this test has been made, using a somewhat different series of inbreds. These substitutions were made on the basis of the performance of the inbreds under severe corn borer infestation.

Out of a large series of inbred strains of dent field corn derived from several eastern varieties of corn and from a number of backcrossed inbreds, several promising lines are appearing. Some of these show very low stalk breakage under heavy corn borer infestation. If these have the ability to combine well with the best inbreds that are now being used, they will have considerable value for future corn production. Field trials were conducted on a number of farms in cooperation with the New Haven County Farm Bureau.

The results of the replicated tests at the Experiment Station farm are published each year in a mimeographed report listing varieties in different maturity groups that have given the best results over a period of years and of which seed is available. This report is available on request.

Sweet Corn

Many growers report success in securing a continuous supply of sweet corn from a single planting, as advocated by this Station. Several seed companies have accepted the idea and are now packaging as a unit six or eight different varieties, each in a separate packet. By planting a row of each kind at one time it is possible to pick corn for a month, or even longer in cooler climates. The succession most commonly used includes the following varieties: Spancross, Marcross, Carmelcross, Lincoln, Golden Cross and Wilson. A second planting of Golden Cross and Wilson will extend the sweet corn season further.

Breeding work is in progress to improve the quality of several of these varieties. A new hybrid, Early Golden C13 x Me 1, can be substituted for Spancross. Early Golden is almost as early and has much better quality. An experimental hybrid, C13 x 17, gave yields as good as Marcross and has better quality. Seed of C17 will be increased in 1945 preparatory to making the 13.17 hybrid. C17 is a backcrossed line of P39 and is essentially a P39 strain, almost as early as C13. In the mid-season maturity class, several new experimental hybrids are promising. All of these have as one parent Connecticut 22, a very productive line both as an inbred and in hybrid combination. The inbred 22 and all of its hybrids have considerable drought resistance and made a very good showing in 1944, the driest summer on record. C22 was secured by inbreeding a first generation hybrid. Possibly more inbreds should be secured by this method. In the late maturity season Magnagold has given better results than Wilson and probably should be substituted for Wilson. Work is in progress to improve Wilson from the standpoint of productivity, quality and smut resistance. Other late varieties are in the process of development. A mimeographed report giving the results of the sweet corn tests and listing the most promising varieties is prepared each year and is available on request.

Squash

Butternut squash is a relatively new winter variety which has probably been developed by selection from Golden Cushaw. Its medium-sized fruits, (10-12 inches long) with good quality, orange flesh adapt it well to the average family's use for baking or for pies.

Thirty-seven different lines of this squash were grown at the Mt. Carmel farm to select productive types with uniform fruit shape. Emphasis was placed on a fruit with a thick meaty neck and a slightly enlarged base. The more common type with a long thin neck and much enlarged round base has a much larger seed cavity in proportion to the amount of flesh than those with thick necks, and the shape makes the fruit pack to poor advantage in shipping boxes. About fifteen of the lines which give promise of producing the type of fruit desired are being inbred and will be planted again next summer for further trial.

Peppers

Twenty-one lines of peppers and six commercial types were grown in replicated yield tests both at Mt. Carmel and at Windsor. The drought at Mt. Carmel made the quality of the fruit very poor, and the yield of all lines very low. However, at Windsor, growing conditions early in the summer were a little more favorable, and some of the lines give promise of being early and prolific, and of producing the dark green, blocky, thick-walled pepper desired by market gardeners. Seed was increased for these lines and is available for trial next year.

Charter Oak, the pepper released in 1942, continues to be productive and of good quality, but in regions that are infected with tobacco mosaic, (such as New Jersey and the Amherst section of Massachusetts), it is a complete failure because it is not resistant to this disease. Twenty-seven mosaic-resistant lines from previous tests, grown at Windsor, were inoculated twice during the summer with tobacco mosaic. All lines were highly resistant (about 2 per cent of all plants in the fields were affected), and several have the desirable California Wonder type fruit. These will be tested further next summer.

Tomatoes

A new tomato developed here was tested further this summer in comparison with both standard commercial varieties and other experimental strains. A considerable amount of seed was produced, and is available for trial next year. This variety has excellent color, good shape and fine table quality, ripens uniformly and is free from cracks. It is more susceptible to blossom-end rot than the varieties commonly grown. An outstanding characteristic is the ease with which the skin can be removed when prepared for canning.

Hollyhocks

The hollyhock is used considerably in this section of the country as a garden flower. However, it is frequently made unsightly by hollyhock rust, which is especially bad in wet summers. A preliminary investigation is under way at Mt. Carmel to transfer and intensify the slight resistance of a strain obtained from Dr. G. A. Mehlquist, University of California, to the more ornamental commercial types.

Tree Crops

Beginning in 1930 a small planting of oriental chestnuts, walnuts and persimmons was made at the Mt. Carmel farm. Observations over a period of years indicate that tree crops have considerable promise for the rough, untillable land in Connecticut of which there are

many thousands of acres, now producing little more than firewood. In Europe chestnuts provide an important food crop for man and beast. Other trees also have possibilities, providing an annual crop without planting and with very little expense for cultivation and harvesting.

The blight-resistant chestnuts now available are not sufficiently productive to justify commercial plantings for their nuts. No resistant varieties suitable for timber production have been produced, although some have possibilities as saplings for fencing.

In cooperation with the Brooklyn Botanic Garden, hybrids are being made of the most promising material available. Seedling trees are now being grown and will be set out in various parts of the state for further testing.

Genetic Principles

Degenerative changes have appeared in several long inbred strains of both field and sweet corn such as reduced size of plant, narrow leaf, crooked stalk, late flowering, chlorophyll reduction and other variations. These apparently are due to a single gene change in each case. When crossed back to the original strain some of these give a hybrid vigor effect. This important point has been carefully tested during the past season and the results are being tabulated. Preliminary observations seem to be confirmed. The performance of these mutant lines when outcrossed to unrelated lines is being studied. These findings help in an understanding of the behavior of inbred strains in hybrid combinations and emphasize the necessity of selecting self-fertilized lines for combining ability as well as for their performance as inbreds.

Further study of C30, P39 and their hybrids was conducted in 1944. C30 is a mutation from P39. It behaves as a single genetic factor for reduced size of plant and ear but gives increased vigor when crossed back to P39 or by other inbreds. Apparently this type of reaction, also found in field corn inbreds, is one contributing factor towards hybrid vigor or heterosis. Since C30 apparently carries a factor for increased yield, a breeding project has been undertaken to transfer this factor to several field corn inbred lines, as well as to other sweet corn inbreds.

Outgrowths on the surface of mature maize seeds have been found to be associated with the breakage and relocation of chromosome parts. A total of 14,505 seeds has been examined under a low power microscope. By taking advantage of easily seen gene markers which make this material especially favorable for this study, it has been shown that growth activating regions exist. These are stimulated to increased growth when brought in contact with other regions of the chromosomes that are normally kept separate.

SOILS

Soil Testing Service

The Station's soil testing service is becoming increasingly useful to the people of the State. The many new names on the record show that the public is becoming more and more aware of its existence. Repetition of the same names year after year shows that people benefit by the reports and have come to depend upon this service.

The total number of soil samples tested at New Haven and Windsor during 1944 was 3,808, a 6 per cent increase over the total a year ago. Home and community garden samples took a big drop, however, from last year when the group reached an all-time high (28.1 per cent of the total last year, 17.2 per cent this year).

Plant Tissue Tests Supplement Soil Tests

A soil test tells how much of the several nutrients are present in available form, at least so far as the particular test is concerned, but it does not indicate how much is actually taken up by the plant. Plant tissue tests show the amount taken up but do not reveal what the fertility level of the soil should be to produce a given amount of growth. Both tests are needed in many instances in order to understand the behavior of plants.

In an experiment with spinach, snap beans and table beets last spring and summer, high yields were generally associated with high plant tissue tests for nitrate nitrogen, phosphorus and potassium. Low yields and high tests indicated either unfavorable growing conditions (cool, partially shaded), or excessive fertilizer treatment. Good yields and low tests (a very common situation) indicated rapid assimilation of the nutritive ions with no surplus of unassimilated material. More fertilizer would probably result in higher yields although this is not always the case.

Beet yields increased with each increase in fertilizer up to the limit (10,000 pounds of 5-10-10 per acre) in the greenhouse; while out of doors, the maximum yields were reached at the 4000 pounds level. With spinach and beans, 2,500 pounds was the best treatment (greenhouse only). Carrot yields (outside only) tended to drop with 2,000 or more pounds per acre. The beneficial effect of the extremely high application on beets may be due in part to a need for a high soluble salt concentration in the soil. Other investigators have reported marked response of beets to sodium chloride (table salt).

Maintenance of Vegetable Soils

A series of 192 plots was started at Windsor in 1940 to study the relationships between vegetable crop yields, soil organic matter, and soil nitrogen maintenance as affected by various green manuring practices in vegetable cropping systems, at two distinct levels of nitrogen fertilizer application.

The first rotation of series "Y" was completed this spring. Soil analyses of the plots in this series showed an average increase of 5.2 per cent organic carbon but a 6.33 per cent decrease in total nitrogen. The soil analyses of the "X" series last year showed decreases of 6.3 per cent for organic carbon and 13.0 per cent for total nitrogen. A preliminary conclusion from these results would be that the previous tobacco soil management left an organic carbon-nitrogen complex which was less resistant to soil microorganisms than the present soil management system.

The season was too dry for satisfactory vegetable production. Slight increases in yields were obtained with all crops receiving extra nitrogen with the exception of tomatoes which produced a lower yield when extra nitrogen was added.

The Lysimeters at Windsor

Series "E" Windsor Lysimeters started May 1939, in which a comparison was made of the interaction of various common fertilizer cations and anions, was completed. The data are being computed for later publication.

A new series, "H", was started September 1, 1944 to determine nitrogen losses from soils under different conditions of soil management.

Series "F" and "G" are being continued. Series "F", started in 1940, is a study of nitrogen utilization as affected by rates of application, soil reaction adjustment and source of nitrogen. In Series "G", started in 1941, a study is being made of soil residual nitrogen, soil reaction adjustment and protection against leaching by cover crops. The study is being conducted on four soils which have received nitrate of soda, sulfate of ammonia, urea and cottonseed meal the previous 15 years.

Effect of Soil Reaction on Green Manure Crops

To determine the effect of soil acidity on legume and non-legume green manures, a group of these crops was grown on a series of plots, ranging from very low to very high acidity. The group of crops grown included millet, sudan grass, soybeans, lupines, cowpeas and vetch.

The cowpeas grew best on all plots, regardless of acidity or alkalinity, followed in order by soybeans, millet and sudan grass. Growth of all crops increased markedly as acidity decreased. Cowpeas were the least affected by the acid or alkaline conditions of the soil. Neither the lupine nor vetch produced a satisfactory stand, regardless of soil reaction, and growth was very poor.

Feeding Habits of Tree Roots

Can trees obtain their nutrients from the lower depths in the soil, provided the material is present in available form, or are only the rela-

tively shallow, surface feeding roots effective in nutrient absorption? Under average conditions, uncultivated forest trees obtain most of their plant food from the top 6 to 10 inches of soil which contains by far the largest proportion of available nutrients, particularly nitrogen.

One approach is to grow trees in an inverted profile, that is, one with the top soil buried down where the subsoil usually occurs, and the subsoil placed at the surface, the intermediate horizon remaining in the same position in both normal and inverted profiles. At the end of the second season, hybrid poplar cuttings grown in the inverted soil produced about twice as much growth as those grown on normal soil. The differences must be due largely to the greater availability of material in the buried top soil because of the more favorable moisture conditions at that depth (28 to 38 inches). Soil at the surface is the first to dry out, and a dry soil is of little value to a plant, no matter how fertile it may be. Also, the normally unavailable plant food in the subsoil may have become partially available when placed at the surface where there is better aeration. Poplars growing in all top soil (38 inches deep) were four times as large as those in the normal profiles. These results indicate that trees can be fed by the deeper roots and that this species responds to an abundance of available nutrients.

White pine rooted cuttings, with a maximum growth of 6 inches in 1944 (compared with about 4 feet in the case of the poplars) could hardly be expected to show much difference at this stage. Those on the inverted profiles tended to be largest but the differences are not significant. Competition from the poplars may account for the relatively poor growth on all-top soil. The poplars have been removed and the experiment will continue with the pine.

FORESTRY

Wood Preservation

In the spring of 1933, eleven poles each of red maple, red pine, Scotch pine and pitch pine were set in the Station shade tent at Windsor. Of these, seven poles of each species had been treated with creosote by the open tank method (hot and cold bath) for a distance of 3 feet from the butt. The remainder, four poles of each species, were left untreated. In addition to the above, there were 10 squared hardwood poles which had been given zinc-meta-arsenite treatment under pressure.

An inspection of the 54 poles in the tent in September 1934 showed:

(1) All the Z. M. A. treated poles were in good condition throughout.

(2) All untreated poles of red maple, red pine, Scotch pine and pitch pine showed evidence of decay at ground line and some showed fruiting bodies of fungi.

(3) All poles which had been butt-treated with creosote were in good condition throughout.

A second inspection was made in the spring of 1938 with results as follows:

(1) All Z. M. A. poles were in good condition throughout.

(2) All untreated poles of red maple, red pine, Scotch pine and pitch pine had become unserviceable because of decay at the ground line.

(3) All poles which had been butt-treated with creosote were still in excellent condition throughout, except for one pitch pine and two red pine, which showed indications of failure at the extreme top.

In 1940, the shade tent structure was taken down and the poles were reset. In the process, eight tags were lost, so that at the inspection in 1944 only 24 of the original 32 butt-treated posts could be identified. Those found were six pitch pine, six red pine, eight Scotch pine and four red maple.

In 1944, the Z. M. A. poles were found to be in good condition. The tops of most of the 24 butt-treated poles were in such poor condition that they were excavated and dissected for inspection with the following results:

(a) That part of all poles which received a good impregnation with creosote (lower 3 feet) was still sound and in excellent condition for all poles.

(b) The tops of the four maple poles identified were still in serviceable condition, but those of pitch pine, red pine and Scotch pine were all in poor condition. Decay, which apparently started at the extreme top, had worked down inside the pole for distances of 1 to 4 feet.

Two conclusions are drawn from these experiments:

(a) A thorough butt treatment with creosote by the open tank process may be expected to protect posts of pitch pine, red pine, Scotch pine and red maple against decay when in contact with the soil for a period of 15 years or more.

(b) The untreated tops of poles of these species may become unserviceable in five years and probably cannot be expected to last more than 12 years in most cases. Treatment of the top is needed to insure a proper balance of durability between the top and butt. It may be impracticable to use creosote on the tops of tobacco poles, due to the effect of creosote fumes on the tobacco plant, but other preservatives could be applied to prolong the life of the tops.

A Charcoal Kiln Built of Cinder Concrete Blocks

Further progress has been made in the development of the new type charcoal kilns mentioned in the 1944 report. The kilns are built of two standard sizes of cinder concrete blocks conforming to A.S.T.M. specifications C-90-44. A very little steel is needed and this could be eliminated if necessary.

After being used for some 50 burns the blocks show practically no deterioration. They are manufactured throughout the United States and should be readily obtainable.

Present plans call for the development of kilns of one, two, three and five cord capacity. Experimental work has already been completed on kilns of one and two cord capacity and a progress report, describing the construction and operation of these two kilns, has already been prepared in mimeographed form. Work on the three and five cord kilns will be completed during the spring and summer of 1945 and a complete report in bulletin form will be published late in 1945. All experimental work has been done in cooperation with the White Memorial Foundation at Litchfield.

The following yields per cord have been obtained in the one and two cord kilns. The figures are for lump charcoal, excluding fine charcoal and are in bushels of 20 pounds each:

Unseasoned white pine top wood	26 bushels
Unseasoned Scotch pine stemwood	19
Semi-seasoned Scotch pine stemwood	29
Unseasoned hardwoods (oak)	38
Seasoned hardwoods (oak and maple)	46

The quality of the charcoal is very good. The percentage of fines is low and the amount of brands quite small.

A complete operation cycle for the one cord kiln when water is introduced as a fine mist to hasten cooling, requires about 48 hours. For the two cord kiln the time is about 96 hours.

The advantages of the cinder concrete kiln are as follows:

(1) It is built almost entirely of non-strategic materials.
(2) Materials for construction are inexpensive.
(3) It can be assembled by ordinary labor.
(4) It requires very little attention during operation.
(5) It can be successfully operated by a novice.
(6) It may be taken down and rebuilt at another site.
(7) It is adaptable to single unit or battery operation.
(8) The yield and quality of charcoal produced are very good.

Wood Gas Generator

During the winter of 1943-44 tests were made in cooperation with the Yale School of Engineering on a wood gas generator designed by Dr. C. F. Jenkins of Keene, New Hampshire. This generator is of unique design and the purpose of the tests was to determine the efficiency of the apparatus. The fuel employed was chipped wood (refuse from birch oil mills). Operation is by air admitted to the fuel charge under pressure at high velocity.

The tests indicated that approximately 80 per cent of the B. T. U. value of the fuel could be recovered in the form of a gas which was saturated with water, but which was basic in reaction and contained practically no alcohols, acids, or ether soluble substances (phenols, tars, etc.) The materials used in this experiment were purchased from a fund of 250 dollars, given to the Station by the White Memorial Foundation of Litchfield.

Inspection of Conversion Units

A number of wood-burning conversion units were under casual observation during the past heating season. The results obtained by the several operators varied greatly. In some cases they were very good, while in others, difficulties of various kinds were encountered. These appeared to be due chiefly to two causes: structural failure resulting from faulty design and crude materials, and failure on the part of the operator to adapt himself to a new type of apparatus.

Strength Tests of Coniferous Woods

In the report for 1942, brief mention was made relative to strength tests on the wood of plantation grown conifers. Some 7,000 such tests and measurements have been completed and the data are now being worked up. They should be ready for publication late in 1945.

The tests were in static bending, compression parallel to the grain and perpendicular to the grain, tension perpendicular to the grain, cleavage, shear and toughness. Specific gravity and moisture content were also determined. The species of wood included were white, red, Scotch, Austrian and jack pines, Norway spruce and European larch.

As far as is known this is the first time that a comprehensive series of strength tests has been made on the wood of planted trees in this country. A preliminary analysis of the data from the indigenous species indicated that the wood is weaker than that of the same species grown in natural stands.

When completely analyzed, the tests should be helpful in deciding the type of management necessary to improve the strength and quality of plantation grown wood.

White Pine Blister Rust Control

During the past summer, this Station, in cooperation with the United States Department of Agriculture and the towns of Norfolk and Salisbury, has conducted wild ribes eradication work in eight towns. There were 50,506 wild ribes destroyed on 25,270 acres of control area, giving protection to 8,835 acres of white pine. In addition, 354 wild ribes were removed from 1,080 acres of sanitation zones surrounding 1,704,000 white pine in four forest tree nurseries.

In the eastern part of the state, 13,793 acres of hurricane "blow down" area were remapped, and on 35,531 acres of control area in the western part, the mapping was rechecked. The purpose of this work was to bring up to date the maps made in previous years which are necessarily subject to changing conditions.

The Station is recommending to those towns having large areas of white pine that they make small annual appropriations toward

town sinking funds to be used for the maintenance of blister rust control areas now established throughout the white pine growing sections of these towns.

During the past five years, eighteen towns have made such appropriations amounting to $11,122.30, of which $2,119.00 has reverted to the general town funds under the terms of the appropriations. The sum of $1,487.15 has been used for the employment of local labor needed for blister rust control, and $7,516.15 is now available for the employment of local labor when the periodic State inspections indicate the necessity for further control work.

Initial eradication of ribes has been accomplished on all control areas, many areas have had the ribes re-eradicated at least once; and the disease has been brought under control throughout the State. The maintenance of these control areas is necessary for the continued protection of 100,000 acres of white pine. The annual maintenance cost will probably not exceed 5 per cent of the value of the annual pine increment.

Rainbow Experimental Forest

The plantations at Rainbow have been subjected to study during the past year with a view to revising the future research program. Some experiments have been terminated because of damage done by the 1938 hurricane and others because of failure to secure satisfactory results. A minor hurricane in September 1944 did no serious damage, although 60 or more trees were felled in scattered locations. These will be salvaged for lumber during the coming winter and some cuttings made at the same time, in accordance with the new program.

TOBACCO SUB-STATION AT WINDSOR

Calico-resistant Broadleaf

The Broadleaf type suffers more from the mosaic disease (commonly called calico, rust or gray top) than any of our tobacco types. Like other virus diseases, mosaic cannot be controlled by such usual methods as spraying, dusting, seed treatment or soil steaming. The only obvious effective control method is the breeding of a strain of Broadleaf that is highly resistant to the disease. An attempt to develop such a resistant strain was started six years ago by hybridizing Connecticut Broadleaf with a South American type (Ambalema) which is highly resistant or almost immune. Many sufficiently resistant lines have been found in the progeny but for the most part they showed certain other differences from our best Broadleaf so that they probably would not be acceptable to the trade. It has, therefore, been necessary to repeatedly back-cross onto Connecticut Broadleaf. One of the lines has been sufficiently selected so that, in 1944, it was grown for the first time on a commercial scale by one of the cigar manufacturing companies. Further refinements seem necessary but with suffi-

cient attention and time, there is no reason why we cannot develop an entirely satisfactory strain of Broadleaf that will not suffer from calico.

Irrigation of Tobacco

The dry growing seasons of 1943 and 1944 offered good opportunities to continue experiments on irrigation. Water was applied by running it down between the rows at a rate equivalent to one and one-half to two inches of rainfall. Some plots were not irrigated, others irrigated with pure water, and a third series with water to which nitrate of soda had been added. The nitrate of soda was introduced as a small stream of concentrated solution which flowed into the water stream at the high point of the row. Rate of application was 100 to 150 pounds of nitrate of soda to the acre.

The results confirmed the conclusions of previous years: (1) Irrigation with pure water, if more than one treatment was applied, reduced the quality and yield of tobacco. (2) By adding nitrate of soda to the water, marked improvement in grading and increase in yield were obtained. (3) The treatment was just as effective when the nitrate was introduced at the source as it was when sprinkled dry into the water along the row (as applied in previous years). This method of introducing the nitrate at the source was used successfully with large power machinery by one of the Shade tobacco companies this year in overhead irrigation.

Ammonium Nitrate As a Source of Nitrogen in Fertilizer

The World War has affected radically the supply of nitrogenous materials available for tobacco fertilizer mixtures. Specifically: (1) The supply of organic meals has been reduced to a point where there is not enough to supply the customary requirements of growers and the price is very high. (2) Government-sponsored plants are producing large amounts of ammonium nitrate at comparatively low prices. Since different nitrogenous materials affect differently the quality and yield of tobacco, and since we have never conducted experiments to determine the value of ammonium nitrate on this crop, trials were started in 1944 to see how far we could substitute ammonium nitrate for the organic meals.

These field tests were begun in the spring of 1944, designed to deal with the following possible substitutions:

1. Ammonium nitrate used as a single source of nitrogen.
2. The efficiency of this type of nitrogen in comparison with that in cottonseed meal.
3. The possible advantages of applying this material in fractions at intervals during the growing season, since it is readily soluble.
4. Ammonium nitrate applied as an ingredient in a mixture of a commercial grade.

Possible Role of Boron in Tobacco Fertilization

It has been fully demonstrated that a small amount of boron is necessary for the normal growth of tobacco, as well as for many other plants. Although no attempt has been made by fertilizer mixers or farmers to include boron in the tobacco mixture, we have never found, in our fields, plants that showed acute symptoms of boron starvation. It has been assumed that the other materials of the mixture, particularly the organics, contain enough boron to satisfy the crop's needs. There still remains the possibility, however, that the boron supply in the soil might be short of the optimum even though acute symptoms are not yet visible. In this case, the addition of a small amount of boron should improve the tobacco. Experiments in 1943 indicated that a proper amount of boron (borax) applied to tobacco land, previously grown to corn, improved crop values 12 to 14 per cent. It was also indicated that adequate amounts of boron should be added when considerable lime is applied to the land.

Experiments were continued in 1944 on old tobacco land with applications of 10 and 20 pounds of borax per acre. Results from this investigation will appear in the annual report from the Tobacco Substation.

Phosphorus Fertilization of Tobacco

A series of experiments on sources of phosphorus in tobacco fertilizer has been carried on for five years. The tests have been conducted in cooperation with the Tennessee Valley Authority.

In comparison with no special carrier of phosphorus in the fertilizer formula, the following materials were included in the experiment: precipitated bone, steamed bone, concentrated superphosphate, calcium metaphosphate, potassium metaphosphate and potassium-calcium metaphosphate.

A final report will appear in the Annual Report of the Tobacco Sub-station.

Can Good Tobacco Be Grown Without Plowing?

There is now a widespread controversy among students of agriculture as to the need for plowing land. A two-acre field experiment was started in 1944 to see whether tobacco is benefited or damaged by plowing the field in preparation for planting the crop. The field was divided into 32 plots, half of which were plowed while the others were only harrowed before transplanting. Part of them received a full ration of fertilizer while the others had only a three-quarter ration. Otherwise all treatments were the same throughout the season. As far as could be judged by growth of the plants in the field during the summer, there were no significant differences between plots, whether plowed or only harrowed. Since the tobacco from these plots has not yet been sorted we do not know whether the quality and yield were affected.

Since the benefits claimed by advocates of plowless farming are possibly due to accumulation of organic matter in the surface soil, it will be necessary to continue this test through a series of years before coming to any conclusion. After the tobacco crop was removed, a cover crop of oats was sowed and produced a dense cover a foot high before winter. This should increase the organic content of the soil and should be easily incorporated since it dies down in the winter.

Investigations on Tobacco Pigments

This investigation was an outgrowth of the project to determine the cause of "black" Shade tobacco. With respect to the yellow pigments, carotinoids and xanthophylls, it was found that the better the commercial grade of Shade tobacco, or the lighter the color of the leaf, the greater was the amount of yellow pigments, and *vice versa*. This relationship was found to exist even between differently colored parts of the same leaf.

More green coloring matter could be extracted from dark leaves than from light leaves.

The aluminum content of commercial tobacco tended to be greater in dark-colored grades than in light grades (same relation as previously shown for iron and manganese).

The highest copper contents were in the darkest grades from plots with low amounts of available soil phosphates.

Nitrogen, calcium and phosphorus content of commercial tobacco showed no consistent relationship to commercial grades. A common belief among growers that "black" tobacco of the lower primings is due to high nitrogen content was disproved.

Sterilization of Seed Beds with Chlorpicrin

Experiments with chlorpicrin (tear gas) as a means of sterilizing seed beds have been conducted at this Station for a number of years. The capacity of this gas to exterminate weeds is somewhat less than that of steaming but most of the weed-pulling labor is eliminated. The results by this new method will be more satisfactory if weed seeds are prevented from blowing into the beds after they are sterilized. Areas surrounding the beds should be kept free of weeds and the cover on the surface of the sterilized soil (which is a requirement of the method) may be left until the following spring.

Twenty to 22 pounds of chlorpicrin will sterilize a 50-sash bed, 6 feet wide.

Tobacco growers have found this gas to be a good substitute for steaming, since many broken-down steam boilers cannot be replaced in wartime.

Chlorpicrin is now applied with a power driven apparatus which dispenses the gas uniformly and at proper depth in the soil.

Shade Breeding

This project, in cooperation with the Genetics Department and the Shade Growers' Association has been continued in 1944 on the plantation of the Imperial Agricultural Corporation. The tobacco is sorted in the warehouse of this company by commercial graders under the expert supervision of Mr. Allen Green. Thirty different strains and single-plant progenies were grown under shade in 1944. At least three outstanding strains have been developed from this project and were tested by growers on a commercial scale in 1944. In the tests of 1943, the strain known now as Connecticut No. 15, gave a yield 36 per cent above the common Shade strain and a grading 40 per cent higher than the common strain. The leaf shape is better, the colors lighter and more uniform. The heavier yield comes from the larger number of leaves on a stalk and the more uniform size from top to bottom of stalk. Non-intentional tests in 1944 indicated that this strain is also highly resistant to black root rot. A closely related strain, designated at present as 15x17G, is a close second to Connecticut 15 and has been judged by some of the companies to be of better quality than Connecticut 15. Connecticut No. 17 produces leaves of the lightest color of all and the quality is good but the leaf shape and yield are not as good as for Connecticut No. 15. There is still some difference of opinion in the trade as to whether the taste and aroma of these new strains is equal to that of the common strain.

Control of Damping-off in Seed Beds

An early damping-off of seedlings was widespread in the seed beds of the State in 1944. Shortly after germination, the tiny plants disappear progressively until the "stand" becomes so thin that the grower does not have enough to plant his fields. In most cases, this obscure trouble is due to the attack of a parasitic fungus (*Pythium debaryanum*). The extent of damage varies from year to year, probably due to weather conditions. The outbreak of 1944, the most severe in 11 years, stimulated further tests on methods of control.

Eleven years ago (Conn. Sta. Bul. 359), after a similar outbreak, extensive tests of control methods led us to recommend the formaldehyde dust application as the best control. Although this method is quite effective and certain of control, it has not been generally adopted by growers; probably because the procedure is not simple enough and because the disease is not prevalent every year.

In more recent investigations it was found that good results could be obtained by sprinkling a concentrated formaldehyde solution on the soil while it is being raked over just previous to seeding (one pint formaldehyde diluted in a gallon of water for 15 square yards of bed). Thoroughly mixed in the top soil, this solution is as effective as the use of formaldehyde dust and is much easier to apply.

It would be still more simple if we could find an effective seed treatment that could be applied before the seed is sowed. A large

number of seed treating chemicals have been tried and although none of them have been found to be as consistently effective as the formaldehyde treatment, there are several of them that approach it. Best results have been obtained by the following, in the order of their standing in all tests up to the present: Fermate, Cuprocide, Arasan, Thiosan and Semesan. The seed is merely shaken in a stoppered bottle with a small amount of the chemical until all seeds are seen to be coated. In no case has there been any damage to germination and damping-off has been reduced to a degree that we can call commercial, although not always complete, control.

ANALYTICAL CHEMISTRY

The Department of Analytical Chemistry is concerned chiefly with official regulatory work involving inspection and analysis of fertilizers, feeding stuffs, foods, drugs and cosmetics, and the certification of Babcock glassware and dairy thermometers, all required by statutes relating to these subjects. In addition, a considerable amount of analytical and consulting service is rendered to other State and Station departments, including the Dairy and Food Commission, the departments of Agronomy and of Animal Diseases of the Experiment Station at Storrs, the Commission on Domestic Animals, the State Humane Society, the Narcotics Division of the State Board of Health, the State Police and various departments of this Station.

In the past year analyses or other examinations have been made of 422 fertilizers, 1,540 feeding stuffs and fodder materials, including biological specimens examined for poisons, 1,169 official and other samples of foods, drugs and cosmetics, 972 miscellaneous materials, and 2,804 pieces of Babcock glassware and thermometers.

Fertilizers

Wartime features of fertilizer inspection are increased tonnage consumption and a marked decrease in the number of fertilizer grades, with a consequent decrease in the number of commercial brands.

During the season 1943-44, fertilizers used in Connecticut amounted to 75,350 tons. This is an increase of approximately 20 per cent over the 5-year average immediately prior to 1942.

In the United States as a whole, it has been estimated that the 1943-44 consumption was 12 million tons as compared with about 8 million tons average annual consumption for the 5-year period prior to 1942, an increase of 50 per cent.

As a war measure, the number of grades has been reduced to about a dozen whereas it was formerly 65 or more. This reduction is reflected in the number of commercial brands registered, which for the past year was 202 as compared with over 300 normally. The number of firms registering has shrunk from about 60 to 40.

Guaranteed analyses, however, have been well maintained. Of all guaranties made, our analyses show that 91 per cent were substantially met or exceeded.

Commercial Feeding Stuffs

Notwithstanding the difficulties that have confronted the feed industry due to limited and uncertain supply of ingredients for mixed feeds, the number of commercial brands has remained fairly constant in the five-year period ending December 31, 1943, and the number of firms registering has not greatly diminished. For several years prior to 1943, approximately 200 firms registered annually about 1,230 brands of feed, including vitamin D carriers. For the past year, 1943, 176 firms registered 1,221 brands.

The varying market supply of ingredient materials has made it necessary for manufacturers to change feed formulas and revise guaranties rather frequently, but nevertheless guaranties have been maintained surprisingly well. Results for the 1943 inspection show that 93 per cent of the guaranties made for feeds were substantially met, and the corresponding percentage for vitamin D carriers is 95.

Toxicological Examinations

Seventy-three biological specimens were submitted to the department to be examined for common poisons. For the most part, this work was supplementary to pathological examinations made in the Department of Animal Diseases at the Storrs Station to discover the causes of mortality in livestock and poultry. In 25 cases, results were conclusive enough to indicate that chemical poisons were probable or possible causes. The poisons found were lead, arsenic, yellow phosphorus, strychnine, prussic acid and copper. Plant poisons were indicated in several instances but not confirmed by chemical tests. Copper appears to fill a physiological need in animal nutrition, but excessive amounts are poisonous, especially to sheep.

In none of these cases was there any evidence that commercial feeds were responsible. Investigation usually disclosed that animals had had access to paint, insecticides, weed killers or other poisonous materials used on the farm, poisonous plants in pasturage, or poisoned bait maliciously distributed.

Foods and Drugs

The Station's chief function under the Food, Drug and Cosmetic Act of this State is to provide scientific, technical and consulting service to the Dairy and Food Commissioner who is charged with the enforcement of the act. This includes analytical, biological or other examinations of samples submitted by the Commissioner.

In work of the past year emphasis has been laid on violations that involve (1) economic frauds, (2) foods contaminated with filth or otherwise unfit for consumption, (3) deceptive packaging, (4) incomplete or improper labelling, (5) indiscriminate sales to the public of drugs that are restricted to prescription use, and (6) substandard drugs. Laboratory examinations have enabled the Commissioner to take cor-

rective action against stocks of olive oil and other vegetable oils that were found to be adulterated or misbranded, shell eggs and frozen eggs that were unfit for food, decomposed meat and poultry, cereal and other foods that were infested with insects or contaminated with filth, short weight or deceptively packaged foods including flavoring extracts, spices, macaroni products and confectionery; and illegal sales of barbiturates and other sedatives, substances of which the indiscriminate sale to the public is prohibited.

Over the 4-year period 1940-43, about 20 per cent of the official samples of foods and drugs submitted for examination were found to be adulterated, misbranded or otherwise objectionable. This is not necessarily to be taken as an index to the quality of the food and drug supply in the State because inspections are often made on complaint or suspicion of violations, or directed to those commodities where experience has shown violations are most likely to occur.

Methods of Analysis

Collaboration with the Association of Official Agricultural Chemists in preparing the 6th Edition of *Methods of Analysis* published by the Association is in progress. This volume of some 750 pages is the official reference text on methodology for federal and state control officials, and is also widely used in foreign countries.

In collaboration with other laboratories, studies of the tentative method for the bioassay of vitamin D carriers used as supplements for poultry feeds have been carried on. This effort is directed to shortening the present procedure and to improving its accuracy.

BIOCHEMISTRY

Soybean Proteins

One of the results of the war has been the great increase in importance to the public of several fundamental problems in protein chemistry. The necessity for the partial substitution in the national diet of proteins derived from cereals or legumes for the more highly esteemed proteins of meat has raised the question of the amino acid composition and nutritive effect of these vegetable proteins. Many agencies throughout the country have collaborated in an effort to obtain the information from which a rational program of protein substitution can be developed. The share taken by the Department of Biochemistry has been chiefly the study of the proteins of the soybean. This seed was investigated for the first time by Osborne in 1897 at this Station and the conditions were developed under which the main globulin, glycinin, can be isolated in what appeared to be pure form. The nutritive properties of this globulin were later shown by Osborne and Mendel to be excellent, and the enormous increase in the soybean crop in this country during recent years makes this seed one of the most important available substitutes for proteins of animal origin.

As part of a collaborative investigation carried out under the auspices of the Committee on Protein Foods of the Food and Nutrition Board of the National Research Council, considerable study has been given to the methods of Osborne for the preparation of the soybean proteins with the object of effecting improvements and rendering these substances available. The chief difficulty with the information to be found in the literature was that such amino acid analyses as had been carried out dealt exclusively with the main globulin but there were no satisfactory data on the proportion of this globulin present in the beans. Although one could compute the quantities of amino acids supplied to a diet by the globulin itself, there was no way to arrive at a knowledge of the quantities supplied when whole beans or bean meal are ingested, since little or nothing has been recorded regarding the amino acid composition of the proteins other than this main globulin.

The assignment given by the Committee on Protein Foods was to learn how best to prepare the main globulin of soybeans of the variety Illini and to obtain sufficient of this protein for amino acid analysis by other collaborators. This was successfully accomplished, but it was found that the highest yields that could be obtained amounted to at most 50 percent of the total protein or 21 per cent of the dry weight of the fat-free bean meal. An additional 20 per cent of the seed protein could be secured in the form of a mixture of more soluble globulins together with the so-called albumins of the meal, but there was always a residue of from 20 to 30 per cent of the total protein that could not be obtained in clear solution and subsequently isolated in satisfactory form by the techniques customarily employed in this type of work. Although as much as 90 per cent of the protein could be "dispersed" into a partially colloidal solution when a small sample of the meal was thoroughly comminuted with a neutral solvent in a high-speed mixing apparatus, it was found that, after this solution had been clarified in the supercentrifuge, only about 70 per cent of the protein remained dissolved. It became evident that the soybean contains a far more complex assortment of proteins than is usually assumed, and that much more remains to be learned regarding the chemical and physical properties of these substances before a procedure can be devised by means of which they can be separated into fractions suitable for detailed chemical study.

As a part of this investigation of the proteins of soybeans, an examination was made of the literature of seed proteins to obtain information helpful to the members of the Committee in solving their fundamental problem of determining the proportions of amino acids furnished to a diet by the cereal grains or legumes. It was found that accurate and trustworthy information is exceedingly scanty. The vast labors of Osborne begun more than fifty years ago have not been followed up in recent years with the use of modern techniques and, although new and improved methods of amino acid analysis have been applied to some of the seed proteins, there are very few seed proteins the composition of which is even moderately well known.

The most conspicuous gaps in our knowledge are as follows: There is no single plant seed from which the entire protein content has been extracted and separated into fractions suitable for the study of physical properties and chemical composition. With the possible exception of wheat, there is no seed to which even a roughly approximate analysis in terms of definite protein components can be ascribed. There is no single seed protein for which a complete amino acid analysis obtained by modern and accurate methods has been secured. The amino acid analysis of even the best known proteins, such as for example, zein from maize and edestin from hempseed, is compiled from data from many sources, and some of the figures, used because no others are available, were obtained many years ago by methods known today to have been subject to grave errors. Perhaps most serious of all, there is no general agreement among biochemists concerned with these problems upon the procedures that should be followed in order to obtain the information that war conditions have shown to be so essential.

The chief results of this study of the literature have been embodied in a report circulated in mimeographed form to the Food and Nutrition Board. In addition certain aspects of the problem were discussed in a published symposium under the auspices of the American Society of Biological Chemists.

Histidine

A new method to determine histidine in the mixture of amino acids that results from the hydrolysis of proteins was referred to in last year's report. This method has now been applied to a series of well-known plant and animal proteins with the interesting result that many of the observations made by Kossel and by Osborne and their respective collaborators in the early years of the century have been closely confirmed. The importance of this observation arises from the fact that the early analyses relied entirely upon the determination of nitrogen in the fraction that was secured by precipitation of the histidine with silver salts under specified conditions. Although this fraction was purified by repeated precipitations with silver and mercury salts, the possibility remained that the results might not be accurate because of the chance that amino acids other than histidine could find their way into the histidine fraction, although doubtless in small proportions, and thus lead to overestimations. Evidence that seemed to favor this view was in fact obtained, in part, through the work at this Station, inasmuch as modifications of the original Kossel procedure developed in the effort to simplify and shorten it gave results that were uniformly lower than the older data.

The new method permits the isolation of the histidine in the form of the insoluble and beautifully crystalline salt of 3, 4-dischlorobenzene sulfonic acid by a procedure that requires the use of only a relatively small quantity of the protein and which can be completed in days instead of the weeks formerly needed. Moreover, the purity of the final product can be established by a demonstration of the con-

stancy of its solubility, perhaps the most rigid test of purity that exists, and, since the solubility of the product is known, it is possible to apply a correction for the very small amount of histidine that remains in the mother liquor from which the compound is separated. Tests with known amounts of histidine under the conditions encountered in the course of an analysis have shown that the recoveries are quantitative within a very small and known error. The agreement of the new results with those secured by the Kossel procedure in its original form is particularly gratifying, not only because the new data support the early work, but also because they have revealed unsuspected and serious errors in the more recent attempts to improve upon the long and difficult method previously used.

Isocitric Acid

The great interest that has been aroused in the dicarboxylic and tricarboxylic organic acids by the development in recent years, by Krebs and his collaborators as well as by others, of an acceptable chemical theory of respiration in living tissue has led to widespread investigation of these substances. As a result such substances as citric and malic acids together with many related acids, although long known as important components of plant tissues, have now become of fundamental significance to biochemistry in general and have been found to be widely, if not universally, distributed in all kinds of plant and animal cells.

Isocitric acid is one of the most interesting of the acids in this closely related group of substances which, by their enzymatic interconversions, provide the chemical mechanism whereby the cell is enabled to take in oxygen and liberate carbon dioxide. For many years isocitric acid has been merely a laboratory curiosity. It was first obtained synthetically in 1889 but has rarely been studied since. The optically active isomer was found in nature for the first time in 1925 by Nelson as a component of the juice of the blackberry, although only in small quantities, and subsequently it has been detected in a few other plant tissues. Until recently there was no record of its presence in animal tissues. Krebs' theory of respiration would imply, however, that it must be present even if only in minute amounts in all cells and, accordingly, isocitric acid has quite suddenly become a substance in considerable demand for investigation. Not only must the physical and chemical properties be studied but accurate analytical methods applicable to very small quantities must be developed.

To be sure, synthetic isocitric acid can be obtained fairly easily in the optically inactive form. The difficulty is that the substance contains two asymmetric carbon atoms and, accordingly, the synthetic preparation is a mixture of at least two, and more probably of four, optically active isomers. It is a general rule, when this situation arises, as it somewhat frequently does, that only one of these four isomers is the substance actually encountered in nature. Thus, although synthetic isocitric acid is readily available, the preparation

that is obtained is only in part the substance that is wanted for many of the kinds of investigation that must be carried out. Although the natural optically active isomer is present in it, the proportion can be at most, 50 per cent of the whole and may be much less. Furthermore, the separation of the isomers is technically very difficult.

It is thus a most fortunate coincidence that, through the work of this Station, a bountiful source of optically active isocitric acid has recently been found in the leaves of the common greenhouse plant, *Bryophyllum calycinum*. This observation was referred to in last year's report but without comment on its significance. The result is that this previously extremely rare substance can now be obtained in reasonably large quantities for detailed investigation at exactly the time that interest in it had been aroused from observations made in other laboratories in an entirely different field.

The studies of isocitric acid that have been carried out at the Station during the past year have had chiefly to do with the synthesis of the optically inactive material. The procedure employed is a modification of that described by Fittig that has been developed in order to obtain consistently high yields of a pure product. In addition, large amounts of the leaves of several species of *Crassulaceae* have been grown in order to secure material for the preparation of the optically active isomer in considerable quantities to be used for investigation.

Nutrition

The complex question of the relation of citric acid to bone development in experimental animals has received further study. It has previously been observed in this laboratory, as well as in others, that citric acid is a constant constituent of bone and is usually present in fairly large amounts. Rickets may be prevented and early rickets may be alleviated by the administration of salts of citric acid, without including vitamin D in the diet.

In order better to understand the part that citric acid may play in the formation of bone, it is essential to know the citric acid content of the bones of normal animals. To secure this information, the work mentioned last year has been extended to include citric acid determinations in the large bones of normal rats for three distinct groups; viz. at weaning, at 200 grams, and at 400-500 grams body weight. A few analyses of bones of rats that were depleted by the feeding of a rachitogenic diet have also been carried out. In addition, in connection with our routine assays for vitamin D for poultry, citric acid has been determined in the tibiae of chicks, groups of animals being chosen so as to show the effect of different amounts of vitamin D.

The results of all experiments thus far confirm the earlier general observation that there are wide variations in the citric acid content of the bones of animals of the same age and nutritional history. However, certain regular differences have been noted. Bones of rats that were fed a rachitogenic diet showed a relative low citric acid content,

in contrast to animals that were fed either citrates or vitamin D to prevent or cure rickets. The citric acid content of chick tibiae varied with the vitamin D intake. Those chicks that received no vitamin D showed low calcification of the tibiae and low citric acid, while those chicks that were fed an adequate amount of vitamin D showed a much higher content of citric acid. Comparable data for rats are not yet available.

Some investigation has been made of the citric acid in certain organs of rats at different ages. In general, the results showed the presence of very small amounts of citric acid in liver, spleen and kidneys, and relatively large amounts in the adrenals.

The analytical data for the normal citric acid content of bone are being summarized for publication and further work on the relation of citric acid to graded doses of vitamin D is in progress.

BIOMETRY

The Station Biometrician acts as a consultant to other members of the Staff and carries out research. In the first capacity, his services as a consultant were available to Staff members in all departments throughout the year. They concerned technical problems on the design of experiments and the analysis and interpretation of experimental results. The results of such consultations are scattered through the reports of the individual departments, frequently in non-statistical form. The Biometrician has also given similar aid to special committees of the U. S. Pharmacopoeia in developing better official methods for the standardization of drugs.

Research on statistical techniques for biological problems centered in the general field of biological assay. Determining the efficacy of agricultural poisons, drugs and vitamins are essentially problems in biological assay. The development of suitable statistical tools in this field has stimulated many investigations which otherwise would have been much less practicable. During the year progress has been made in assembling material for a book describing the statistical methods suitable for use in biological assay. A collaborative study on the assay of digitalis under the auspices of the U. S. P. evaluated critically the data upon which the method adopted in the U. S. P. XII was based. A study has since been initiated for applying the techniques of statistical quality control to the standardization of this drug. More recently a proposed U. S. P. assay for penicillin has received considerable attention. This analysis has led to improved statistical techniques which will be useful in other biological assays as well. Other studies concerned the assay of vitamin D for chick feeds and the evaluation of insecticides under field conditions.

THE LIBRARY

During the year ended October 31, 1944, the Station Library had approximately the following number of additions:

U. S. Department of Agriculture publications	507
State Agricultural Experiment Station publications	964
Scientific and agricultural domestic and foreign journals	1,461
Single books	81
Total	3,013

The Library subscribes to 90 sets of scientific journals. It receives in exchange for the publications of this Station about 20 sets of domestic farm journals.

The number of bulletins and journals bound during this year was 254 volumes.

Approximately 60 microfilms and photostats were obtained in place of inter-library loans, although a few volumes were borrowed.

The total number of cloth and paper bound volumes on hand is now approximately 27,700. United States Department of Agriculture and State Experiment Station publications, as well as scientific journals, are received in pamphlet form and are not included in the volume count until bound.

LIST OF PROJECTS

active in 1944-45

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.
37. Substitutes for lead arsenate in orchard sprays in 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.
62. Control of the borers in nursery trees.

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.)

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.
   c. The properties of the wood of several of the important species. (In cooperation with the Yale Forestry School.)
6. Studies of forest plantations throughout the State.
   a. Growth and yield of several species in relation to site.
12. The utilization of native woods.
   a. Use of preservatives.
   b. Portable charcoal kilns.

Control and Service

7. Control of white pine blister rust. (In cooperation with the U. S. Dept. Agr.)

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 disease 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

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.
9. The evaluation of various soil factors in terms of land use and types of farming.
10. Nitrogen relationships in soil maintenance by green manures in vegetable cropping systems.

Tobacco Sub-station

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

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

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

17aa. Study of tobacco pigments. (Inactive.)

17b. The study of the cause of black Shade tobacco. (Inactive.)

19. Investigations 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.

20. The biology and control of insects that attack tobacco. (See Entomology No. 52.)

22. Irrigation of tobacco.

32. Plowing *versus* discing as preparation for tobacco.

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No. 474. Control of the Apple Maggot with Rotenone Dusts. Philip Garman.

No. 475. Report on Food Products and Drugs for 1942. E. M. Bailey.

No. 476. Commercial Fertilizers. Report for 1943. E. M. Bailey.

No. 477. Report of the Director for the Year Ending October 31, 1943.

No. 478. Tobacco Sub-station at Windsor. Report for 1943. P. J. Anderson, T. R. Swanback and S. B. LeCompte, Jr.

No. 479. The Imported Long-horned Weevil, *Calomycterus setarius* Roelofs. J. Peter Johnson.

CIRCULARS OF THE STATION

No. 158. Laws and Regulations Concerning the Inspection of Nurseries in Connecticut and Transportation of Nursery Stock. M. P. Zappe.

No. 159. Controlling Pests of War Gardens. Neely Turner and James G. Horsfall.

No. 160. Poison Ivy and Its Eradication. E. M. Stoddard.

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All of which is respectfully submitted.

WILLIAM L. SLATE,

Director.

REPORT OF THE TREASURER

Summary Statement of Receipts, Expenditures and Balances

For Period July 1, 1943 to June 30, 1944.

BALANCE ON HAND JULY 1, 1943			
Federal Appropriations:			
Purnell Fund			$ 598.37
RECEIPTS			
State Appropriations:			
Personal Services	$232,515.00		
Contractual Services	13,950.00		
Supplies and Materials	16,100.00		
Equipment	4,377.00		
Plant Improvements-Biennial	4,375.00	$271,317.00	
Federal Appropriations		55,655.29	
Feed Fees		16,793.91	
Fertilizer Fees		11,655.18	
Trust Funds and Grants		13,051.89	
Total Receipts			368,473.27
			$369,071.64
EXPENDITURES			
Personal Services	279,694.57		
Contractual Services	14,154.54		
Supplies and Materials	18,881.22		
Equipment	4,401.71		
Plant Improvements	2,993.22		
Total Expenditures		320,125.26	
UNEXPENDED BALANCES			
State Appropriations (Reverted to State Treasury)	47,502.35		
Balance on Hand June 30, 1944			
State Appropriations Plant Improvements-Biennial	1,381.78		
Federal Appropriations Bankhead-Jones Fund	62.25		
Total Unexpended Balance		48,946.38	$369,071.64