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REPORT OF THE DIRECTOR

For the Year Ending
October 31, 1936

Connecticut
Agricultural Experiment Station
New Haven

CONNECTICUT AGRICULTURAL EXPERIMENT STATION

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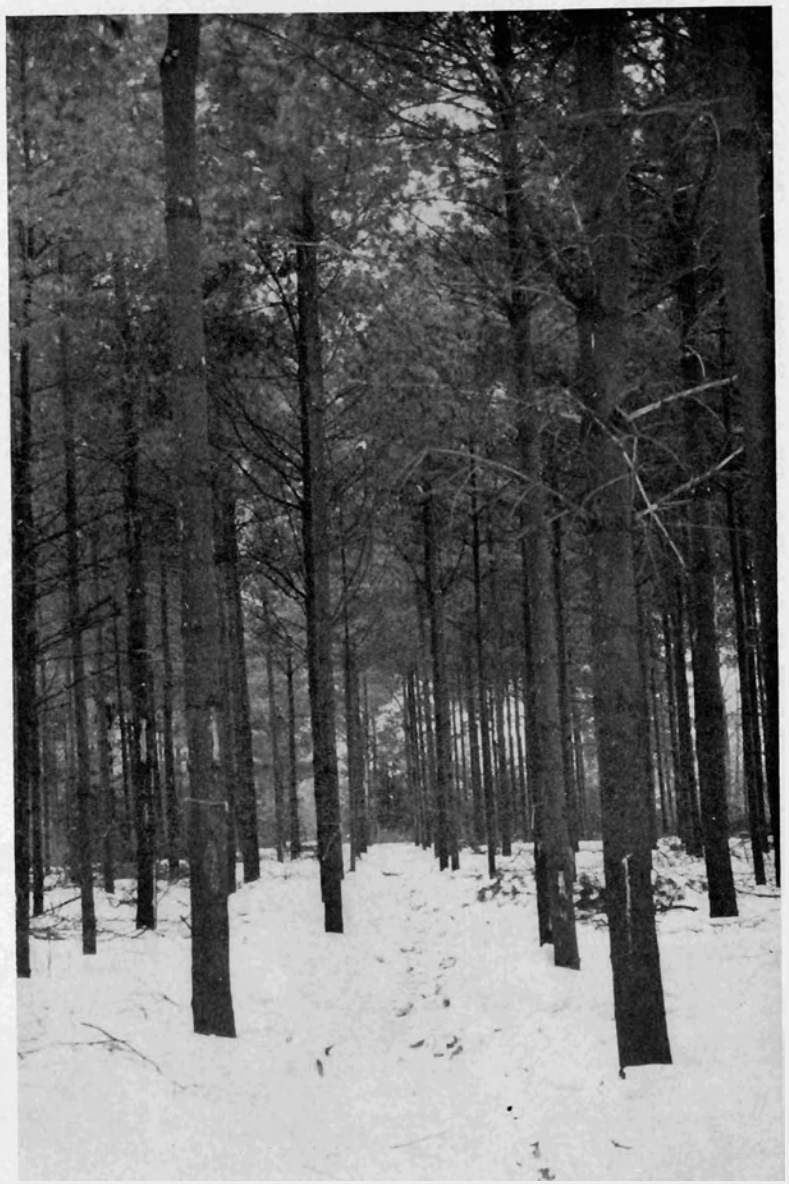

RAINBOW EXPERIMENTAL FOREST AT WINDSOR
The Station pioneered in forest research. Experiments were started here in 1902.

REPORT OF THE DIRECTOR

FOR THE YEAR ENDING, OCTOBER 31
1936

To the Board of Control of the Connecticut Agricultural Station:

IN 1875 the General Assembly passed a special act establishing the Connecticut Agricultural Experiment Station. For two years it was located at Wesleyan University, Middletown. In 1877 the Assembly provided for the continuance of the Station to be located at New Haven. This act or charter reads in part: "That for the purpose of promoting agriculture by scientific investigation and experiments, an institution is hereby established, to be called and known as the Connecticut Agricultural Experiment Station." Thus Connecticut was the first state to establish a station as an organic institution for research in the interests of agriculture.

The original advocates and sponsors were the State Agricultural Society and the State Board of Agriculture, including all of the prominent farmers in Connecticut. The first board was made up of men representing the important types of farming, and of scientists who believed in the purpose of the Station. Among these were: T. S. Gold of Cornwall, James J. Webb of Hamden, Edwin Hoyt of New Canaan and E. H. Hyde of Stafford. There were also Professors W. H. Brewer and Samuel W. Johnson of the Sheffield Scientific School at Yale.

Members of the Board served without compensation and at considerable sacrifice, giving freely of their time to the management of the Station. The arrangement proved most fortunate and has been continued to the present time. The Board still represents the farming interests of the State.

The Station was established by farmers, for the service of agriculture. Throughout its 62 years it has continued to render that service, economically and efficiently. Its contributions to agricultural science have won it an enviable reputation at home and abroad.

Concentrating on research, it gradually built up a staff with expert knowledge in the sciences underlying agriculture. When various problems relating to pest control, food and drug inspection, or fertilizer analyses came before the Legislature, it became a matter of course to turn to the Experiment Station for help. And because the staff had the information needed, these and many other statutory duties were made a part of its work.

The Dutch elm disease furnishes an illustration of this point. Before the disease was found in Connecticut, the Station Botanist had studied it and kept in touch with its progress here and abroad. When, in 1934, the

State was faced with the problem of control, it assigned the task to the Station. Closely linked in the program are studies of the disease-causing fungus and of the insect carriers in laboratory and field, and the coöperation with the Federal Government in holding the disease in check through scouting and eradication.

Much of the Station's control work is carried on in coöperation with the Dairy and Food Commissioner, the Agricultural Commissioner, the United States Department of Agriculture and other agencies. Whether the services called for have been in the form of advice on mosquito elimination, examination of milk for vitamin content, or termite-proofing in new and old buildings, the foundation of the knowledge acted upon has always been research.

Research is not often spectacular. It does not lend itself to newspaper headlines. The men who do the work are at home in their laboratories and frequently uncomfortable when confronted by large numbers of persons who have no fundamental understanding of what scientists are doing. For that reason the public in general accepts the benefits of research reaching to it through the farm bureaus, extension service, or commercial companies, but has no knowledge of the intensive labor that has gone before. Thus the public can hardly know that before the application of the knowledge of proteins and vitamins, went years of study in the biochemical laboratory at this Station. They can demand finer fruits and vegetables, but they cannot know that perfect apples, peaches and other products result from season after season of experimentation with sprays that prevent or control insect and disease injury. They know that they get better results when they plant hybrid seed corn, but they do not know that plant breeders at the Experiment Station first worked out the method for producing those hybrids and furnished the information to seed companies.

Such accomplishments are only possible when men of ability and training are given a quiet place to work undisturbed by changing administrations. The Station has been particular y blessed because it is a chartered institution with a permanent policy. It has at no time in its history been open to political influence.

Despite its preoccupation with research, the scientific staff keeps in constant touch with the farmer. One means of contact is through the different agricultural societies of the State. The Vegetable Growers Association has a research committee which meets with members of the staff who are breeding better vegetables for Connecticut, studying soils and fertilization or control of insects and diseases. Together they discuss the program for the year and the growers bring new problems to the attention of the staff. The Pomological Society has a similar arrangement. The researchers meet with the growers and extension workers and together plan the experimental program.

Farmers constantly bring or send to the Station samples of soil that has produced poor crops. In 1936 more than 4,000 such samples were examined at New Haven and Windsor by the Universal Soil Testing System developed here. Specimens of all kinds are submitted for examination

by the botanists, entomologists and chemists. There is a constant flow of information by telephone, correspondence and personal call. Each year groups of students, teachers and garden club members visit the Station to see the work.

Another means of contact between public and staff is through field days. In the summer of 1936 the Station held open house four times at the farms at Mount Carmel and Windsor. On these occasions citizens are invited to look at the experiments in the field, to examine exhibits and to meet the scientific staff personally. Such contacts are valuable to both grower and scientist.

Frequently the public becomes interested in a particular line of research and men engaged in the work are invited to speak at meetings. During the past year the favorite subjects were termites, soil tests, insect pests of the garden and orchard, state forests and parks, and the Dutch elm disease.

The Station was established by farmers for the service of agriculture. But agriculture touches all people, and through concentration on research in agricultural fields, the Station is serving the entire citizenry.

Staff Notes

Last summer Dr. W. E. Britton was awarded "Honorary Recognition" at Farm and Home Week at the State College. Each year the College Board confers this honor on one or more persons for outstanding contributions to agriculture and rural life in Connecticut. Doctor Britton was the only one so honored in 1936.

The United States Department of Agriculture has assigned an entomologist, Mr. A. W. Morrill, Jr., to Connecticut. Mr. Morrill began work July 1, coöperating with Mr. LaCroix who is part-time Station Entomologist at Windsor.

The Station and the farmers of the State suffered a great loss on April 22 in the death of Mr. George A. Hopson, superintendent of the Station farm at Mount Carmel. For many years, Mr. Hopson was a member of the Station Board.

Although nearly 76 years of age, he was active until the week of his death. Born in Wallingford, he spent most of his life there on the family farm. He served his town in the Legislature, as Selectman, and was a charter member of the Grange. At the time of his death, Mr. Hopson was president of the New Haven County Horticultural Society and presided at a meeting in East Rock Gardens the night before he was taken to the hospital.

The following pages contain brief accounts of the work carried on by the departments. Space does not permit our reporting the details of each project, but a list of those active in 1936-37 is given on page 210. A list of services the Station is equipped to render may be found on page 213. There is also appended a report on the library, and the titles of circulars, bulletins, and scientific articles published by members of the staff in 1936.

Progress of the Station's Work

ANALYTICAL CHEMISTRY

The work of the Station started in the chemical laboratory. In the beginning it consisted chiefly of analyzing fertilizers and animal feeds, and of research along these lines. A short time later agricultural products such as butter and vinegar—especially those suspected of adulteration—were added to the list. And after passage of the Food and Drugs Act in 1907, the variety and number of foods and drugs analyzed rapidly increased. In all of this analytical work, the Station was assigned to act merely as an impartial, fact-finding agency. Any corrective measures were and are the responsibility of the Commissioner. Three reports published annually give the results of chemical analyses of products examined.

Food and Drug Control

In the sphere of food and drug control, the department examined nearly 2,000 samples in 1936. Of these 587 were of milk and cream tested for milk producers, and 343 were drugs dispensed by pharmacies.

Vitamin D Milk Tested

A feature of the inspection is the regular and systematic examination of vitamin D milk which is now commonly sold on the market. The test makes use of the colony of albino rats maintained at the Station for experimental purposes. By special diet, rickets is produced in litters of young rats. Feedings with standard cod liver oil containing a certified amount of vitamin D start healing of the bones in 10 days. Milk containing the same amount of vitamin D should have similar curative value. Examination of the bones is made according to the standard line test. Of the 61 samples of milk tested in 1936, 44 were found to be satisfactory in the dealer's claim of vitamin D content; 7 passed and 10 were below standard.

In all cases where deficiencies in vitamin D content have been found, corrective action has been taken by the Dairy and Food Commissioner on the basis of these findings. The control of this commodity is on the same basis as that of other foods under the state food statutes: Samples are collected by the Commissioner's office, examined at the Station and results reported to the Commissioner, the producer and the vendor.

Adulteration of Olive Oil

For many years unscrupulous dealers have adulterated olive oil with other cheaper food oils. From time to time the frauds are detected and **the Commissioner takes steps to protect the public.** It has been known for a long time that a new adulterant was being used, but the substance blended so perfectly with olive oil that it defied recognition. It has been found that this material is teaseed oil, a product derived from the seeds of a plant closely related to the beverage tea, and imported from the Orient for use in the manufacture of paints and varnishes. When racketeers discovered its possibilities as an adulterant, imports reached unprecedented heights.

As a result of exhaustive study, a government chemist devised an **infallible color test for teaseed oil.** It is significant that no teaseed oil was found in official samples of olive oil examined in Connecticut in 1936 after the new test had been announced. However, other adulterations or deficiencies were found in six of the thirteen samples examined.

Spray Residue on Fruits

In their efforts to produce perfect fruit, growers of the State spray their trees thoroughly with recommended insecticides and fungicides. The best of these contain lead and arsenic and there has been some apprehension that residue left at harvest might be harmful to consumers. Experience has shown that weather conditions in this section of the country are generally favorable to remove spray so that there are few instances of excessive amounts. However, since foods should be free from all poisonous contaminations, limits of tolerance are fixed only for such products as cannot be produced otherwise. Until suitable substitutes can be found for lead and the arsenicals used in controlling insect pests, some tolerance will have to be allowed, and the limits now in force are regarded as adequate to safeguard public health. Substitutes for lead-arsenate sprays are continually being tested at this Station.

As many as 300 samples of fruit, chiefly apples, were examined for excess spray residue in the dry summer of 1935. Growers submitted 127 of these samples and the Dairy and Food Commissioner conducted a survey of orchards collecting the rest. The findings were: 19.6 percent exceeded the tolerance for lead (.018), and 4.5 percent exceeded the tolerance for arsenic (.01 grain per pound). These figures are most unusual and would not be matched in a year of average rainfall when residue is normally washed away. The results of these analyses are sent to the growers so that they may take steps to remove the residue before marketing the fruit.

Vitamin C Content in Fruit Beverages

The consumption of citrus fruit juices has notably increased in recent years due to the recognition in their content of the nutritional factor, vitamin C. Chemical methods for the evaluation of this factor are now available. Beverages of the orangeade type made from orange base concentrate have long been dispensed at soda fountains, and, more recently, distributed by dairies. No claim is made that they are straight juice, but the benefits of vitamin C are often stressed in advertising. The limited number of samples examined contained from 2.5 to 9 percent as much vitamin C as fresh, undiluted orange juice.

Fertilizer Inspection

During the year 55 firms registered 319 brands of fertilizers at the Station as required by statute. This is about the same number as in each of the preceding years, but substantially fewer than the registrations of 1930. The Station Agent visited 72 towns and villages and drew 345 official samples, including all of the registered brands that could be found. In all, 719 samples, official and otherwise, were submitted and examined in 1936 and Bulletin 390 is a record of the work done on them.

Manufacturers made 600 guaranties on the 201 samples of mixed fertilizers, 71 percent of which were met in all respects. Failure to meet nitrogen guaranties was the most frequent deficiency and only two samples had deficiencies amounting to more than one dollar a ton in commercial value. Analyses are reported to the manufacturer and to the purchaser whose stock is sampled, and portions of the laboratory sub-sample are supplied to the manufacturer for checking purposes whenever demanded.

Inspection of Feeds

Samples of feeding stuffs and related materials to the number of 1,320 were examined during 1935. These consisted of 850 samples of concentrated feed stuffs, 127 miscellaneous feeds examined for individuals, 4 samples examined for poisons, 311 samples of pasture grass and other fodder submitted by the Storrs Station and 28 check samples of cottonseed meal. There were 2,536 guaranties, including protein, fiber and fat, in the 850 official samples examined. These were substantially met or exceeded in 95 percent of the products. The results of the inspection were published in Bulletin 385.

Plans are in progress to include biological tests of vitamin D carriers intended for the feeding of live stock and poultry as a part of regular feed control. Baby chicks will be used for this purpose.

Other Department Activities

Miscellaneous samples are submitted for analysis by other departments of the Station, by instutitions and by individuals. These may include anything from chocolate suspected of poison to the contents of a cow's stomach.

Members of the staff serve as referees or collaborators of the Association of Official Agricultural Chemists in studies of analytical and biological methods. Subjects included are: Milk solids in bread; tests for teaseed oil in olive oil; biological tests for vitamin D; the determination of santonin, phenolphthalein and colomel in drug mixtures; the determination of pyridium in drugs; and acidity and basicity of fertilizers. The chemist in charge has served as a member of the Committee on Definitions and Standards for Foods of the United States Department of Agriculture, the Council on Foods and Council on Pharmacy and Chemistry of the American Medical Association, and as chairman of the Revision Committee of Official and Tentative Methods of Analysis of the Association of Official Agricultural Chemists.

BIOCHEMISTRY

Our research in this field dates from 1888 when Thomas B. Osborne began his life-long studies of the vegetable proteins. Later, in collaboration with Lafayette B. Mendel, the nutritive value of these proteins was investigated in a series of classic experiments. Both of these phases are still actively pursued, in addition to an intensive chemical investigation of growing plants. From time to time, as the research progresses to a sufficient degree, scientific papers and bulletins are published by members of the staff. (Page 207)

Chemistry of the Tobacco Plant

The study of the behavior of the constituents of tobacco leaves when these are subjected to culture on water, on dilute glucose or on an inorganic salt solution, in the light and also in the dark, has been continued throughout the past year. The technic of culture and the methods of chemical analysis employed permit following the changes that occur in the proteins, the amino acids, the amides, the carbohydrates, and the organic acids, in considerable detail. It has been found that leaves cultured in light rapidly synthesize an increased store of organic compounds, the presence of which is recognized by an increase in organic solids. But the increased content of carbohydrates, which are supposed to be the immediate products of photosynthesis, accounts for only about half of the increase in organic solids. Clearly, therefore, the synthetic reactions proceed much further than the mere production and storage of sugar and starch in the leaf tissues, and it is obvious that the cells of these detached leaves in culture solutions are the locus of complex chemical reactions associated with the process of metabolism—in short, that the leaves are still alive and active even after considerable periods of culture.

The changes which occur in leaves kept under similar culture conditions in the dark are frequently in marked contrast to the changes in the light. For example, citric acid is rapidly synthesized in the dark, but remains constant in the light. Malic acid, on the other hand, decreases rapidly in the dark but remains constant in the light. Sugars, of course, increase in light, and are rapidly utilized in the dark. The proteins, however, undergo digestion at a rate that is practically the same both in light and in dark during the first four days of culture.

Analytical Methods Developed

A new method to determine starch in leaf tissues has been developed and published and much work has been done on the development of a method to determine purine nitrogen in leaves. If finally successful, this will be of great assistance in following the metabolism of the nucleoproteins of leaves during culture experiments. The method to determine glutamine, which is a modification of the method proposed by Professor Chibnall of London, England, some years ago, has been published as a collaborative paper with him.

Amide Metabolism

The occurrence of a substance in tobacco leaves which yields ammonia on being treated with boiling water raised the question of the presence of the amide glutamine in this plant. The amides of tobacco leaf tissue have therefore been isolated in crystalline form for chemical identification. From 13 kilos of fresh leaf, approximately 18 grams of pure asparagine and 6 grams of pure glutamine were prepared, the yields being 74 percent and 43 percent of the quantities of these two substances actually present in the tissue, according to the results of the indirect methods of analysis applied.

Although these yields are gratifyingly high when the nature of the operations necessary for the isolation is considered, it is clear that the entire amide composition of this plant is not yet established. In fact evidence has already been secured that the stalk may contain yet another substance, the properties of which are analogous to those of an amide. Accordingly further study of the amide composition of plants is projected.

Studies of the amide metabolism of the beet plant have shown that the glutamine content of the root can be enormously increased by application of ammonium salts to the soil. Daily applications to plants grown in the greenhouse resulted in the production of root tissues that contained as much as 5.4 percent of the dry weight as glutamine. These plants had been seriously intoxicated by the treatment and were chlorotic and wilted, but the reserve capacity of this plant to detoxify extraneous ammonia by converting it into glutamine was well illustrated.

Protein Investigations

During the year attempts have been made to develop improved methods for the determination of the dicarboxylic amino acids that result from the hydrolysis of proteins. The extremely rare hydroxyglutamic acid was synthesized and employed in experiments directed towards the development of a method to detect and determine this substance. These studies are still incomplete but give reason to believe that new methods for glutamic and aspartic acid will ultimately be developed. They also hold some promise of success in dealing with the third member of this group, hydroxyglutamic acid, which has hitherto been isolated in pure form only by Dakin, who discovered it, and by one other worker.

Nutrition Investigations

The study of the nutritional needs of the rapidly growing rats of our colony has been continued with especial emphasis upon the composition of the inorganic salt mixture furnished to them. The new salt mixture has been tested in comparison with the Osborne-Mendel mixture as a constituent of various types of diets, such as low and high protein diets and low and high fat diets. In all cases a satisfactory calcification of the bones of the experimental animals has been secured when the new mixture was administered at the rate of 2 or 2.5 percent of the diet. In order to obtain a similar degree of calcification for the same rate of growth, it is necessary to furnish 4 percent of the Osborne-Mendel mixture.

Investigation of the effects of repeated pregnancies and lactations on the bone ash of mother rats indicates that there is, in fact, a drain on the ash content of the bones of the mother, but that this drain is not excessive under the breeding conditions usually employed in our colony.

One of the classic experiments of Osborne and Mendel has been repeated with diets of a modern type. Many years ago they were able to show that tryptophane and lysine were essential constituents of the animal diet. The original experiment has been repeated and confirmed in all particulars and the essential nature of these two amino acids is also clearly manifest when a modern type diet with proper vitamin supplements is employed. The rate of growth of the experimental animals is, however,

somewhat less than that characteristic of our colony today and the suggestion is clear that there is some as yet undetected deficiency in these diets.

Experiments upon the effects of injections of extracts of the thymus gland have been continued with the collaboration of Dr. L. G. Rowntree of the Philadelphia Institute for Medical Research. The marked precocity in development of the third generation of such animals, that he has observed in his own laboratory, has not yet been duplicated in ours, but the importance of this problem is so great that the work is being continued in the hope of ultimately arriving at an explanation of the phenomena.

BOTANY

THE BOTANICAL DEPARTMENT was established in 1888 when Dr. Roland Thaxter was appointed Station mycologist. Plant diseases have always been a serious problem of farmers. Accordingly studies of the diseases, of the causal bacteria or fungi, and of any possible means of control have been the particular sphere of this department. The first spraying experiments in the United States were conducted by the Station and the original apparatus has been preserved and may be seen in the herbarium. Annually the department makes a survey of plant diseases, studies new and old troubles, and builds up the library and herbarium that are of first importance in Connecticut.

Virulence of Chestnut Blight Tested

Chestnut seedlings have been set out in different parts of the State in the past five years and in 1936 these plantations suffered somewhat from late frosts and dry weather. This was especially noticeable at Rainbow Forest where a number of seedlings developed more than one main stem because of the unfavorable conditions. However, as yet only occasional seedlings have died as a direct result of the blight caused by *Endothia parasitica*. More than the usual number of forest sprouts and seedlings bearing fruit was reported during the autumn.

The chestnut of Lebanon, last survivor of the old native trees, is expected to die very soon. The blight has attacked new limbs and there were fewer leaves than there were last year.

Cultures of the blight, kept alive in the laboratory for the past 23 to 26 years, are used in experiments to test the comparative virulence of old and new cultures. The object is to determine whether the blight may become less virulent in nature and allow our native chestnuts gradually to come back. We know that the number of spores must be fewer because there are fewer sprouts and seedlings open to infection. On the other hand, we have no definite proof that the outdoor blight has declined in virulence.

Again in 1936 the old cultures failed to infect inoculated seedlings of *Castanea dentata*, but a recent culture took fairly well. Experiments were more extensive than previously because of the coöperation of Dr. A. H. Graves of the Brooklyn Botanic Garden in New York. In late July we inoculated larger trees on his place at Mount Carmel with five old cultures of *Endothia parasitica* originally obtained from native chestnuts and oaks.

Doctor Graves also inoculated a limb of each tree with a new culture, taken in July from a native chestnut. Five trees each of *Castanea dentata*, *C. crenata*, *C. crenata* by *dentata*, *C. mollissima*, and three each of *C. sativa*, were treated. The old cultures failed to grow except in one or two questionable cases, but inoculations with the new vigorous strain took in all trees except those noted below: It failed with *C. mollissima*, which is supposed to be immune, with one questionable exception so far. On *C. crenata*, more or less immune, the inoculation took with one or two possible failures. Observations will be continued.

Diseases of Vegetables

Further Studies on Late Blight of Potato and Tomato

Recent investigations of the late blight of potato and tomato have been chiefly concerned with how the trouble passes over the winter, other than in the infected tubers of potatoes. We want especially to learn whether the tomato is one of its carriers. Detailed study of five possible means have brought no conclusive results.

The Station Botanist was the first to find oospores, the mature or winter stage of this fungus, in cultures made from the potato. So far no one has found them in nature although we have searched diligently for their presence under a great variety of conditions and in all seasons. We also failed to get any sign of oospore production in cultures made from tomatoes or with the few crosses of *Phytophthora infestans* obtained from different sources.

Again we have had no success in infecting healthy tomato plants directly from the mycelium or spores found in the tissues of old, diseased tomatoes.

During 1936 a particular search was made for other possible hosts of this disease which might be responsible for carrying it over. However, even attempted outdoor infection by placing diseased potato vines in contact with some of the plants studied failed to bring results.

Investigations of other species of Phytophthora found in this State led to a search for *P. Thalictri* on *Thalictrum polygamum*. This is a downy mildew most nearly resembling the late blight on potatoes and tomatoes and mature oospores have been found on the leaves of its host. Scanty amounts were discovered in two places in 1935 at the very end of the season. In 1936 one case was found at Milford in September, after the blight had been seen on potatoes elsewhere and after all the potatoes at Milford were dead. Since attempts to infect tomatoes with this fungus and to infect *Thalictrum polygamum* with fungus from the tomato have so far failed, it does not appear that downy mildew on Thalictrum is a possible source of infection.

After extensive experiments in the laboratory and out of doors, the evidence is also against any infection coming from the soil of previously infected crops. This leaves only infected potato tubers planted in the field as a source of the disease in current crops of tomatoes and potatoes. If that is true, the trouble should appear in tomato fields after it has started in potato fields, which has been the case in past observations.

The first infections of potatoes in the State have occurred occasionally as early as the first week of July. From then on infection may occur at any time until the middle of September, depending on weather conditions. On the other hand, the blight affects tomatoes in late summer or early fall, usually in September. It has never been found here before the middle of August. The early crop of tomatoes escapes and the blight becomes destructive later only in favorable years.

As a result of the above observations we have been trying for two years to determine the earliest appearance of the potato and tomato blight, and to learn whether it spread from potato to near-by tomato fields before appearing in the more isolated ones. In 1935, we found the blight in only two tomato fields and one of these was near an infected potato field. Although both seasons were unfavorable to the growth of the fungus, a few cases were observed.

Our investigations of these led to the conclusion that the late blight of tomatoes depends largely on the infection of potatoes. When it is general in the potatoes or appears early, it is likely to be more widespread and serious on the late tomatoes, depending on moisture, wind, and possibly insects, as carriers. We found the spores on the bodies of leafhoppers. Our few attempts, however, do not prove that these insects could aid in spreading the disease to other plants. Leafhoppers were the only insects generally present when the late blight showed on the potatoes this year.

Bordeaux Mixture on Potatoes

Again this season potatoes sprayed with Bordeaux mixture produced more than untreated plants. Yields were low in all cases because of the drought which caused premature death. However, the sprayed plots gave 205 bushels per acre as compared with an average of 152 for the unsprayed. Plots first sprayed on June 11 outyielded those treated on July 2 by 23 bushels. Tops of plants died early so that no late application could be made and there was no marked difference in results from the use of 4-4-50, 6-6-50 and 8-8-50 strengths of Bordeaux. Copper phosphate, basic copper sulfate and copper oxychloride sprays gave definite increases in yield over unsprayed plots but not so large as those obtained with Bordeaux.

The blight-resistant potato (No. 44-488 USDA) was found to surpass the Green Mountain variety in both yield and in ability to withstand drought. On sprayed plots this new strain produced a maximum of 322 bushels as compared with 229 bushels of Green Mountain under similar conditions. On unsprayed plots the ratio was 213 to 170.

Slip-Seeding of Sweet Potatoes to Avoid Disease

An increasing number of farmers are interested in raising sweet potatoes to sell on the expanding local market. Three problems arise in the culture of this vegetable. Sweet potatoes are subject to disease; the fertilizer needs differ somewhat from those of other Connecticut crops; and special arrangements must be made for storage.

This department is working on experiments in disease control at the farm at Mount Carmel. The Soils Department is studying the soil and fer-

tilizer problem at the Tobacco Substation at Windsor. And a former vegetable shed at Windsor has been converted into an electrically-heated storehouse for experiments in keeping sweet potatoes.

Some of the most serious diseases of sweet potatoes are carried in the roots. Slip-seeding of vines is one method devised to produce healthy seed for another year. For the second time in 1936 this method has been used successfully at Mount Carmel. Healthy sweet potatoes were bought on the market and buried in moist sand in the greenhouse. Sprouts from these were set in the field on May 27 and eight weeks later had sent out vines two or three feet long. On July 21, twelve to fifteen-inch slips were cut from healthy vines and planted in adjoining soil. The slips were dug on October 15 and on each were found from three to eight small sweet potatoes that were large enough to be stored for next year's seed. Although the sweet potatoes in the parent plot at time of digging showed infection from stem-rot, black-rot and scurf, those produced on the slips were free from diseases.

Further Experiments in Sand Culture of Seedlings

Greenhouse experiments in controlling damping off by using sand in place of soil to grow seedlings were described in Station Bulletin 380 as well as in this report in 1936. Further work has been chiefly concerned with the mineral nutrition of seedlings in sand, with the purpose of finding the most simple nutrient salts and means of fertilization. Much attention has been paid to the nutrient salts that will best control growth in sand. Ammonium sulfate used alone has been found very useful in preventing etiolation of young plants.

Except in a few cases, it is apparently unnecessary to treat seed in preparation for planting in sand. However, the hot water treatment for cabbage seed has been found desirable when cultures are to be kept for a long time, or if ammonium salts are used to produce short-stemmed seedlings. Mixtures of sand and peat moss have been found useful in conserving moisture in the sand and in preventing nutrients from washing out after many waterings.

Muskmelons Stimulated by Sprays

Although the season of 1936 was too dry for downy mildew, plots of muskmelon were sprayed and some interesting results obtained. Unsprayed plots containing three different varieties produced 23 melons of salable size as compared with copper oxychloride spray, 31; basic copper sulfate spray, 30; and red copper oxide spray, 28. One plot of the same number of hills sprayed only once late in the season with Bordeaux mixture produced 25 melons and others with this same spray used throughout the summer showed evidence of spray injury in both stunted foliage and decreased yields. Such plots produced only 16 good melons.

Yellows Resistant Cabbage

The Fusarium Yellows disease of cabbage, which has destroyed large crops elsewhere in the country in past years, was found in Connecticut in the hot summers of 1935 and 1936. To meet the emergency in other states, breeders developed cabbages that resist yellows. A number of these strains were tried out for Connecticut conditions in 1936 at the farm at Mount Carmel. The following resistant varieties were grown in comparison with standard varieties of this State. Marion Market, Jersey Queen, Wisconsin All Seasons, Wisconsin Hollander, Improved Allhead Select, and Disease Resistant Early Jersey Wakefield. Although some of the above produced slightly smaller heads, they were firm and the yields were comparable with those commonly grown here.

Fruit Diseases

The "X" Disease of Peach

Continued studies strengthen our belief that the "X" disease of peach orchards is caused by a virus probably carried to peach from diseased choke cherry growing nearby. Several lines of investigation were followed in the past year. In 1935 scions of diseased choke cherries had been budded on healthy trees of each kind. Much of the stock was winter killed but of the remainder there was a high percentage of infection of peach on peach, a small amount of cherry on cherry, one positive and several doubtful cases of cherry on peach, and doubtful results from peach on cherry. Again in 1936, 200 peach stocks were budded with both healthy and diseased cherry and peach buds, accompanied by appropriate arrangement of check stocks, and these will supply further data in 1937.

Our many observations in the field showed that without exception diseased peaches were associated with diseased choke cherries, but that the disease could appear on choke cherry independently of the presence of peach. Sometimes it occurred on bushes miles from any peach orchard.

Just how it is carried to the peach is still unknown. A limited amount of research has been done with insects. This season entomologists at the Station coöperated in making studies of insects found on peach and choke cherry. In a few cases certain ones taken on a diseased tree were caged on healthy trees to see whether the disease would appear. Although there have been no results so far, the trees will be carefully watched next spring.

Among the methods used for controlling X disease, various chemical treatments of both soil and trees were employed. Of these, zinc sulfate had been used experimentally on virus diseases of other plants, but the rest were chosen at random. None of the results indicated that a specific for the peach disease had been found.

Another method followed again this year was the removal of diseased parts of peach trees and the destruction of choke cherries growing nearby. Orchards so treated in 1934 were improved. After two such clean-ups at midsummer in 1936, a fair percentage of trees in a newly infected orchard showed no further symptoms of disease.

Assuming that choke cherries are the source of infection, it is important to make their removal permanent. In cutting down the bushes, sprouts are bound to grow and these may carry infection. Therefore experimental attempts were made to kill the bushes with chemicals. A spray of one-half pound of sodium chlorate, *Atlacide*, to one gallon of water, sprayed on the foliage, gave a complete kill of the parts of the bushes above ground

and for a considerable distance on the roots. Again final conclusions cannot be drawn until 1937. Arsenic trioxide, also tried, made no impression when used at a strength that was economical.

In our experiments, all discernible choke cherry was killed around four orchards. In three of these the X disease was already present in considerable quantity and was cut out. The fourth orchard was set in the spring of 1936 and, at the time of killing the choke cherry, had developed only one case of X disease which was removed immediately upon discovery. Results on this protective work will not be available until later, as undoubtedly there are infected trees in these orchards which have not yet showed external symptoms.

In the heavily infected Southington area, there is still one orchard quite healthy at three years of age. No diseased choke cherries are adjacent. This bolsters our hope that the removal of the cherries will protect peaches from the X disease.

Botrytis Rot on Strawberries

Instead of spraying for control of botrytis rot of strawberries this year, three methods of rubbish removal were tried: (1) All trash was cleaned from the rows and no mulch added. (2) Rubbish was removed and a mulch of shavings placed in the rows. (3) Mulch was added without any preliminary clean-up. Other adjacent rows of strawberries were left untreated for purposes of comparison. When counts of rotted berries were made, it was found that the best control was in the mulch-plus-trash rows; second, on the mulch without trash; and third, on the cleaned and unmulched rows. These methods, accompanied by sprays, will be tried next season.

Spraying Apples With Fungicides

As has been the custom for many years past, fruit spraying experiments were conducted in coöperation with the Entomological Department. It has been found that sulfur has a toxic effect on the parasites of some insect pests, notably the red mite, and that it must therefore be omitted from sprays on many varieties of apples. With this in mind, the continued success of the arsenate of lead-lime and fish mixture as a fungicide now assumes new importance and value.

Two types of wettable sulfur controlled apple scab on McIntosh as effectively as dry lime-sulfur. This is further demonstration that the form of fungicide used is not so important as the timeliness and thoroughness of the application. A catalytic sulfur was used in combination with dry lime-sulfur to determine whether it is effective in preventing foliage injury or causes loss of the fungicidal value of the lime-sulfur. The data show no effects from the use of this material.

Seed Testing

The testing of seeds for purity and germination has reached capacity output with the present staff and equipment. About the usual number of samples, 171, were submitted for germination by citizens of the State. Official samples collected by the Commissioner of Agriculture numbered 204 and these were analyzed in compliance with the pure seed law. In addition, the Commissioner collected 500 packets of flower and vegetable seeds from 23 dealers throughout the State. These were used for a study of the germination quality of packet seeds and they were rated according to the average germination percentage of the seeds. Although the classification was arbitrary, it was felt that the study gave a picture of general conditions and confirmed the opinion that bargain seeds are usually the most expensive. Results of these studies are published in Bulletin 44 of the State Department of Agriculture, Hartford.

Plant Disease Survey

During the year notes have been made on 142 different diseases or unusual troubles of plants, most of them caused by fungi. Each was found on one or several different hosts. They can be classified as those caused by fungi or bacteria, those of a physiological nature, and those caused by nematodes.

The fungi and bacteria new to the State are as follows: *Bacterium tonellianum* on *Nerium oleander; Coniothyrium concentricum* on *Yucca* sp.; *Fusarium batatatis* on *Ipomoae batatas; Puccinia andropogonis* var. *pentstemonis* on *Pentstemon unilateralis* x *Torreyi* and *P. acuminatus; Septoria* sp. on *Aquilegia alpina.* Previously reported fungi were found on nine new hosts.

The new physiological troubles found were: Deterred blossoming on *Antirrhinum majus;* fasciation of *Clarkia elegans, Chrysanthemum* sp. and *Taraxacum officinalis;* petalinus leaf of tulip species; graft failure on rose species.

A large grower attempted unsuccessfully to secure grafts on Oregon-grown Manetti stock with his line of hybrid roses, although he succeeded with similar foreign and other western-grown stock made at the same time. The failure was not due to poor or diseased stocks or scions but to lack of a sufficient rest period for the Oregon stock. Later attempts were successful.

The nematode troubles were limited to new hosts: *Heterodera radicicola* on *Pelargonium* sp., *Anemone* sp. and *Coleus Blumei* var.; *Aphelenchus Fragariae* on *Chrysanthemum* sp. (Granny Scoville and one unnamed new variety).

The nematode on chrysanthemum is now a serious trouble on certain outdoor varieties. We experimented at Bristol where it has become increasingly severe but previously had been limited largely to the Cavalier and Mercury varieties. Investigations showed that the trouble is carried over in the greenhouse stock as well as in the soil outdoors. Treatment with Bordeaux and nicotine sulfate both indoors and out showed good results. The firm also used these sprays on large beds containing several varieties this year and reported much improvement over the unsprayed beds of 1935.

THE DUTCH ELM DISEASE

THE DUTCH ELM DISEASE continues to be a problem of vital importance to citizens of Connecticut. Scouts discovered 102 new cases in 1936 and these trees were promptly taken down and destroyed. The trouble has been spreading slowly since its discovery in the State in 1933, and at present the control area extends along the shore from the New York line to Waterford.

The work falls into two sections, investigation and control. Research on the insect carriers of the fungus is the problem of the Entomology Department; investigations of the fungus itself and of the facts related to the disease here and elsewhere, of the Botanical Department; and the Forestry Department coöperates with the Federal Government in the scouting and other measures looking toward control.

The Federal Department of Agriculture used relief labor supplied by WPA and CCC for control work in 1936. All but three of the 102 trees found diseased grew in Fairfield County. Late in September specimens from areas outside the zones of infection were examined in the federal laboratory at Moorestown, New Jersey, and were confirmed as cases of Dutch elm disease. One of these came from Branford and the other two from Guilford.

When infection is found in a new area, a control zone is set up for 10 miles around the diseased tree. Previously six cases had been discovered at Old Lyme, more than 50 miles from the other Connecticut area of infection in Fairfield County. With the discoveries at Branford and Guilford, the zone extended to all towns along the shore from Greenwich to Waterford. This does not mean that there are diseased elms in all of the towns included in this section of the State. It is simply a precautionary measure in an effort to keep the disease from spreading.

All scouting for Dutch elm disease was done by federal men in 1936. State funds were used in measures of coöperation with the Federal Government in its program of sanitation. The program included the removal of dead and dying elms from the control area and supervision of a statewide sanitation project in coöperation with WPA. The work provided jobs for 355 men in 66 towns and was confined to publicly owned elms. The number of trees removed before November 1, 1936, was 3,568, and 42,145 were pruned.

The disease has not spread so rapidly in Connecticut as was feared in 1934. Sanitation has undoubtedly helped to reduce the beetle population and the beetles appear to be incapable of long flights. Except for a small portion of Fairfield County, Connecticut is still outside the badly infected area.

The isolated infection at Old Lyme appears to be under control, and if the Branford-Guilford infection proves to be another such outbreak, it can probably be controlled in the same way. The situation is encouraging rather than otherwise, but intensive scouting throughout the control area must be consistently carried on during the season of 1937.

Disease and Insect Investigations

The Station Botanist and Pathologist have been interested in Dutch elm disease since it was reported from Europe in 1918. Dr. Christine Buisman, one of the outstanding research workers on the disease in the Netherlands, visited the Station in 1930. A culture of the fungus was sent from Holland and studied in the laboratory here. Foreign literature and reports were thoroughly searched.

In 1934 the Station Botanist sent a questionnaire to 30 European investigators. More than 20 replies were received from 11 countries and these are reproduced in the addenda of Bulletin 389, the Dutch Elm Disease, written during the year. The bulletin contains a record of the research work done in Connecticut to date. It also reviews the situation in foreign countries. A section is devoted to the description of the disease in the field, and another to the work with the fungus in the laboratory here.

The authors point out that the number of cases of Dutch elm disease found in Connecticut has increased each year: 1933, 1; 1934, 56; 1935, 76 and 1936, 102. They believe that although these are few in contrast with the infections in New York and New Jersey, the facts suggest the possibility of control rather than eradication. Study of the fungus will be continued in the laboratory in 1937.

The fact that the fungus causing the Dutch elm disease is carried by the elm bark beetle brings the Entomology Department into the picture. About two years ago investigations at this Station showed that the native, as well as the European, bark beetle is responsible for the spread of the disease. An entomologist has been assigned to study the habits and life history of this native species. The first publication on the subject was the Morphology of the Elm Bark Beetle, Bulletin 387 of the Station.

Continued study has yielded information on hibernation, habits of the larvae during the feeding seasons, number and duration of instars and of the pupal stage. A considerable amount of data have been accumulated on predatism and parasitism, and on the relation of moisture conditions to breeding habits and survival of the beetles. Further material will be published as the research progresses.

ENTOMOLOGY

THE ENTOMOLOGY DEPARTMENT was formally established in 1901 when the General Assembly created the office of State Entomologist. Actually a member of the Station staff had been in charge of research on insect problems for a number of years, but there was no official title or department. Alarm of fruit growers over the San José scale was the immediate reason for the appointment. According to Statute, the entomologist was to carry on investigations, to suppress all insect pests and to make inspections of nurseries, orchards and greenhouses of the State. Thus research, control and service were included in the duties of the State Entomologist. From time to time other responsibilities have been added to the office.

Additions to the Insect Collection

During the past 40 years the Station has made a collection of more than 100,000 insect specimens which are mounted in cases in the entomological library. This collection contains Connecticut species second to none in the United States. In 1936 there were about 7,000 additions made up of donations, insects taken after the flood and others gathered on field trips or reared from larvae. Professor Charles P. Alexander gave more than 50 species of two-winged flies, of the family *Tipulidae*, captured in Connecticut. Another donor was Harry L. Johnson who presented the Station with about 500 specimens.

There is also a group of more than 10,000 spiders, largely collected by Dr. and Mrs. B. J. Kaston, which are to be used in a study for the Geological and Natural History Survey.

Among the insects is one new to our collection: *Zonosemata electa* Say. commonly called the pepper maggot. Larvae infest pepper and egg-plant and have made considerable trouble in New Jersey.

Termite Investigation and Control

The Eastern subterranean termite has attracted wide interest in Connecticut in the past few years. The number of buildings reported infested has increased enormously. In 1936 members of the staff examined more than 500. By special request the staff made a survey of state institutions early in the year and of the 462 permanent structures, 102 were infested. In each case specific suggestions for control were made.

During the spring the Station published Bulletin 382, *Termite Control in Connecticut Buildings*, based on observations and research in this State and the experience of experts elsewhere. This illustrated bulletin describes the termites, their habits, the manner in which they injure buildings and the means of keeping them out. After discussing the possible controls and the opinions of men who have been engaged in termite work for many years, the authors state that the weight of evidence is in favor of termite-proof construction. A reinspection of buildings in Connecticut that had previously been treated with chemicals or protected by structural changes bears out this conclusion. In general, it was found that the chemical treatments, all of which were made under the supervision of staff members, did not furnish permanent protection except in one instance where results have been satisfactory so far. On the other hand, in all cases structural changes apparently have been successful.

Distribution of the termite bulletin made it possible to reduce the number of examinations of buildings for individual owners. Requests for examinations numbered 165, and in 116 cases buildings were found infested. Thirteen showed no signs of termites; 18 were infested by powder-post beetles; six were damaged by carpenter ants; two by wood-boring beetles and two by wood-dwelling wasps. The eight remaining cases were of insects not associated with destruction of wood.

Control of the European Corn Borer

The European corn borer continues to be a destructive pest of an important crop. In 1936 the annual clean-up of gardens, with inspection of fields after April 25, was carried out under supervision of this department; control experiments with sprays, parasites and dates of planting were continued during the growing season; and in September a survey of potato fields in Hartford and Tolland counties was made to determine the amount of infestation in potatoes.

THE ANNUAL CLEAN UP

Last year the General Assembly amended the corn borer compulsory clean-up law fixing April 25 instead of April 10 as the final date when all cornstalks, weeds, or other stalks or debris subject to infestation by the borer shall be safely disposed of. Eight inspectors began work on April 27 going to those regions where the pest has caused the greatest amount of trouble. These men worked for about a month, or longer, to cover the territory assigned to them. Altogether 68 towns were inspected and delinquents reported to the prosecuting authorities. The total cost of this clean-up enforcement was about $1,817.

DATE OF PLANTING EXPERIMENTS

Early, mid-season and late varieties of corn were planted at 10-day intervals from April 20 to July 10 to ascertain the relationship between planting dates and infestation by the European corn borer. As was the case in 1935, ears maturing in July and in September were more heavily infested than those ripening in August. The season in 1936 was advanced so that the infestation was slightly earlier. The first generation, most abundant in ears harvested between July 11 and 21, was more serious in sweet corn than the second generation which occurs in greatest numbers between August 25 and September 15.

INSECTICIDES USED AT MOUNT CARMEL

The insecticides developed by the United States Department of Agriculture were thoroughly tested again on both first and second generation borers. In general, these materials were highly satisfactory although some slight modifications in the formulas listed in Station Circular 114 seem advisable. The circular will be revised accordingly and complete results of all of the tests will be published later.

From time to time parasites of the European corn borer have been released in Connecticut by the United States Department of Agriculture. In 1935 and 1936 the Station made field liberations of Trichogramma spp. but the results were negative. Colonies of 16,000 to 168,000 per acre were placed in 23 fields near Milford. Extensive counts of corn borer eggs were made, as well as examination of stalks at the end of the season. Although a slight increase in parasitism was noted with the larger liberations, there was no significant difference in the number of borers. Since this parasite does not appear promising, attention will be turned to tests of other species.

CORN BORERS IN POTATOES

As a result of complaints from farmers, in September members of the staff made a survey covering 275 acres of potato land in Hartford and Tolland counties. They found that 60 percent of the fields examined were infested by the European corn borer and that losses ran up to as much as 25 percent of the crop. During the season there were reports that dahlias and certain other fleshy-stemmed plants were infested.

Studies of the Corn Ear Worm

In coöperation with the United State Department of Agriculture studies on the corn ear worm were continued. The first generation appeared late in July, was scarce and caused little damage. The second generation infested 18 percent of the ears maturing during the second week in September. At the same time unsprayed corn showed a 30 percent ear infestation of the European corn borer, and only 58 percent of the ears were free of one or the other of these pests.

Carpenter Ants in Telephone Poles

For several years carpenter ants in telephone poles have been the subject of coöperative research between members of this department and the Southern New England Telephone Company. It has been found that the injection of an amount of a modified creosote mixture in the top of the ant gallery will kill the colony. A collaborative report is to be published on this subject in the near future.

Insecticides Used in Apple Orchards

Yearly experiments with spray materials for insect and disease control are carried on in the orchard at the Station farm at Mount Carmel in cooperation with the Botanical Department. The object is to find the best sprays and spray schedules for Connecticut orchards, and the work is done on a large enough scale to make results commercially practical.

In 1936, 168 trees were used, 96 of which were 25 years old and the rest younger. Thirteen varieties of apples were represented. Findings led to the conclusion that in most Connecticut orchards lead-arsenate-lime sprays with a sticker control insect and fungus diseases in a normal year. On varieties especially susceptible to scab, further treatment is needed, however.

Three plots containing many varieties were sprayed with lead-arsenate and lime, with a different sticker in each plot. The spray formula was: Arsenate 3 pounds, hydrated lime 10, and water 100 gallons, with one quart of fish oil on one plot, 4 ounces of Casco glue on another, and one pint of colloidal fish oil to 100 gallons of spray on the third.

All plots yielded a high percentage of good apples. There was little insect injury and practically no scab or sooty blotch. Furthermore there was no injury by the European red mite, a pest that is of growing importance in Connecticut orchards. Apparently the enemies of the red mite are killed when sulfur is included in the sprays.

Tar oils were again used for control of rosy aphis eggs and showed considerable promise. However, in commercial orchards where tar lubricating oil was applied, the outbreaks of the European red mite were unusually severe. Efforts to supplant the usual summer oil with a much cheaper product showed favorable results.

There was also considerable work with the European red mite using various oils and fortifying them with different materials.

White Apple Leafhopper Studied

White apple leafhopper, when abundant, can do considerable damage in Connecticut orchards by sucking sap from the foliage and spotting fruit. A study of infestations at Lebanon showed an initial population of the first generation of less than 50 per 100 leaves. However, the number increased enough in late August to be a menace, and sprays were used.

Derris sprays applied early in the season kept down the numbers in September but the treatment was not considered entirely satisfactory. More promising was the attempt to control European red mite and white apple leafhopper with one spray, consisting of white oil emulsion and nicotine sulfate. This material was applied just before the middle of August. Experiments with similar sprays will be continued in 1937.

Substitutes for Lead Arsenate in Orchard Sprays

Combinations this year consisted of cryolite, sulfur and derris, cryolite and sulfur, an improved calcium arsenate with lime and sulfur, lime-glue without poison and phenothiazine with flour sticker. All substitutes with the exception of the cryolite-derris combination were used as late sprays for maggot control and were preceded by the usual lead arsenate applications. The results indicate that the best apple maggot controls were obtained in the cryolite-derris plot and phenothiazine sprayed trees. Continued work with the phenothiazine and the cryolite-derris combination appear to be desirable.

Work on the Oriental Fruit Moth

The research program for control of the Oriental fruit moth includes experiments with dusts and sprays, and the rearing and liberation of parasites in coöperation with the United States Department of Agriculture.

The population of this injurious pest was smaller than was anticipated in 1936. An attempt was made to reduce the size of the third brood on peaches by using treatments of derris powder but the results were negligible. On quinces we tried a reduced program of three lead arsenate sprays applied at the beginning of June, July and August. Only 32.7 percent of the fruit was clean, a disappointing outcome.

When the Oriental fruit moth appeared in Connecticut a number of years ago, the peach industry suffered serious loss until it discovered that the pest could be controlled by the introduction of parasites. The Pomological Society raised funds to start this work and since then has coöperated with the Station by acting as the intermediary. During 1936, 11,960,000 Trichogramma egg parasites were distributed to growers at a low price. These discs of eggs are placed in the trees at the proper time and the emerging insects carry on the fight against the fruit moth.

Other species are also bred in coöperation with the Federal Bureau of Entomology. The following numbers were released in 1936: *Macrocentrus ancylivorus* 5,213; *Dioctes molestae* 3,825; *Bassus diversus* 16,118; *Perisierola angulata* 12,000. Recoveries were made of *Dioctes molestae* and *Bassus diversus*, but they have not yet increased to a point where they exert much influence on fruit moth populations.

Arrangements have been made with the Federal Bureau to secure breeding stock of the pupal parasite *Phaeogenes haeussleri*, which we hope to breed and liberate during 1937.

Bureau men working in coöperation with the Station liberated 1,184 imported parasites during the summer. Most of the eight species released are new to the Connecticut fruit moth parasite list.

Suppression of the Gypsy Moth

Connecticut is divided into two sections for the control of the Gypsy Moth. The state crew operates east of the Connecticut river and is assisted by WPA and CCC men. The federal forces have been responsible for work in the western portion of the State. No important new infestations were discovered and no defoliation caused by this pest was noticeable in Connecticut. Altogether 115 towns with 393 infestations were scouted. The men creosoted 358,171 egg-clusters, sprayed 51 infestations with 131,510 pounds of lead arsenate, crushed by hand 2,763,251 larvae and pupae, applied 863,134 burlap bands, scouted 4,034 miles of roadside and 781,574 acres of woodland, and cleaned 1,670 acres of woodland.

Control of European Pine Shoot Moth

Control of the European pine shoot moth is a joint enterprise of the forestry and entomology departments. This pest infests red, Scotch and certain other varieties of pine, killing the terminal shoots. The present control is to clip off and burn infested tips.

In the spring of 1936, CCC and WPA labor worked on 7,550 acres of red and Scotch pine plantations and found the insect well under control in most places. In New Haven and Fairfield counties, however, the infestations seemed to have increased slightly. Of the 1,825,000 infested tips removed, 1,750,000 were from these two areas. Later in the year CCC men under direction of a member of the staff and WPA workers under federal supervision made a survey of pine plantations of the State. Control measures in 1937 will depend upon findings.

There are as yet no definite results to report on the research program. Experiments include the use of seven insecticides, and population studies under different forest conditions. Results can only be determined over a period of years.

Elimination of the Mosquito Nuisance

Mosquito projects throughout Connecticut have made tremendous strides in the past few years through the use of relief labor in the various towns where the work was done. Early in 1936, ditching, draining and pest control were transferred from FERA to WPA and on the average 600 men have been employed during the year. As a result, much has been accomplished in the way of permanent improvements such as masonry and concrete manholes complete with tidegates, correcting streams and stoning up sides, draining fresh water swamps in and near urban districts, construction of tidegates on the Branford river, and the engineering of similar work. During the summer there was a marked reduction in numbers of salt water mosquitoes wherever work had been completed

but there were more fresh water mosquitoes than usual. Many complaints came to the Station, and in most cases investigations were made and advice given on the elimination of the nuisance.

Station employees maintained ditches on the 11,500 acres of state-accepted salt marsh areas. The maintenance of the 9,000 acres ditched since 1933, and all of the fresh water maintenance were left to local authorities, as the present appropriation does not provide for upkeep.

Orchards, Nurseries and Apiaries

Inspection of orchards, nurseries and apiaries is a part of the work of the department. Besides the usual number of orchards examined in the course of experiments, 13 calls were made at the request of owners. All registered nurseries were visited during the season and there was an increase of nine, 380 qualifying in 1936 in comparison with 373 in 1935.

The two inspectors examined 1,438 apiaries, containing 9,278 colonies. Of this number, 89 apiaries and 176 colonies were infested with American foulbrood and one colony had European foulbrood.

Asiatic Beetle

No attempt has been made officially to control the Asiatic beetle, *Anomala orientalis* Waterh., but the Station has identified grubs, examined lawns and given information regarding treatment. Lawns properly treated with lead arsenate, 3 pounds to 100 square feet, as described in Circular 113, remain uninjured after several years. This pest has now spread into many sections of New Haven and West Haven, and is also present in Bridgeport, Greenwich, Hamden and Norwalk. During the past year 41 infested lawns were examined.

Control of the Japanese Beetle

Six new towns have been added to the list of those infested by Japanese beetles. During 1936, the Station, in coöperation with the United States Department of Agriculture, set out 300 traps in places where no beetles had previously been found. In Canaan one beetle was trapped; in Litchfield, eight; in New Milford, two; in Newtown, two; Southbury, one, and Winsted, two.

At present the beetles are most abundant in the cities of Bridgeport, Hartford and New Haven where considerable damage to roses, dahlias, grapevines and Virginia creeper has resulted. In Hartford, the beetles were so numerous in Riverside Park that some of the trees were about 40 percent defoliated. Consequently the City Park Department treated the entire exposed lawn area with lead arsenate, together with the lower portion of Bushnell Park, and the vicinity of the rose garden in Elizabeth Park, using 30 tons of lead arsenate. The insect is not yet destructive in the country districts.

Nurseries and greenhouse establishments are inspected and classified as regards Japanese beetle infestations. During the past year inspections have been made and 48,407 certificates for shipments of nursery and floral stock and farm products, and 316 certificates for shipments of soil, sand and manure, have been issued.

FORESTRY

FROM TIME TO TIME the Station has acquired land in different parts of the State to be used for experimental work in forestry. Near Windsor is Rainbow Forest, a 110-acre tract, (see frontispiece), where the first experimental plots were laid out in 1902. A second forest is located at Mundy Hollow, near Poquonock, the present site of CCC Camp Britton, and still another small holding was once part of the communistic Shaker Farm at Enfield. Ours was one of the first Experiment Stations to establish research in forestry. Some of the experimental plantations at Rainbow are the oldest of their kind in the country.

The Forestry Department also maintains nursery plots at the Tobacco Substation at Windsor from which thousands of young conifers are distributed to land owners each season.

The projects of the department include research, control and service. Several of these have been substantially advanced during the past four years through the availability of relief labor. The constant supervision required placed a heavy burden on staff members but, in spite of inexperienced labor, short hours and other handicaps, good progress was made.

Progress at Rainbow and Mundy Hollow

One CCC crew from Camp Britton was available for forestry work during most of the year. On the Mundy Hollow tract, fire lines were cleared along the boundaries and across the area. Some of these were developed as truck trails, thus making all parts of the tract more accessible for purposes of work and fire protection. Several water holes were also built for use in case of fire.

Experimental plots were laid out in the hardwood growth on which cuttings of various kinds were made, followed by planting of conifers in some cases. Mundy Hollow is now in condition to furnish valuable information in the future regarding growth of hardwoods and management of woodlots on sandy valley soils.

At Rainbow, long planned thinning and pruning operations were carried out; fire lines cleared out and extended; a small dam built which will provide a water supply in case of fire; and the entire tract put in condition to secure the best results from the established experiments.

Most of the wood cut during these operations at both Mundy Hollow and Rainbow was used for fuel by the camp, but some provided bridge timbers for truck trails, and posts for treating experiments described later. During the summer, a former CCC foreman and forester was employed to survey the Rainbow experiments in preparation for a forthcoming progress report.

Forest Planting Stock Distributed

During 1936, 235,000 trees, mostly pine and spruce, were distributed to Connecticut landowners. This represented a large increase over the 1935 demand. Sales were restricted to lots of 2,000 or less in most cases, in order that no one should be disappointed. Less than 10 percent of the trees were sold to farmers, but it is probable that this percentage will be increased by the new Soil Conservation Program.

White Pine Blister Rust Control

Through the use of relief labor, blister rust, a disease threatening the valuable white pine stands of the State, has been kept under control. The work is thoroughly organized and is carried out as five distinct projects.

The nature of the disease is such that its spread depends upon the growth of Ribes (gooseberries or currants) within 900 feet of white pine. The first step in control is to know where white pines grow and how many of these are diseased. Next, Ribes growing within infecting distance must be found and finally must be eradicated.

In the past year all of the land area in five towns was examined and the white pine areas located and mapped. Approximately 30,000 acres were mapped in detail by WPA workers. State WPA labor also made a study of pine infection in 49 townships in southern and eastern Connecticut. More than 2,000 infected trees, carrying 4,500 cankers, were found on the 10,150 acres covered. Examination disclosed that the greatest amount of infection originated in 1925 and 1926. The disease has built up slowly in southern Connecticut due to the scarcity of wild Ribes and possibly to unfavorable weather conditions.

Wild and cultivated Ribes to the number of 629,000 plants were destroyed in a control area comprising 27 townships, through the coöperation of the Federal and State WPA, CCC and Resettlement Administration. The men covered nearly 79,000 acres of territory and gave protection to 9,915 acres of white pine.

As a result of interviews with 430 landowners, the crews found 102 patches of cultivated Ribes. These included 114 European black currants, the most dangerous variety in the spread of rust. Since the black currants are outlawed in Connecticut, all of these bushes were destroyed, together with 54 other cultivated Ribes growing within 900 feet of pine stands.

Forest Planting Stock

For 30 years the planting of conifers has been going forward on both public and private land. Much of this has been stock furnished by the Station at cost. These plantations offer a wealth of scientific information but funds have been lacking to make careful surveys and measurements. This lack is now being supplied by the CCC.

Under a coöperative agreement with State Forester Hawes, a representative of the CCC is working with this department gathering data regarding the growth of red pine in plantations. With CCC labor they have remeasured and thinned 22 plantations and secured the necessary measurements for a volume table which is being prepared for publication.

Treating Wood to be Used as Posts

During the past year, post seasoning has taken precedence over wood preservation experiments. This is because it seemed better to use the

personnel available (CCC) in a specialized study of seasoning, prior to treatment.

Red maple is common in Connecticut. It makes a satisfactory post except that it checks badly in seasoning. In 1936, 1,000 posts of this species have been handled experimentally in an attempt to overcome this difficulty. While the experiment has still considerable time to run, two tentative conclusions may be of interest:

1. Incising the surface of peeled posts of red maple with the grain results in the formation of a large number of fine checks. Posts treated in this way usually do not develop large checks. Whether such treatment can be made economically is as yet undetermined.

2. Red maple posts cut and seasoned for a year with the bark on show very little tendency to develop large checks when peeled. Posts seasoned unpeeled should be piled in open cribs at least a foot above ground to allow a free circulation of air.

Dutch Elm Disease

The Forestry, Entomology and Botany departments are all concerned with investigations and control of the Dutch elm disease in Connecticut. A report of the work is reviewed on page 180.

PLANT BREEDING

THE TASK of the plant breeder is the development of strains of varieties that yield larger and better crops, that are disease resistant, or that are better suited to our climate, soils and markets than those commonly grown. But this is no longer merely a blind search among the thousands of present types or crosses. The modern geneticist is discovering how desirable characters are inherited, and much of his time is most profitably spent in studying inheritance in the plants he seeks to improve. The practical results, the new and better varieties, depend on this research in pure science.

This department was established in 1910 although work in improving seed corn had been done at the Station previously. Among the achievements for which it is recognized was the application of the principles of inbreeding and crossing to produce better hybrid corn. In 1926 the Station introduced the first crossed sweet corn on the market. Six years later approximately 80,000 acres of hybrid sweet and field corn were grown in the United States. A survey in 1935 shows that more than 2,700,000 pounds of hybrid seed of sweet corn, enough to seed 276,000 acres, were produced. This remarkable advance is due partly to the fact that growers are becoming conscious of the superiority of hybrids and partly to the drop in the price of such seed. Experiments are carried on both in the greenhouse and laboratory at New Haven and on the farms at Mount Carmel and Windsor.

Heredity in Maize

It has long been known that changes in the color and texture of seeds of corn are caused by segregation of some kind during development, a

removal from some of the cells of dominant genes which govern that particular color or quality. Examination of seeds of many different varieties under the microscope revealed a much greater frequency of these changes and a wider diversity than was formerly suspected. In many cases there is such a shift of genes that color disappears from one aleurone cell and is deepened in an adjoining cell. The resulting tissue grown from these two daughter cells produces a paired mosaic or twin spot. In many cases the cells that are altered in color, are also changed in size and arrangement, so that depressions and outgrowths appear on the seed. Study of these mosaics in corn helps in understanding the "bud sports" that occur in vegetatively propagated fruits, flowers and vegetables, and has an important bearing on abnormal growth in both plants and animals.

Potency of Sun Red Tested

Sun-red color has long been known in maize. It was incorporated in Redgreen, the first commercial sweet corn hybrid developed at this Station in 1924. In Wisconsin, Brink found that sun red, described by the formula ABpl, and dilute purple plants (AbPL) gave a higher yield than the normal green which is really dilute sun red, Abpl. This point is being tested at the Station. If confirmed, sun red may well be introduced into popular commercial varieties in Connecticut.

Purdue 39 was crossed with Connecticut 75, which is sun red (AB pl), and the hybrid has been backcrossed four times to Purdue 39, always selecting sun-red plants for breeding. The final offspring will be inbred to obtain plants homozygous for AB pl and Ab pl. These will be crossed with some common green inbred and the resulting green and sun-red hybrids will be planted and compared for yield.

What Causes Sun Red?

Assuming that sun-red plants are more productive, the question arises as to the cause. The answer may lie in finding what particular band of the solar spectrum is responsible for the production of the anthocyanin pigment. With this in mind we covered newly developing ears shoots of sun-red corn with opaque paper bags, thus excluding the light responsible for the sun-red color. When the bags were removed on September 15, the foliage was green. Immediately the ears were re-covered, this time with wrappings of different colored cellophane. Each of the colors—red, pink, yellow, amber, dark green, dark blue, light blue, violet and light violet—was used over four ears and colorless Cellophane bagged four as checks. At harvest time, two weeks later, the covers were taken off and results noted. Sun-red coloring had developed in all of the leaves with the exception of those under the red Cellophane. Here the ears remained green, showing that red light alone is incapable of producing the sun-red color.

Tests of the range of light transmission penetrating the various colors of Cellophane showed that the dark red admitted no light below 5,400 Angstrom units. The most effective transmission was between 5,800 and 6,500 units at the red end of the spectrum. Other colors admitted light at a much wider range, including considerable ultra-violet.

Further experiments are going forward to locate more definitely the light responsible for sun red.

Effects of Inbreeding and Crossing

The variations found in lines of corn inbred for many generations have indicated the importance of studying this subject further. The three Leaming lines that have now been self-pollinated for more than 30 generations have been divided into a large number of separate lines to be examined for differences in size, time of maturity and yield. These inbreds are remarkably uniform and therefore slight differences among the several lines may be detected. It is hoped that this study will furnish information concerning the small variations that make up the differences in productivity and other qualities of cultivated plants.

Hybrid Corn in 1936

The results of our survey last year prove that there is a definite trend toward the use of crossed varieties of corn.

The most promising hybrids in 1936 at the Station farm at Mount Carmel were: *First early varieties to ripen*—Marcross 3 (C 13 by Spancross 2), Marcross 6 and Marcross 13.6; *second early varieties to ripen*—Spancross 2, Marcross 39, Seneca Golden, E. Bancross 39, Spancross 39, Gemcross 39; *midseason varieties*—Sencross 39, Suncross 39, Whipcross 6.2, Whipcross 39.2, Whipcross 39, Pearlcross; *late midseason*—Golden Cross Bantam; *late*—Redgreen, Bloomcross 39.

All of the varieties except the last are first generation hybrids between two inbreds or between an inbred and a variety.

Several new Spancross 2 types were found to be promising in 1936. These are all crosses between inbreds out of Spanish Gold and Connecticut 2. They are not yet ready for production.

A New Method of Producing Hybrids

A new method of hybrid sweet corn production is being tried with the Whipple variety and Purdue 39. Whipcross 39 is a good hybrid but shows considerable variation within the cross and more variation between different lots when the variety is crossed by the inbred, producing a topcross. This is because the Whipple variety is quite variable and a good many selections have been developed from it by different seedsmen. Each strain of Whipple has its own characteristics and gives different results when crossed by Purdue 39. Such a situation always exists when any open-pollinated variety is crossed by an inbred to give a topcross. The same conditions hold for different samples of Spancross 2, and to correct this, a new system of breeding is suggested.

New Strawberries in Connecticut

The inbreeding and crossing method has been applied to strawberries apparently with success. Using inbreds of the standard varieties, Howard 17, Glen Mary and Chesapeake, as many combinations as possible were made. The resulting plants numbered nearly 8,000 and were set out at the farm at Mount Carmel to be compared with popular standard varieties. Each year since 1930 selections of the best strains have been made for further propagation. Of those remaining in 1935, 14 different

crosses were outstanding for yield and some for quality. These were as follows: C56, 62, 110, 111, 123, 143, 282, 348, 362, 373, 420, 426, 452, and 454. Some plants were sent out to growers for trial in 1936 and favorable reports of their growth have been received. When other reports come in, the best of the hybrids will be increased, named, and distributed to nurserymen.

Increasing Straightneck Squash Seed

Connecticut Straightneck Squash, a selection following hybridization isolated at the Station in 1926 from a cross between straight and crookneck types, continues to be early, productive, and desirable for market use. Squash is very susceptible to open pollination in the field. Therefore efforts to have this strain increased in commercial quantities have resulted in considerable contamination with other types. If the seed is to be kept pure, stock seed must be increased in isolation at the Station and distributed to seedsmen.

New Experiments in Producing Seed in Beets

The breeding of garden beets has received little attention either here or abroad. One of the reasons for this is that seed does not set readily when isolated under paper bags because of the high temperatures within the bags. In 1936 beet roots were potted and held in a temperature control chamber at 60°F. with continuous illumination for 60 days. This treatment caused them to bolt to seed early so that the plants could be transferred to the field by the first of May in a flowering condition. Inflorescences were bagged from May 15 to 25 and a fair set of seed resulted. Seed was produced by a much smaller proportion of plants which were bagged in June at a time when the outside temperature was high. Attempts to isolate the pigment of beet in crystalline form are under way.

New Pepper Wins Award of Merit in 1936

Windsor-A, a sweet pepper developed at the Station, was officially released as a new variety in 1936. Although this new type is not ideal in shape, it is prolific and early. It has been outcrossed to other types and will be backcrossed to the Windsor parent in order to improve the shape. In the All American Seed Trade National Test of new varieties, Windsor-A was one of three vegetables given an award of merit for 1936.

An interesting point was observed this year in pepper trials. When individual plants were selected from an increase plot of fifth generation inbred line, they out-yielded the bulk seed from the plot by 80 percent for early fruit and by 40 percent for total yield. This indicates that segregation is still taking place in the fifth generation following hybridization.

SOILS

ALTHOUGH THE DROUGHTS, floods and dust storms of the past few years have only recently roused Americans to the importance of conserving our soil resources, Connecticut has been studying its soils scientifically for several decades. The first survey work of the United

States Bureau of Soils began in the Connecticut Valley in 1899. Since that time other sections of the State have been selected for study, but not until 1923 did the Experiment Station set up a separate department of soil science.

The whole State is the laboratory of this department, but more specifically the staff carries on experiments in the greenhouse and in Thaxter Laboratory at New Haven, on the farms at Mount Carmel and Windsor and in the Station and State forests. Research includes a soil survey of the State with a classification of the different soil types, development of a system for testing soils, soil and fertilizer requirements for different crops, including forest and shade trees.

Soil Erosion Survey

During the past few years national attention has been focused upon the serious problem of soil losses caused by water and wind erosion. In general, it has been felt that Connecticut is fortunately situated in this respect, since our climate, soil and type of farming all tend to prevent erosion from becoming active.

Based on knowledge of characteristics of soil types of the State, the Soils Department selected the Enfield very fine sandy loam as the one most likely to present a real erosion problem. This soil occurs chiefly in a belt from three to five miles wide, extending from the vicinity of Glastonbury northward to Somers, and is associated with two other soils that are erosive to a somewhat lesser degree—Manchester fine sandy loam and Cheshire fine sandy loam. The region comprises one of the richest farming sections in the State.

In a considerable portion of this area, there has been a rapid expansion of potato growing in recent years. This is particularly true in the towns of East Windsor, South Windsor, Ellington and Enfield. Potato culture, especially of a late variety, does not readily lend itself to the growth of winter cover crops and there has been a tendency to grow potatoes year after year without rotation, as was previously the custom when the land was used for tobacco.

Preliminary observations were made in the area during the spring of 1936, following the heavy rains that had resulted in the great Connecticut River flood of March 21-30. It was readily apparent that severe soil erosion had occurred in practically every potato field where any degree of slope existed. Rye had been planted in some fields, but the growth made after the October harvest of potatoes was insufficient to prevent gullies from forming, especially where there were bare fields farther up the slope.

In order more fully to evaluate the extent of erosional losses in the above and similar districts, the coöperation of the Soil Conservation Service of the United States Department of Agriculture was obtained. A field party of four soil surveyors spent nearly three months in preparing detailed maps, on an enlarged aeroplane photograph base, of the entire area included in the Scantic River watershed. Areas were classified and outlined with respect to soil type, land use (crop grown), slope, and extent of erosion that had already taken place.

The report and assembled maps based on the above survey will be available during the next few months. A recognition of the importance of soil erosion under conditions of this sort and a fuller understanding of the value of cover crops, crop rotation and gully protection, should lead to the conservation of these most desirable soils against their irreparable destruction.

A Land Type Map of Connecticut

During the past year the work of classifying the land area of the State on the basis of soil, topography and other factors affecting its suitability for agricultural use has been practically completed, and within a few months the map will be ready for publication. Funds have not permitted the examination of details of local soil variation such as exist on individual fields, and the scale of the map, one inch to two miles, does not permit their representation. However, this survey will make possible a fuller understanding of the relationship of soils to land use adjustments in the State. The map will be supplemented by a revised descriptive bulletin of the soils of Connecticut, to supersede Bulletin 320, now out of print.

Nitrogenous Fertilizer and Soil Acidity

In 1934 a lysimeter experiment was begun at Windsor to measure the relationship of nitrogenous fertilizers to soil acidity. Data are now available for two full years and for the six-month period of the third year during which most of the nitrogen in the fertilizer that is converted into nitrates is recovered in the leaching.

Two soils of Merrimac sandy loam were compared. One of these was from a plot in a nearby tobacco field that had not received lime, and was at 4.9 pH when placed in the lysimeter. The other was from a limed plot in the same field that had been brought to 6.3 pH by two applications of dolomitic hydrated lime.

Sulfate of Ammonia was used under three conditions on each soil: With full acid effect; with calcium carbonate sufficient to supply the same amount of calcium used in other nitrogen treatment, approximately equivalent to the sulfate content; with an amount of calcium carbonate equivalent to the full theoretical acidity of the treatment.

The above combinations have resulted in a considerable range of pH, from 4.2 on the fully acidic treatment on the more acid soil, to 6.2 on the acid-neutralized treatment on the less acid soil. This variation has been accompanied by significant differences in recovery of nitrogen in the leachates. There is definite indication of decreased liberation of nitrates below 4.8 pH and above 5.4 pH. On the less acid soil this range is from 495.5 pounds for the fully acidic treatment (soil at 4.9 pH) to 331.4 pounds on the acid-neutralized treatment (soil at 6.0 pH).

Urea has been compared on each soil under two conditions: With full acid effect, and with the theoretical acidity neutralized with calcium carbonate. Here, again, the correction of the acidity of the fertilizer has reduced its availability in terms of nitrates recovered, especially on the less acid soil.

Cottonseed meal, similarly compared, has been increased in availability by correcting for the acidity of the fertilizer in case of the more acid soil. On the less acid soil, lime was used with the fertilizer in amounts sufficient to maintain the pH at its original level. It caused a lower production of nitrates (260.1 pounds) as compared with that resulting from the use of cottonseed meal without lime, where the soil at 5.55 pH permitted the liberation of 338.0 pounds of nitrate nitrogen.

The above experiments indicate that the practice of adding lime to fertilizer mixtures may have significant effects upon the availability of the fertilizer nitrogen after it is added to the soil, depending upon the character of the soil, especially with respect to acidity.

An important question to be determined is: Does the greater biological activity and consequent assimilation of available nitrogen in microbial growth account for the smaller amounts of nitrates resulting from sulfate of ammonia, urea and cottonseed meal at the higher pH levels, approximately 6.0. Or is there an actual loss of nitrogen into the atmosphere, which is greater when the nitrogenous fertilizer is supplemented by lime carbonate designed to prevent acid formation in the soil?

Potato Soils in Connecticut

During 1936 a group of 12 soils, selected from typical fields used for commercial potato production in various parts of the State, have been intensively studied by laboratory analyses and greenhouse tests.

All are moderately to strongly acid, ranging from 4.49 to 5.28 pH. There is considerable variation in organic matter and nitrogen content. However, the average total nitrogen 3,470 pounds per acre, is considerably below the average of the cultivated soils of the State which is 4,842 pounds. In spite of liberal applications of "potato fertilizers", 5-8-7 or a similar analysis at 1,500 to 2,000 pounds per acre, phosphorus was still somewhat deficient on most of the soils. Three of the 12 soils gave less than 40 percent yields of tobacco in greenhouse tests without phosphorus. This is evidence that the major part of the residual phosphorus from the types of fertilizers used for the potato crop is no longer available to succeeding crops on soils of such degrees of acidity.

Potassium has apparently been used in excess of crop needs on most of the soils under study, since greenhouse yields of the very potash-responsive tobacco were generally quite satisfactory on two successive crops grown without potash fertilization. Only four soils produced less than an 80 percent crop in the absence of this element, and the lowest was 47 percent. These results indicate that an unnecessarily liberal amount of potash has been applied on a number of these soils. It is also to be noted that a preliminary soil test identified all four of the more potash-responsive soils as low to very low, while the others gave tests ranging from medium to very high.

Agronomic Significance of Soil Tests

During the past few years numerous methods have been devised for simplified soil tests, designed to give useful information on the chemical status of the soil at a minimum of effort and expense. The scheme of

soil testing developed at this Station, called the Universal Soil Testing System, has been applied to samples from several thousand fields of the State during the three years since its introduction. Our method is also used by at least six other states and similar tests for one or more chemical soil constituents are widely employed as a guide in soil diagnosis in various parts of the country.

Our experience after testing large numbers of soils of known history suggests certain conclusions. It is believed that when the results of the tests are carefully considered in relationship to one another and to the physical character of the soil, it is possible to make a reasonable estimate of the general productivity level of the soil.

If the tests are to be used in connection with fertilizer and lime recommendations, it is necessary first to know the desirable condition for the crop and soil type in question. Then the inter-relationships of the tests on a given soil should be interpreted in terms of the goal. Any effort to predict fertilizer response from a single soil test, considered independently, is likely to be useless and misleading. For this reason the Station advises against the use of chemical soil tests by anyone who is not in a position to conduct and study carefully many hundreds of tests on a wide range of soil and crop conditions. There is grave danger that the indiscriminate use of these so called "quick tests" will tend to confuse the understanding of fundamental principles of soil management that agricultural teachers and writers have labored diligently to build up during the past half century.

Experiments on Forest Soils

Relation of Site Quality of Oak Stands to Soil Properties

Studies on 75 oak stands widely scattered over the State indicate that other conditions being equal, site quality, as measured by tree development, is fairly well correlated with the moisture equivalent, total nitrogen content and total base capacity of the surface soil. In many cases, however, other factors such as presence of high water table, seepage from higher ground, shallow rocky soil, excessively dry gravelly sites, severe shrub competition, etc., are so strong as to mask the effect of the soil itself upon tree growth.

These outside influences make it difficult to evaluate a site from the standpoint of the soil alone. In our studies, indexes ranged from 30 to 83, which means that, at the same age, trees on the poorest site averaged 30 feet in height, while those on the best site averaged 83 feet.

Topographically the flat areas and the foot of long slopes were most favorable for growth. This ties in with the studies on relative wetness (available moisture) during the critical dry periods of summer in which it was found that such sites contained more moisture than did upper slopes or hilltops. A growth of blueberry or huckleberry bushes seemed to be associated with low site index; the same was true for witchhazel and mosses. On the other hand, raspberry, blackberry and dewberry bushes appeared more frequently on the better sites.

Litter Cover Benefits Soil Structure

Measurements of the soil structure of lysimeter soils with and without litter cover show that where a good crumby soil structure exists, removal of the litter is detrimental to that structure. This is significant in erosion and flood control and also in the maintenance of favorable growing conditions for the forest, particularly with respect to reproduction. The presence of a humus cover on a soil that is naturally firm or compact is of less importance from the standpoint of soil structure; but even in this case the cover helps prevent further compaction by rain.

Small Benefit in Fertilizing Seedlings

For several years we have experimented in the field of nursery fertilization as a means of producing larger seedlings and transplants in a given period of time. Results offer small encouragement. Red pine, particularly, is quite unresponsive to treatment in our sandy loam soils. Four-year-old red pine, Norway spruce and arborvitae, and six to twelve-inch sugar maple, when planted in plots receiving fertilizer, have been benefited slightly by all treatments with the possible exception of sulfate of ammonia. The results of these studies will be published in 1937.

Soil Fertility Experiments with Vegetable Crops

The series of vegetable fertilizer experiments started at Windsor in 1930 has now run for seven years. In spite of irregularities due to weather conditions and slight variations in soil from plot to plot, it is now possible to present data on individual crops with a reasonable assurance of accuracy. Twelve crops commonly raised in Connecticut were studied for four or more years, not including years of crop failure when no reliable records were possible.

During the last three years, trials of nitrogen at half the standard rate have been included in both normal and double strength formulas.

For the past two years, plots have been included which involve the use of cyanamid, applied at 45 pounds of nitrogen per acre (approximately 210 pounds of cyanamid) as an early spring top dressing on rye grown as a cover crop; the balance of the nitrogen (45 pounds) applied in the usual forms (NO_3N, NH_4N and Organic N, approximately one-third each) just before planting.

On the basis of the data obtained, it is safe to conclude that the following amounts of nitrogen and potash are economically adequate for the crops involved in these comparisons:

	Nitrogen lbs. per A.	Potash lbs. per A.
Beets (early)	140–160	100–120
Carrots	100–120	100–120
Corn, sweet	100–120	120–140
Lettuce (1st planting	120–140	160–180
(later planting	60– 80	140–160
Onions	120–140	100–120
Peppers	40– 50	60– 80
Potatoes (Cobbler)	80–100	80–100
Radishes	80–100	80–100
Spinach	140–160	140–160
Squash	120–140	160–180
Sweet Potatoes	40– 50	140–160
Tomatoes	100–120	100–120

No statement can be made with respect to phosphoric acid, since the soil used in this experiment is very well supplied with available phosphorus and the 90 pounds of P_2O_5 used as a standard rate has been adequate if not excessive. (In an experiment with potatoes—Green Mountain—on a nearby field of similar characteristics, 40 pounds of P_2O_5 per acre has produced better yields than any higher rate of treatment during the four years of trial.) However, on soils that are more nearly average with respect to phosphorus content, the use of from 100 to 160 pounds of phosphoric acid per acre may be justified on some crops.

It must also be considered that the above summary of plant food requirements is on the basis of continuous cropping to vegetables, without manure or legumes. Most of the crops grew better with only half as much fertilizer when manure was used at 20 tons per acre. This amount of manure supplies about 200 pounds of nitrogen, only about 40 percent of which is available, and this at a much slower rate than for ordinary fertilizer nitrogen (based on lysimeter data at Windsor). The manure application furnishes a corresponding amount of potash, most of which is readily available. Legume crops, when plowed under, add from 40 to 100 pounds of nitrogen to the soil, at least 60 percent of which is liberated during the current season.

The experiment with cyanamid indicates that it would be good practice to place at least a part of the annual nitrogen application as a top dressing on a non-legume cover crop which is to be plowed under. This procedure gives a more permanent organic residue and prevents possible injury by tying-up soluble nitrates during the decomposition of a low-nitrogen material, such as rye.

There has been a marked difference in relative growth of the various crops planted on the unlimed plots at Windsor. The soil acidity on these plots is not extreme, averaging about 5.4 pH, but exhibiting considerable seasonal variation, being occasionally as low as 4.8 pH. However, the active aluminum has not been nearly so high on the unlimed soil as on most soils of the State at a similar range of pH. This is probably due to the high phosphorus content of the Windsor field.

Soil Amendments on Sandy Plots Effective

Trials of a series of organic materials used as soil amendments in an area of poor sandy soil have been conducted for the past three years. The following were compared: Stable manure, dried cow manure, commercial native peat and tobacco stems. All of these have been quite effective, especially when used in connection with a moderate fertilizer application (1,000 pounds 5-10-5 per acre). Ground tobacco stems have given especially good results, and at current market price are much cheaper per unit of organic matter than the others. They also supply considerable amounts of potash.

Fertilizers for Sweet Potatoes

For the past two years we have used a small plot to determine the most suitable fertilizer ratios for sweet potatoes in which some farmers are interested. Both in 1935 and 1936 best results were obtained from a fer-

tilizer low in nitrogen and high in potash, 2-6-10 analysis, at 1,200 pounds per acre. There also appeared to be a slight advantage in applying all of the fertilizer as a side dressing about two weeks after the plants were set. The average yield ranged from 250 to 300 bushels of marketable roots per acre.[1]

What Soil Reaction is Best for Vegetables?

In the spring of 1936 a new series of plots was established, with lime applied at various rates so that the pH was at various levels (5.0, 5.4, 5.8, 6.2, 6.6). **Carrots, eggplants and strawberries were grown this year.** A poor stand of the latter crop was obtained and no data are available. Carrots grew best at 5.8 pH and were a practical failure at 5.0 pH. Eggplants grew satisfactorily at 5.0 pH, but best at 5.4 pH. Above **5.4, yields** gradually declined, with a definitely poorer result at 6.6 pH.

Potato Fertilizer Ratio Experiment

The series of plots being conducted at Windsor in coöperation with the Storrs Agricultural Experiment Station has now produced data for four crops of Green Mountain potatoes. Yields in 1936 were generally poor on the entire field, due to unfavorably hot, dry weather during the first two weeks of July. The following table is based on average results.

SUMMARY OF RESULTS AT WINDSOR—POTATO FERTILIZER PLOTS

Average Data 1933-36 (4 years.)

Lbs. Per A.	Bu. Per A.	Lbs. Per A.	Bu. Per A.
PHOSPHORIC ACID		POTASH	
none	276.0	none	246.2
40	294.8	40	266.7
80	277.8	80	276.4
120	276.1	120	276.1
160	264.6	160	270.1
		200	266.7
MAGNESIA		LIME	
none	265.5	none	259.2
33	279.1	Dolomitic lime	
67	293.9	to adjust acidity	
100	267.1	of fertilizer	276.1
NITROGEN			
60	265.0	No fertilizer	242.3
80*	289.0		
100	276.1		
120*	251.0		
½ N as organic (Total 100 lbs.)	275.3		

* 2 yrs. only

In the above experiments amounts of the following were applied when one of the constituents was at a varying rate:

Nitrogen	100 lbs.	Potash	120 lbs.
Phosphoric acid	120 lbs.	Magnesia	50 lbs.

[1] For work on slip-seeding sweet potatoes, see page 175.

TOBACCO SUBSTATION AT WINDSOR

THE TOBACCO SUBSTATION is located at Windsor in the heart of the Connecticut Valley tobacco country. In 1920 wildfire, a serious disease of tobacco, appeared in Connecticut, threatening to destroy one of the most important industries of the State. Immediately the Station staff at New Haven began to work on methods to control the disease and in a few years the scourge was so regulated that today there is scarcely a case to be found. During this time a laboratory was set up at the Hartford County Farm Bureau. Tobacco growers became interested in having a branch of the Experiment Station established in the midst of their fields to devote full attention to all phases of tobacco growing, and the Substation was opened at Windsor in 1921.

The farm consists of 13 acres of tobacco land with three sheds. There are also laboratories and an office, a greenhouse, tool house and garage, and a new, electrically heated storehouse for sweet potatoes, added in 1936. **The large battery of lysimeters is located there.** These are tanks filled with soil, and arranged so that the drainage water may be collected for chemical analysis. Thus it is possible to study the soil changes and losses that result from different systems of fertilizing and cropping.

In recent years vegetables have become increasingly important in the Valley. To serve this industry, eight acres of land adjacent to the tobacco farm have been leased for vegetable experiments. Thus we now have a Tobacco and Vegetable Substation at Windsor.

The Station also maintains a forest nursery at Windsor.

Irrigation of Tobacco

Connecticut tobacco, especially the shade type, is grown on relatively **sandy soils.** In dry seasons the crop suffers for lack of water, and in very wet periods it starves because the nutrients are washed from the light soil. Therefore, although the lighter soils produce the finest tobacco, the risk of cultivating such land is great.

Proper irrigation would insure crops on this best soil. For a long time shade growers have tried various systems but have met with indifferent success and there are no data available. The effects of drought have been especially noticeable during the past six years because of the subnormal rainfall in New England. Moreover the problem has been aggravated by the fact that manure, which increases the moisture-holding capacity of the soil, is no longer available as in the past. As a result, some of the best tobacco soil has been abandoned and the heavier types, not so susceptible to weather foibles, have been cultivated.

In order to make a thorough test and to obtain statistical data on irrigation of sandy soils, experiments were started on the Station farm at Windsor in 1930 and have been repeated each dry summer since that time. Water was supplied from a hydrant, conducted to the higher part of the field by a four-inch fire hose and allowed to run down between the rows. The number of irrigations depended upon the weather.

During the first years of the experiment, tobacco on the irrigated plots looked larger and more luxuriant in the field but often appeared paler

toward the end of the season. The yield records, however, showed that there was no actual increase in weight, and sorting records revealed that irrigated tobacco was inferior in quality because of the large number of yellow, dead, starved leaves. When soil tests were made, it was found that heavy watering had leached away the nitrogen.

The following year, therefore, nitrate of calcium was sprinkled in the water between the rows that were irrigated twice. The rate of application was 125 pounds of nitrate of calcium to the acre each time, and the results were positive.

This treatment overcame entirely the defects of irrigation. The tobacco was not yellow and starved; the actual yield was not much greater than that from non-irrigated rows, but the grading was 30 percent higher. The rows irrigated in 1936, *without* addition of nitrate, showed the same starvation effects as in previous years, and the yield was about 200 pounds to the acre less than either the non-irrigated or the irrigated with added nitrate.

The results showed that on a sandy, leachy field, the bad effects of irrigation may be completely overcome and the beneficial effects realized by application of nitrate in the water. Further tests are planned to determine best rates of application on different types of soil and to work out more convenient methods of applying the nitrate.

Soybean Meal as a Fertilizer

The production of soybeans in this country has increased enormously in the past 15 years. The meal left after the extraction of the oil has been used chiefly in the dairy industry. However, it is similar in composition to cottonseed meal and has been known as a fertilizer in the Orient for centuries. The same use might be justified here if price and value compare favorably with those of other fertilizer meals such as cottonseed and linseed.

The soybean meal was first included in the Station fertilizer trials in 1935. Since the results were very promising, the tests were expanded in 1936. During these two seasons, the former a rather wet one and the latter quite dry, this material has produced tobacco of excellent quality as judged by commercial graders. The yields were equal to or somewhat higher than those produced with other materials. The tests were made on very sandy Merrimac loam as well as on a medium soil. It is possible that smaller quantities than the equivalent of 200 pounds N per acre may be used on heavier soils.

Effect of Shade Cloth on Atmospheric Conditions

The extensive and highly capitalized shade tobacco industry of the Connecticut Valley depends upon the known fact that leaves grown under cloth are thinner, of finer vein and texture than those grown outside, and therefore worth more money. It is a popular belief that this desirable effect is produced by the partial shade. During the last few years accurate and extensive records of atmospheric conditions have not only measured the reduction in the intensity of light under the cloth but have shown other

changes in conditions that are probably as important as the shading in their effect on the leaves.

Reductions of light intensity under shade tents ranged from 30 to 63 percent. Measurements under trees were taken to show the relative reduction under heavy shade. These ranged from 83 to 95 percent of intensities in the open.

Temperature and relative humidity measurements disclose interesting facts. In three out of five cases temperatures were lower under the shade tent than outside. They were equal in the other two cases. Relative humidities were from 11 to 23 percent higher in the tent in all but one case, a foggy morning. The common observation that air temperatures are several degrees higher under shade tents than outside is thus in error, due to the lower evaporating power of the air, and the consequently higher body temperatures of the observer.

The value of relative humidity measurements in an interpretation of the effect of shading is great. An average increase of 15 percent in relative humidity, together with a decrease of 50 percent in light intensity is the equivalent of a climate many degrees of latitude removed from Connecticut conditions. The effects on the physical characteristics and chemical composition of the plant are very pronounced.

Harvesting Tobacco at Different Stages of Maturity

There is considerable difference of opinion among growers in regard to the proper stage of maturity at which tobacco should be harvested. How long after topping should it be left in the field?

An experiment was started in 1935 with the object of answering this question by measuring the effect on yield, size and quality when the plants are left standing different lengths of time before harvesting. Each year the crop was divided into three parts. The first section was harvested one week after topping; the second, two, and the third, three. The most striking difference observed was the increase in weight when the plants remained in the field longer. During the second week each year the yield increased more than 300 pounds to the acre. During the third week it increased approximately 200 pounds. In the first year (a wet year) the quality of the crop was best on the tobacco harvested the second week after topping. In the season of 1936 (a dry year) it was much the best on the tobacco that was harvested last. Apparently the best time to harvest varies somewhat with the season.

The increase in weight is due mostly to expansion in the leaves as indicated by tabulating the measurements during the sizing of the crop. There is a continuous increase in leaf length and width. Chemical analyses showed that there is no actual increase of mineral salts as measured by percentage of dry weight.

Control of Flea Beetle on Tobacco

During the last few years flea beetles have been the most injurious of all the insects that infest tobacco. The entomologists at the Substation therefore have devoted most of their efforts to improving and standardizing the methods of controlling them. To date the only practical method

found is to dust the infested growing plants with insecticides. The object of the present investigation, then, is to compare the efficiency of the various insecticides and to determine what are the best diluents and the most practical rates of dilution and application.

In 1936 three materials, barium fluosilicate, cubé root powder and sodium aluminum fluosilicate, as well as a combination of the first two, were tested on widely separated field plots of both shade and Havana seed tobacco. Each material was diluted with pulverized tobacco dust. All treatments gave good control. The combination of cubé root dust and barium fluosilicate is more expensive than the others, but the fluosilicates, when used alone, left slightly more residue on the leaves than did the cubé root dust. The sodium aluminum fluosilicate did not distribute as evenly from the dust gun as the others and was therefore objectionable from that standpoint also. Cubé root powder is less likely to cause discomfort or injury to the operator. Considering everything, it appears to be preferable although it also at times can cause irritation.

Value of Cottonhull Ashes in Fertilizer Formula

During recent years an old formula composed of cottonhull ashes and cottonseed meal has become very popular with tobacco growers. Advocates hold that it produces superior quality tobacco. In order to learn whether there is any basis for such claim, this formula was compared on field plots with a similar formula containing no cottonhull ashes but with the same amount of potash from sulfate and carbonate. All plots were in quadruplicate and continued in the same location for five years. Results were judged on the comparative yield, grading, observations on all quality characteristics, fire holding capacity, smoking tests on cigars and chemical analyses.

The results were: (1) No difference in yield. (2) A very slight improvement in grading. (3) No significant differences in chemical composition. (4) No difference in fire holding capacity, smoking characters, ash characters, aroma or taste. (5) The soil became slightly more alkaline through continuous use of cottonhull ashes, but not dangerously so.

Calcium Tests

In past years this Station has made extensive tests on the effect of potash, magnesia and liming of tobacco. No attempt, however, has previously been made to determine the effect of the element calcium aside from its neutralizing action on yield and quality, as judged by burn and taste.

With this object in mind we laid out a series of plots in the spring of 1936 to test calcium at three different rates of application equivalent to 100, 300 and 600 pounds CaO per acre compared with controls receiving none. Calcium was derived from a mixture of landplaster (gypsum) and calcic hydrated lime so as to alter the soil reaction as little as possible. Acidity readings at the end of the season showed a variation of only 0.2 pH between controls and the highest applications.

Results from this first season indicate that leaves are of a better grade when calcium is added to the soil. Yield increased about 200 pounds per acre from the application of 100 pounds CaO. Further additions did not improve the yields. When this crop has fermented, tests in smoking and burn, as well as chemical analyses, should be made. Final conclusions may be drawn only after examination of several crops.

Tests to Find Optimum Nitrogen Applications

In trying to determine the optimum quantity of nitrogen to apply in fertilizing an acre of tobacco we are confronted by a double problem: What quantity produces the largest yield of leaf? And how much is needed to produce the best quality tobacco? Five years of field tests show that the highest yield is not of the best quality. Three hundred pounds of nitrogen to the acre in the fertilizer produces the largest crops but included is too large a proportion of dark, heavy, coarse leaves. The best quality grows on soil treated with about 200 pounds of nitrogen, or possibly a little more when the season is favorable and the general average yield is larger. At 150 pounds or below, there are too many yellow starved leaves of inferior quality. Also the yield falls off rapidly as the quantity of nitrogen is reduced below 200 pounds. The results vary somewhat with the character of the season, particularly with the amount of rainfall, but during the five years of this test we have never in any season found any advantage in reducing the quantity below 200 pounds. Nitrogen is the most costly ingredient in the fertilizer mixture but it is obviously false economy to attempt to cut down the cost of tobacco production by reducing the quantity of this important element. On the other hand, there is a point beyond which nothing is gained by increasing the quantity of nitrogen because it not only raises the cost but reduces the quality, and the slight increase in yield does not offset the disadvantages.

The experimental plots were on medium sandy loam, typical of a large part of the Connecticut tobacco soils. It is probable that on a heavier soil containing more clay, the optimum nitrogen application is somewhat lower.

Better Yield and Quality from Fractional Application of Nitrogen

Tobacco is no exception to the well known rule that plants absorb nitrogen, preferably in the nitrate form. Also nitrates are the least expensive form of nitrogen to use in a fertilizer mixture. However, since nitrates leach very readily, especially on the sandy soils that are commonly used for tobacco, a means should be found to overcome this difficulty.

When nitrate of soda was first used at this Station in a test as a single source of nitrogen, the entire quantity was applied at one time, about 10 days before planting. The results were very disappointing. For a five-year period the average acre yield amounted to only 849 pounds of very inferior tobacco. This was mainly due to starvation caused by leaching of the nitrogen, and obviously the adhering bases early in the season.

In a second five-year period, the nitrate of soda was divided into five applications, the first about 10 days before planting, the second at time of planting and the others afterwards at 10-day intervals. The last application was made within the first week of July.

The results for the second five-year period, just completed, show an increase in yield of more than 1,000 pounds per acre. The quality was just as good as that of tobacco produced on adjacent plots by such standard nitrogenous materials as cottonseed meal, linseed meal, dry ground fish, and castor pomace.

THE LIBRARY

During the year ended October 31, 1936, the Station Library has had approximately the following number of additions:

U. S. Department of Agriculture bulletins and reports	875
State Agricultural Experiment Station publications	1,092
Scientific and agricultural domestic and foreign journals (separates)	2,787
Single books purchased	81
Total	4,835

The library subscribes to 86 sets of scientific journals. It receives in return for Station publications about 24 sets of domestic farm journals and 26 sets of foreign agricultural journals.

The total number of cloth and paper-bound volumes on hand is now about 24,000. Most of the United States Department of Agriculture and State Agricultural Experiment Station publications, as well as scientific journals, are received in pamphlet form and are not included in the volume count until bound.

PUBLICATIONS

Bulletins of the Station

1936

REPORT OF COMMERCIAL FERTILIZERS FOR 1935. E. M. Bailey. No. 377.
THE EASTERN TENT CATERPILLAR. W. E. Britton. No. 378.
INSECT PESTS OF GROWING TOBACCO IN CONNECTICUT. Donald S. Lacroix. No. 379.
SAND CULTURE OF SEEDLINGS. A. A. Dunlap. No. 380.
REPORT OF THE DIRECTOR FOR YEAR ENDING OCTOBER 31, 1935. No. 381.
TERMITE CONTROL IN CONNECTICUT BUILDINGS. Neely Turner. No. 382.
CONNECTICUT STATE ENTOMOLOGIST. 35th Report, 1935. W. E. Britton. No. 383.
A LYSIMETER STUDY OF SOIL CHANGES RESULTING FROM NITROGENOUS FERTILIZATION. M. F. Morgan. No. 384.
COMMERCIAL FEEDING STUFFS. Report on Inspection, 1935. E. M. Bailey. No. 385.
TOBACCO SUBSTATION AT WINDSOR. Report for 1935. P. J. Anderson, T. R. Swanback, and O. E. Street. No. 386.
MORPHOLOGY OF THE ELM BARK BEETLE. B. J. Kaston. No. 387.
REPORT ON FOOD PRODUCTS AND DRUGS FOR 1935. E. M. Bailey. No. 388.
DUTCH ELM DISEASE. G. P. Clinton and Florence A. McCormick. No. 389.

Circulars of the Station

WINDSOR-A, A NEW SWEET PEPPER. Lawrence C. Curtis. No. 107.
CONNECTICUT LAWS CONCERNING PLANT PESTS, DISEASES OF BEES AND MOSQUITO ELIMINATION. W. E. Britton. No. 108.
CONTROL OF THE MEXICAN BEAN BEETLE IN CONNECTICUT. Neely Turner and R. B. Friend. No. 109.
REQUIREMENTS FOR TREE WORKERS IN CONNECTICUT. No. 110.
CONTROL OF THE WHITE APPLE LEAFHOPPER. Philip Garman and James F. Townsend. No. 111.
SWEET CORN INBREDS. W. Ralph Singleton and Donald F. Jones. No. 112.
LAWN MANAGEMENT. M. F. Morgan, E. M. Stoddard and R. B. Friend. No. 113.
INSECTICIDES TO CONTROL THE EUROPEAN CORN BORER. Neely Turner. No. 114.
LAWS AND REGULATIONS CONCERNING THE INSPECTION AND SHIPMENT OF NURSERY STOCK IN CONNECTICUT. W. E. Britton. No. 115.
REGULATIONS CONCERNING TRANSPORTATION OF NURSERY STOCK IN THE UNITED STATES AND CANADA. W. E. Britton. No. 116.

Journal Papers

BAILEY, E. M. Associate referee's report on methods for the determination of methyl alcohol. Jour. Assoc. Off. Agr. Chem., 19:2. 1936.
BLOCK, R. J., and HUBBELL, REBECCA B. Studies on the vitamin B complex: Further indications for the presence of a third factor. Yale Jour. Biol. and Med., 8: 169-174. 1935.
BOTSFORD, R. C. Progress of mosquito control in Connecticut, 1935. N. J. Mosquito Extermin. Assoc. Proc., p. 151. 1936.
BRITTON, W. E. Book review, *Insect Enemies of Shade Trees* by Glenn W. Herrick. Jour. Econ. Ent., 29: 222. 1936.

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CLARK, H. E. Effect of ammonium and of nitrate nitrogen on the composition of the tomato plant. Plant Physiol., **11**: 5-24. 1936.

CLINTON, G. P. Biographical memoir of Roland Thaxter (1858-1932). Natl. Acad. Sci., **17**:55-68. 1936.

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GARMAN, PHILIP. Control of the European red mite and white apple leafhopper. Mass. Fruit Growers' Assoc. Rpt., p. 144. 1936.

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KASTON, B. J. The slit sense organs of spiders. Jour. Morphology, **58**: 189. 1935.

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KASTON, B. J., and BECKER, W. B. *Spathius canadensis* Aslm., a parasite of *Hylurgopinus rufipes* Eich. Jour. Econ. Ent., **29**: 807. 1936.

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MENDEL, LAFAYETTE B., and HUBBELL, REBECCA B. Jour. Nutrition, **10**: 557-563. 1935.

MORGAN, M. F. Ion equilibria in soils and drainage waters as influenced by nitrogenous fertilization. Abstracts of Doctors' Dissertations, No. 18: 305-312. Ohio State University. 1936.

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PUCHER, G. W., and VICKERY, H. B. Determination of starch in plant tissues. Indus. and Engin. Chem., Anal. Ed., **8**: 92-97. 1936.

SINGLETON, W. R. A study in crossed sweet corn. Rural New Yorker. March 14, 1936.

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PROJECTS ACTIVE IN 1936-37

Analytical Chemistry

1. Inspection of fertilizers.
2. Inspection of feeding stuffs. (Including biological tests of fortified poultry feeds.)
3. Inspection of food and drugs. (Including biological tests 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 on analytical methods.

Biochemistry

1. Cell chemistry.
   a. A detailed examination of the constituents of plant cells, in particular those of leaf tissues. The further development of methods for the determination of the different forms of nitrogen in such tissues.
   b. Chemical investigations of the constituents of the tobacco plant with special reference to the changes that occur during culture under various conditions.
   c. The metabolism of the organic acids in plants.
2. Protein chemistry.
   a. The methods for the determination of the basic amino acids yielded by proteins with the object of increasing their accuracy and convenience.
   b. The methods for the separation of other amino acids yielded by proteins.
   c. The properties of certain of the amino acids and their derivatives.
   d. Methods for the preparation of pure proteins.
3. Nutrition investigations.
   a. The relation of diet to the rate of growth with special attention to certain factors that appear to determine rapid growth.
   b. The investigation of the relation of certain constituents of the diet, in particular the mineral salts, to growth.
   c. A study of reproduction in the Osborne-Mendel strain of white rats.
   d. An investigation of the effect of extracts of the thymus gland on the rate of growth of the offspring.

Botany

2. The nature and cause of mosaic diseases of plants.
5. Plant disease survey of Connecticut.
8. Spraying and dusting experiments on apples and peaches. (See also Entomology, No. 3.)
15. A study of the virulence of the chestnut blight.
20. Diseases of shade trees.
27. Investigations of elm diseases.
28. Studies on the identification of apple varieties by seed characters.
30. Investigations of the diseases of vegetable crops and their control.
   a. Potato spraying—time, frequency and concentration.
   b. New fungicides for muskmelons—time and frequency of application.
   c. Control of cabbage yellows and club root.
   d. Fungi carried on vegetable seeds.
31. Investigation of a new peach trouble ("X" disease).
32. Sand and other artificial culture methods of seedlings and growing plants.

Control and Service

12. Seed testing. (In coöperation with the Commissioner of Agriculture.)
25. Spray service. (With the Extension Service, Connecticut State College.)

Entomology

3. Spraying and dusting experiments on apples and peaches. (See also Botany, No. 8.)

9. Insect survey of Connecticut.
7. Studies on the control of the Oriental fruit moth, including parasites. (In coöperation with the U. S. Dept. Agr.)
28. Investigations on oil sprays.
30. A study of insects that attack the tobacco plant. (In coöperation with the U. S. Dept. Agr.) (See also Tobacco Substation, No. 20.)
31. Studies on the biology and control of the European pine shoot moth. (See also Forestry, No. 13.)
32. The biology and control of the potato flea beetle.
34. Tests of methods to control clothes moths.
35. The biology and control of the white apple leafhopper.
36. Methods for the control of onion thrips.
37. Substitutes for lead arsenate in orchard sprays.
38. The relation of rate of growth and pruning methods to the recovery of white pine to weevil injury. (In coöperation with the U. S. Dept. Agr.)
39. The Carpenter ant as a pest of telephone poles.
40. Studies of sprays and parasites for the control of the European corn borer. (In coöperation with the U. S. Dept. Agr.)
41. Studies on the corn ear worm. (In coöperation with the U. S. Dept. Agr.)
42. The biology and control of termites.
43. The spruce gall aphid.
44. A native elm bark beetle, *Hylurgopinus rufipes*, Eich.
45. Investigation of parasites of the Japanese beetle.
46. Methods for the control of the squash bug.
47. Value of derris dusts in the control of aphids.

Control and Service

10. Inspection of orchards and nurseries.
11. Control of the gypsy moth. (In coöperation with the U. S. Dept. Agr.)
12. Elimination of the mosquito nuisance.
13. Inspection of apiaries.
19. Control of European corn borer. (In coöperation with the U. S. Dept. Agr.)
24. Control of the Asiatic beetle.
25. Control of the Japanese beetle. (In coöperation with the U. S. Dept. Agr.)
27. Rearing and distributing parasites of the Oriental fruit moth. (In coöperation with the Conn. Pomological Society.)

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.
   b. Methods of management for those species that have survived.
   c. Studies on growth and habits of the several species.
2. Effect of thinning in white pine at Shaker Station.
3. Effect of thinning in hardwoods at Quassipaug Lake.
6. Studies of forest plantations throughout the State.
   a. Comparative growth of various species.
   b. Reasons for success or failure.
   c. Soil and other site factors necessary for success of each species.
10. An investigation of the distribution and growth of forest trees as influenced by soil conditions and other site factors.
12. A study of preservative treatments of native woods used for posts.
13. Studies on the biology and control of the European pine shoot moth. (See also Entomology No. 31.)
14. Studies on extensive control of the white pine weevil.

Control and Service

5. Distribution of forest planting stock. (Under Clarke-McNary Act.)
7. Control of white pine blister rust. (In coöperation with the U. S. Dept. Agr.)
15. Control of Dutch elm disease. (In coöperation with the U. S. Dept. Agr.)

Genetics

1. A genetic study of hereditary characters in corn involving their linkage relations and variability.

2. The effects of inbreeding and crossing upon corn.
3. Methods for the improvement of naturally cross-fertilized plants by selection in self-fertilized lines, with particular attention to field corn for grain and ensilage; alfalfa; and to some of the more important vegetable crops such as sweet corn for market gardening and canning, beets, cabbage, carrots, cucumbers, melons, onions, radishes, rutubagas, squash; and some fruits such as bush fruits and strawberries.
4. Methods for the improvement of naturally self-fertilized plants, with particular attention to tobacco, and vegetable crops such as lettuce, lima beans and tomatoes.
5. A study of variation and the effects of selection in strains of cross-fertilized and self-fertilized vegetables.

Soils

2. The physical and chemical characteristics of important soil types in relation to the nutritive response of tobacco and other crops when these soils are variously treated in the greenhouse.
3. Nutrient requirements of vegetable crops on important soil types used for market gardening in Connecticut.
4. A study of the physical, chemical and biological conditions of several soil types in natural mixed hardwoods and in planted coniferous forests.
5. Lysimeter studies of the drainage losses and other changes that occur in several soils under heavy fertilization as practiced for tobacco and vegetables.
6. Lysimeter studies of the composition of drainage water as affected by the forest floor.
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.

Tobacco Substation

1. Fertilizer experiments—various sources and rates of nitrogen, phosphoric acid, potash, lime and magnesia.
4. Tobacco nutrition studies—the role of nitrogen, sulfur, potassium, phosphorus, calcium, manganese, boron, magnesium and other elements.
5. Improvement of Havana seed tobacco by selection. (In coöperation with the U. S. Dept. Agr.)
6. Improvement of Broadleaf tobacco.
7. Improvement of Cuban shade tobacco.
13. Preservative treatment of shade tent poles. (See Forestry, No. 12.)
17. Investigations in the curing of tobacco.
19. Diseases of tobacco.
20. A study of insects that attack the tobacco plant. (In coöperation with the U. S. Dept. Agr.) (See also Entomology, No. 30.)
22. Experiments on the irrigation of tobacco.
23. Studies on the rate of growth of tobacco.
24. The effect of harvesting tobacco at different stages of maturity.

WHAT THE STATION CAN DO

Each mail brings to the Station requests for information and service, the range of subjects being almost without limit. Every effort is made to comply with these requests, even though they are outside the fields under investigation. This is one of the purposes for which the library is maintained. However, some of the letters request help that requires an intimate knowledge of live stock management and the like and others ask us to make laboratory determinations for which we do not have the equipment or staff. Therefore it is helpful to publish from time to time a list of the subjects on which we are best equipped to furnish information and the kinds of samples we can accept.

The Station can furnish information on:

Fertilizers and fertilization.
Soils and their management.
The chemical composition of foods, drugs, insecticides and fungicides.
Insect pests of plants and their control.
Fungous and other diseases of plants and their control.
Sprays and spraying.
Fruits and fruit management.
Weeds and their control.
Forestry—all phases.
Care of shade trees, all phases.
Plant breeding.
Lawns, establishment and care.
Bees.
Mosquito elimination.
Tobacco.
Vegetables, especially varieties and strains.

Samples and specimens that can be analyzed, tested or identified:

Fertilizers.
Feeding stuffs.
Foods and drugs.
Milk—except for bacterial count.
Seeds.
Weeds and other plants.
Insects.
Diseased and injured plants.
Soils.

The Station does not furnish information on:

Live stock feeding and management, including poultry.
Animal diseases.
Household management.
Clothing.
Farm management.
Markets and marketing.
Requests for information on these subjects should be sent to the Connecticut State College, Storrs.

The Station cannot make analyses and examinations of:

Drinking water—apply to the State Board of Health, Hartford.
Milk for bacterial content—apply to the Dairy and Food Commissioner, Hartford.
Sick or dead poultry should be sent to the Animal Diseases Laboratory, Agricultural Experiment Station, Storrs.

All of which is respectfully submitted.

WILLIAM L. SLATE,
Director.