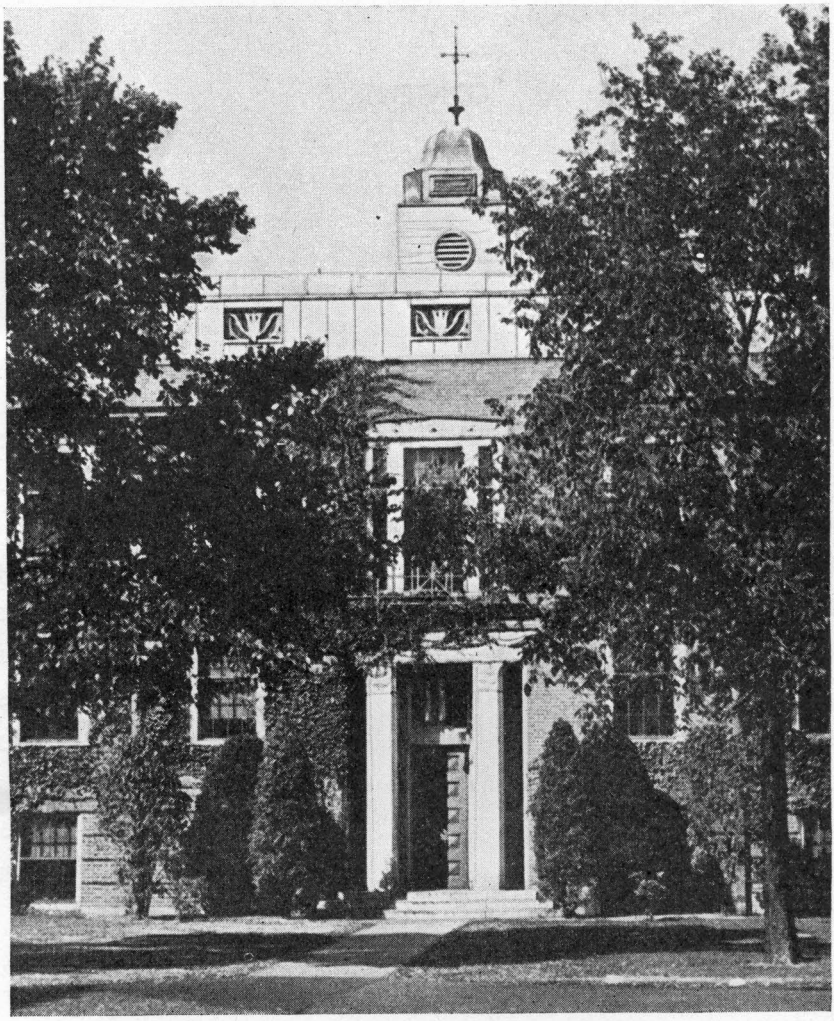
SCIENCE *Works* *for* AGRICULTURE



JENKINS LABORATORY

STATE OF CONNECTICUT
PUBLIC DOCUMENT No. 24

CONNECTICUT AGRICULTURAL
EXPERIMENT STATION
NEW HAVEN, CONN.
ANNUAL REPORT FOR
THE YEAR ENDING
OCTOBER 31, 1946

CONTENTS

LETTER OF TRANSMITTAL

To His Excellency
James L. McConaughy
Governor of Connecticut

The Board of Control of the Connecticut Agricultural Experiment Station respectfully submits its Annual Report for the Station year ending October 31, 1946. The Report of the Treasurer will be found on page 4.

E. C. SCHNEIDER,
Secretary

Publication Approved by
The Commissioner of Finance and Control

Printed under authority of Section 142, General Statutes of Connecticut, Revision of 1930, as amended by Section 45e, Supplement of 1939.
FRED R. ZELLER,
State Comptroller.

REPORT OF THE TREASURER

Summary Statement of Receipts, Expenditures and Balances For Period July 1, 1945 to June 30, 1946

BALANCE ON HAND JULY 1, 1945			
State Appropriations:			
Plant Improvements Extended		$ 4,151.45	
Federal Appropriations:			
Bankhead-Jones Fund		210.10	
Purnell Fund		21.10	
Total Balance on Hand			$ 4,382.65
RECEIPTS			
State Appropriations:			
Personal Services	$236,295.00		
Contractual Services	14,298.70		
Supplies & Materials	16,410.00		
Equipment	20,645.00		
Plant Improvements	9,100.00		
New Structures	10,000.00	306,748.70	
Federal Appropriations		56,960.28	
Feed Fees		21,328.61	
Fertilizer Fees		9,779.44	
Trust Funds & Grants		9,405.62	
Total Receipts			$404,222.65
			$408,605.30
EXPENDITURES			
Personal Services	298,589.30		
Contractural Services	18,463.11		
Supplies & Materials	23,809.69		
Equipment	11,344.04		
Plant Improvements	6,416.95		
Total Expenditures		$358,623.09	
UNEXPENDED BALANCES			
State Appropriations:			
Reverted to State Treasury	5,622.24		
Balance on Hand June 30, 1946			
State Appropriations:			
Equipment	15,774.51		
Plant Improvements Extended	17,503.05		
New Structures	10,000.00		
Federal Appropriations:			
Hatch Fund	6.15		
Bankhead-Jones Fund	627.17		
Purnell Fund	449.09		
Total Unexpended Balance		$ 49,982.21	$408,605.30

Science Works for Agriculture

ANNUAL REPORT

OF THE

CONNECTICUT AGRICULTURAL EXPERIMENT STATION

FOR THE YEAR ENDING OCTOBER 31, 1946

"To put Science to work for Agriculture"—thus did Professor Samuel W. Johnson, the father of the Experiment Station idea in America, and the founder of this, the first Station, define the purpose and set the pattern for these agricultural research institutions.

Through the seventy-two years since its founding, the Connecticut Station has held to this concept of its functions. The road to tangible results is often long and devious. Nature does not yield her secrets readily. Yet each year marks an advance, a new tool for the farmer and a guidepost for further research.

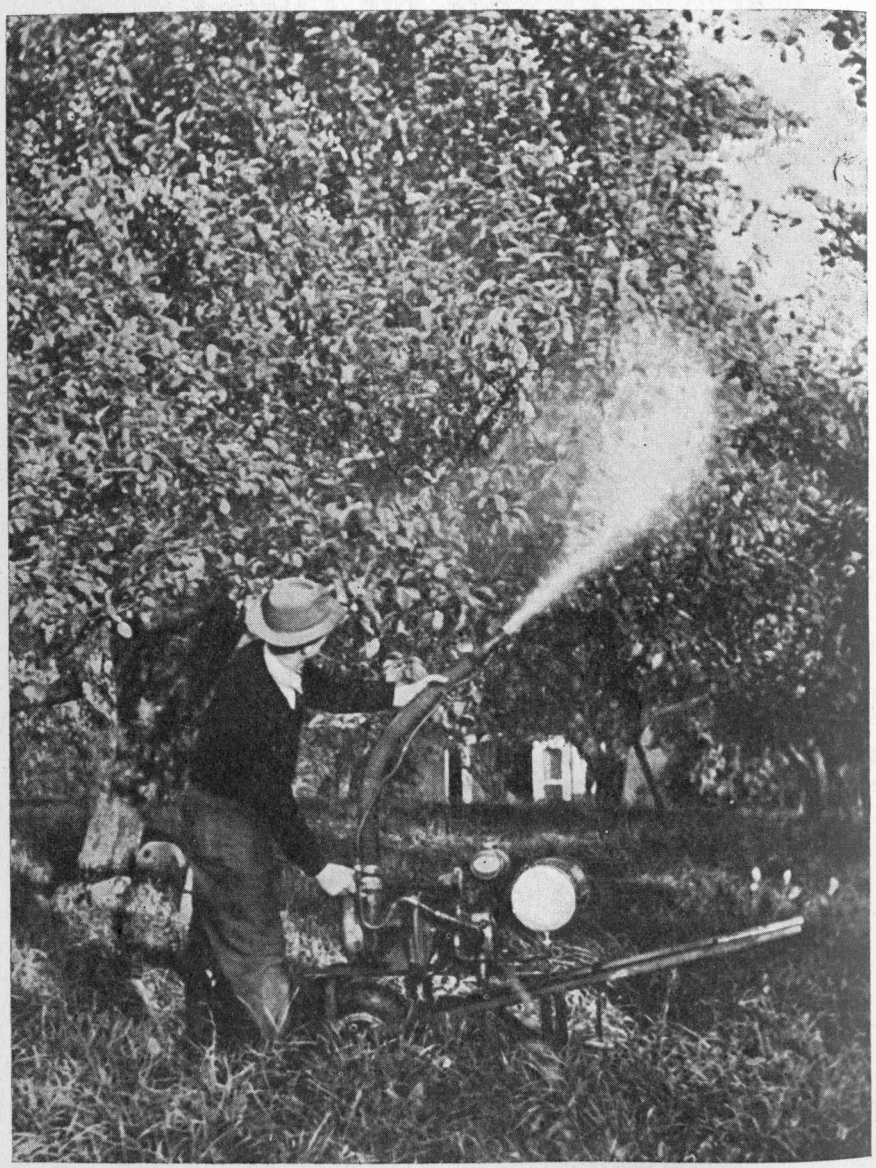
Although recent years have been especially difficult, for the Station, as for everyone, it is encouraging to find real progress has been made in service to Connecticut agriculture. After ten years of discouragement, a ray of light shines on the baffling problem of wireworm control in potato fields. Improved corn hybrids, both field and sweet, combine better quality with increased yields. Reduced spray schedules for controlling orchard pests save time and labor for the fruit grower. New insecticides and fungicides are making disease and insect control easier and more efficient. Hand in hand with these are new methods of application. Notable here are the mist blowers for applying concentrated sprays, and chemotherapy which opens up a new approach to plant disease control.

These and other forward steps are briefly described in the pages that follow, pointing the way to a better, more efficient agriculture.

W. L. Slate

Science Works for Agriculture through:

INSECT CONTROL



One of the newest methods of applying insecticides is by means of mist blowers. This portable machine, operated here by R. A. Spencer, has a three-gallon capacity and weighs only 85 pounds. It is expected to be useful in nurseries, small orchards, estates, resorts and, possibly, the home garden.

POTATO PESTS

Wireworms

The outstanding feature of the 1946 field studies for the control of wireworms affecting potatoes was the high efficiency of benzene hexachloride, especially when employed as a soil insecticide and to a lesser degree when used as a seedpiece treatment or when incorporated in a poison bait. From the standpoint of wireworm control, the material is effective and can be applied easily and practically but, from the standpoint of the taste imparted to tubers grown in treated soils under most conditions, further study is imperative. Under the present circumstances, the most satisfactory method for using the material requires some form of rotation in which potatoes are not planted until the year following treatment.

A study of methods for the application of benzene hexachloride included: (1) broadcast treatment, in which the material was applied as a dilute dust by a grain drill and disc-harrowed into the soil; (2) row treatment, in which the material was applied as a dilute dust to the open furrow at planting time; (3) seedpiece treatment, both as a dust and as a dip; (4) poison bait, in which the material was incorporated with wheat bran at the rate of 1 part to 1,000 by weight and placed next to each seedpiece, half of which were treated with lead arsenate as a repellant.

The first two methods of application reduced the population of tubers "out of grade U. S. 1" from more than 50 per cent in the controls to 2.5 and 0.5 per cent, respectively, and the over-all percentage of injured tubers from more than 70 per cent in the controls to 8.4 and 5.0 per cent, respectively. The last two methods of application were not nearly as efficient, yet the degree of control obtained materially improved the quality of the tubers in comparison with those grown where no treatment was made.

A small-scale replicated field trial of "D-D Mixture" [1], in which the material was applied by a hand injector, showed the ideal dosage for Connecticut soils to be somewhere between 10 and 25 gallons per acre if effective wireworm control is to be attained.

Another field experiment, in which a 10 per cent ethylene dibromide mixture was applied at dosages ranging from 15 to 40 gallons per acre by a commercial power applicator, resulted in no control at any dosage. Commercial applicators do not appear to be satisfactory for use on our soils and the lack of results in the above experiment is attributable to faulty application and not to the material [2] used.

Other Insects on Potatoes

Field-scale tests of insecticides and fungicides for control of pests of potatoes were carried out in cooperation with the Department of Plant

1. Shell's Dichloropropane-dichloropropylene.
2. Iscobrome D, Innis Speiden & Co.

Pathology and Botany on five farms in Hartford and Tolland counties. On two of these farms, the principal comparisons were between fungicides combined with DDT. On three farms, there were comparisons involving insecticides.

In all DDT treatments, the insecticide was applied as 2 pounds of 50 per cent wettable powder to 100 gallons of spray mixture. On test farms where DDT was used, yields were 100 to 200 bushels per acre higher than in 1945, when no DDT was used. Ten applications of DDT and 10 applications of Dithane [1] gave better insect control than six applications of DDT and 10 of Dithane. Highest yields were obtained with a combination zinc-Dithane and DDT. Both Rhothane [2] and benzene hexachloride were less effective in controlling flea beetles and leafhoppers than DDT. Contrary to expectations, benzene hexachloride did not control aphids as well as DDT did. The Rhothane plots yielded as well as DDT in spite of inferior pest control.

As in the laboratory, it was found that smaller DDT particles in water suspension resulted in greater toxicity of the insecticide. This was borne out in field tests conducted on flea beetles and leafhoppers. It was also found that the addition of a wetting agent reduced insect control sharply and affected the yield as well.

The effect of formulation on control was tested by comparing DDT spray powders with emulsions of DDT in a solvent. The spray powder was much more effective in controlling flea beetles, slightly more effective in controlling leafhoppers and produced a better yield.

INSECTICIDES

During recent years, the interest in chemical agents of insect control, that is, insecticides, has increased greatly. In the development of insecticides, many factors must be considered. During 1946 work on the factors affecting the toxicity of residues of DDT suspension in water was carried on. The particle size of the DDT was found to be very important; the smaller the particle size, the greater the toxicity, other things being equal.

The addition of other ingredients to the DDT suspension also affects its toxicity. It was found that wetting agents decreased the deposit and reduced toxicity, both in the laboratory and in the field.

Tests of the efficiency of DDT residues, using houseflies, indicated that kerosene solution left a more effective residue on painted wood than on wire screen, and the same solution left a better deposit on unpainted wood than on glass. All DDT deposits on glass deteriorated rapidly—that is, showed remarkably less toxicity after a few days.

A comparison of DDT in the form of water suspension and emulsion showed that water suspensions were much more effective in controlling

1. Disodium ethylene bis dithiocarbamate.
2. Dichloro-diphenyl dichloroethane.

potato flea beetles than emulsions. The same was true, to some extent, for leafhoppers.

Preliminary studies of the effect of diluents on the toxicity of DDT in dusts indicated the same trends as those reported previously for rotenone, cryolite and nicotine. In dusts, particle size of DDT was apparently not an important factor; in fact, larger particles performed slightly better than smaller ones.

The study of the relationship between chemical constitution and toxicity of nicotine compounds to insects has been continued in cooperation with the Eastern Regional Research Laboratory. In general, single salts were more toxic in sprays on aphids than double salts. Chlorides, bromides and iodides were less toxic than oleates and thiocyanates. Ethyl and butyl compounds were more toxic than methyl, octyl, octadecyl and cetyl compounds. Lauryl, benzyl, chloro and nitro-benzyl compounds were still more toxic. Few of the compounds were as toxic as nicotine sulfate. Continued work on injection of these same chemicals indicates that the principal reason for the low toxicity of the complex nicotine compounds was the failure to penetrate the insect cuticle.

The insecticide dichloro-diphenyl dichloroethane was less effective than the trichloroethane (DDT) for potato pests. Benzene hexachloride was also less effective than DDT.

ORCHARD SPRAY SCHEDULES

Further experiments with reduced spray schedules on apples, for the purpose of improving scab control on McIntosh and codling moth control on this and other varieties, were carried out in 1946. A series of plots in two different orchards were treated with reduced schedules designed to give adequate protection. Satisfactory results were obtained with five sprays in the Burton orchard on all varieties, compared with 11 and 12 applications as generally applied in commercial orchards. In spite of the fact that 1946 was a bad scab year, apples were produced with as little scab as developed under the full spray schedule. The fungicide tetra-methyl thiuram disulfide (Tersan) was used in a series of orchard tests. Scab control varied but an improvement in finish and color resulted from the use of this material. Other schedules included Puratized [1] and Fermate [2] supplements applied between the reduced program applications.

The only tests where codling moth was considered were at the Lyman orchard in Middlefield where a block was sprayed in cooperation with the owner. It was learned that a light infestation of this insect can be handled with reduced schedules provided DDT is added to the last applications.

Several experiments were conducted with a view to finding the solution of the mite control problem in apple orchards where DDT-sulfur-lead arsen-

1. Phenyl mercuric triethanol ammonium lactate.
2. Ferric dimethyl dithiocarbamate.

ate sprays are used. From our work this summer it became evident that DN-111[1] and Genecide[2] gave satisfactory relief when combined with DDT. Work in this field is being pushed by laboratory experiments during the winter. There are a number of chemicals available which may ultimately provide an answer.

A test designed to compare a non-arsenical with a full arsenical spray program was conducted at Mount Carmel. For early season sprays, benzene hexachloride containing 10 per cent gamma isomer was substituted for lead arsenate and, for the later applications, DDT with DN-111 added was utilized to control late feeders. Curculio control was equal to but no better than that obtained with arsenate of lead. Leaf feeders and surface fruit feeders with the exception of the red-banded leaf roller were adequately controlled, while the European red mite was much reduced, as compared with sulfur-lead arsenate. Furthermore, the trees receiving benzene hexachloride-DDT-DN-111 had better foliage at the end of the season, and the fruit harvested from Baldwin trees of comparable size was much larger as a direct result of mite reduction.

Treatment schedules using a mist blower were employed in the Burton orchard on apple trees. Here, we attempted to deposit the same amount of insecticide on the trees using one-half gallon per tree as compared to 15-20 gallons commonly employed with the conventional high pressure rigs. In this orchard, at least, it was demonstrated that insect and disease control can be obtained with this type of outfit. With improvement in the mechanics of application, the method should afford a considerable reduction in cost of application. In this work we used a converted duster provided with a small pump and water tank for the spray mixture. The nozzle, an oil furnace type, was inverted in the end of the air delivery tube.

CODLING MOTH

Work on the codling moth problem in 1946 was directed largely toward observations on the effects of the intensified control program, special attention being given to orchards that have been studied for several years.

In infested orchards previously under observation, infestations were kept at low levels or reduced with improved control practices and sprays of either arsenate of lead or DDT.

DDT proved definitely superior to arsenate of lead. The presence of strains of the insect resistant to arsenate of lead is suspected in two or three orchards, but it has not yet been demonstrated that control cannot be obtained with arsenate of lead accompanied by other good general control practices. The benefits of such practices in both orchard and packing shed have been emphasized, particularly in Illinois and Ohio. Experience in Connecticut also indicates such measures as major rather than minor factors in codling moth control.

1. Dicyclo-hexylamine salt of dinitro-cyclo-hexyl-phenol.
2. Xanthone.

JAPANESE BEETLE CONTROL

Results of experiments carried on in this State, as well as elsewhere in the United States, show that DDT is an excellent insecticide for the control of Japanese beetle larvae in grass land. In one experiment 10 per cent DDT dust was used at the rate of 250 pounds (25 pounds actual DDT) per acre, the application being made May 20, and within five weeks the mortality of grubs reached 75 per cent. In the succeeding generation, that is, the generation of larvae hatched from eggs laid during July and August, the initial infestation averaged 72 to 75 grubs per square foot, but by September 18, DDT had reduced this to an average of two per square foot. At the same time, the average infestation in an untreated check area was 79 per square foot.

Against the adult beetles, DDT in a kerosene solution, applied at the rate of 1 and 3/5 pounds of actual DDT per acre, effectively protected vegetation for a period of three weeks, after which the adults returned to the area in small numbers.

MIST BLOWERS

The recent advent of very toxic insecticides such as DDT which can be applied in concentrated form in small quantities has led to the development of mist blowers for applying such insecticides. This project has been carried on in cooperation with the Bureau of Entomology and Plant Quarantine of the U. S. Department of Agriculture.

These machines apply concentrated insecticides in small quantities in the form of a mist very effectively; the principle involved is the discharge of a finely atomized mist by an air current developed by a powerful fan. Suspensions, emulsions and solutions of the materials may be used.

The blowers are able to discharge a mist 100 feet or more in the air vertically and up to 300 feet horizontally. They promise to be very useful in controlling a number of insects affecting forest, ornamental and orchard trees. Using a solution of DDT, we obtained control of feeding caterpillars on trees 75 to 100 feet high with as little as one pint of the material. One of the great savings provided by the blower is due to the small quantity of insecticide employed. In addition to its use in controlling many pests of plants, the machine has a great field of usefulness in freeing areas of flies and mosquitoes cheaply and rapidly. At the present time this type of machine is in commercial production and several firms in the United States are manufacturing various models.

We have been interested in developing a smaller type blower which has, we believe, great usefulness in treating plants up to 35 feet in height. This apparatus has a three-gallon capacity, weighs only 85 pounds and can be mounted on either a wheelbarrow or a platform. It is easy to handle and transport, and uses efficiently suspensions, emulsions and solutions of insecticides in concentrated form. It is not suitable for the treatment of large trees due to limits in vertical distribution of the mist. At least one commercial concern has gone into the manufacture of this apparatus.

NATURAL ENEMIES

One important factor in pest control is the role of natural enemies of insect pests. We have been particularly interested for several years in the insects and diseases which attack the Japanese beetle, the Oriental fruit moth and Comstock's mealybug.

In cooperation with the Bureau of Entomology and Plant Quarantine of the United States Department of Agriculture, we have introduced into Connecticut several parasites of the Japanese beetle and a bacterium which causes an infection known as the "milky" disease of larvae. These have become established in the State and are giving a certain degree of control over the pest.

At the request of the Connecticut Pomological Society we continued the production and liberation of parasites for the control of the Oriental fruit moth. Improved techniques enabled us to increase the production of *Macrocentrus ancylivorus* by 43 per cent, and during 1946 over 100,000 individuals of this species were released in peach orchards.

We have attempted for some time to obtain an effective control of Comstock's mealybug, a pest of apples and pears in this State, by using parasites. In 1946 we released 7,200 *Allatropa convexifrons* adults and 7,200 *Pseudaphycus* adults in an orchard where parasites had not been previously colonized. These were furnished us by the Bureau of Entomology and Plant Quarantine of the United States Department of Agriculture.

AMERICAN FOUL BROOD OF HONEYBEES

In 1945 it was reported that feeding sugar syrup containing 0.5 gram of sulfathiazole per gallon gave excellent control of American foul brood, a serious disease of honeybees.

During 1946, penicillin, sodium sulfathiazole, sulfapyradine, sulfaguanidine and furacin in sugar syrup solutions were tested as medications in a manner similar to that employed in the use of sulfathiazole. Considering the length of treatment, sodium sulfathiazole and sulfaguanidine gave results indicative of promise as a control for the disease.

X-ray treatment (deep therapy) of badly infected frames was not effective in controlling the disease.

BEE POISONING

Unless great care is exercised, honeybees may be seriously poisoned when plants are sprayed for the control of insect pests. In view of the fact that bees are necessary for the pollination of many fruit blossoms, anything that is deleterious to them is of importance to agriculture in this State. Preliminary tests with possible repellents were carried out during the past year. Of a number of materials tried, isoquinoline, "2-way Repellent", cresol, meta cresol, azoxybenzene, n-Butyl di-malate and N,n-Amylsuccinimide gave some promise.

CONTROL AND SERVICE

Inspection of Plants and Plant Products

During the summer and fall of 1946, 326 nurseries, representing 4,120 acres of nursery stock, were inspected. The usual number of pests was found, but none was serious enough to warrant the destruction of very many plants.

Federal and State quarantines for gypsy moth, Japanese beetle and European corn borer require that plants and plant material be inspected and certified as being free from these pests before they may be shipped out of the quarantined area. This required inspection and certification by State and Federal inspectors of 621,913 plants for Japanese beetle; 4,076,419 plants, 54,824 pieces of lumber such as poles, piles, posts, ties, etc., 9,068,566 board feet of lumber, 3,017 cable reels, 518 cords of fuel and pulp wood, 18,647 bundles and bales of evergreen and forest products for gypsy moth, and 445 shipments of plants and seed corn for the European corn borer.

One hundred and ninety-nine duplicate nursery certificates were issued to Connecticut nurserymen so that they might ship their stock to other states which require the filing of duplicate certificates with their state entomologists. Seventy-one dealers' certificates were issued to stores and individuals who sell nursery stock but do not grow it. A total of 235 package certificates was issued to private individuals who wished to ship plant material.

Five hundred and two certificates were issued for seeds shipped to foreign countries. On account of the white pine blister rust, 370 control area permits were issued for currant and gooseberry plant shipments.

Inspection of Apiaries

During the summer our three bee inspectors visited 2,827 apiaries and inspected 11,920 colonies of bees. There was a slight increase in the amount of American foul brood found this season, 2.29 per cent for 1946 as compared to 2.23 per cent for 1945. Winter mortality accounted for the loss of 12.6 per cent of the bee colonies, a little less than half of the 1945 loss.

Dutch Elm Disease

This disease has increased in intensity in the western half of the State and many valuable elms have died during the last year.

Some indication of the status of the disease in western Connecticut can be obtained from the information furnished by our sample plots in Greenwich, Stamford, Darien and Norwalk, established in 1942. In 1946 there was an increase in the infestation in three of these four towns. We estimate that 2 per cent of the trees in the plots in Greenwich, 13 per cent in Stamford, 4.5 per cent in Darien, and 3 per cent in Norwalk were newly infected during the past year.

During 1946 the Dutch elm disease spread farther to the east and has now reached Stafford, Tolland, Chaplin, Scotland, Lisbon, Preston, Montville, Waterford and New London. This leaves only about one-fifth of the eastern part of the State disease-free.

Miscellaneous Pests

During the year November 1, 1945, to October 31, 1946, 412 samples of insects were received at this office with requests for information about their injuriousness and control. The majority of these pests were those infesting shade and forest trees, timber and wood products, shrubs and vines, and those found in the household and infesting stored grain.

Gypsy Moth Control

During the past year a survey made in 63 towns in the State disclosed about 183 infested areas in a number of which control operations were deemed necessary. These areas were treated with DDT, using aircraft or ground spray equipment. A series of tests was made in an effort to determine more precisely the best time to apply DDT for moth control. The results of these tests will be ascertained in the winter of 1946-47, when the egg mass population can be determined. During the summer of 1946 a survey of 103 towns in the eastern and central parts of the State showed some defoliation in 22 of these towns, the greater part being in the north central section. A total of 326 acres was 75 per cent to 100 per cent defoliated by the caterpillars. Three hundred and sixty traps for male moths were set out during the summer in various towns in the eastern part of the Barrier Zone. No serious infestations were discovered. We have continued the type mapping work as time permitted and maps of several new towns have been completed during the past year.

The Federal Bureau of Entomology and Plant Quarantine cooperates with this Station in many phases of its gypsy moth control work and aided in several of these projects.

White Pine Blister Rust

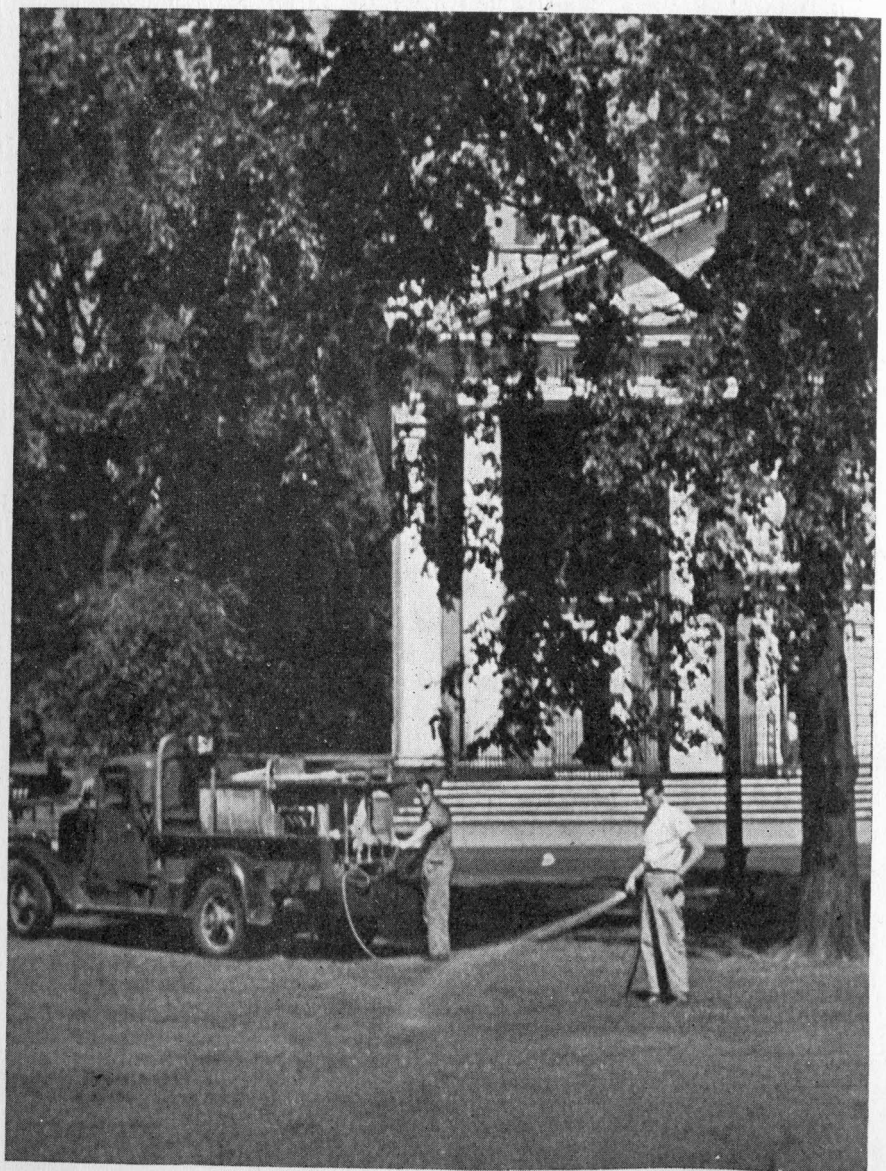
White pine blister rust control work in Connecticut has continued under cooperative agreement between the Connecticut Agricultural Experiment Station, the U. S. Bureau of Entomology and Plant Quarantine, and the State Agricultural Extension Service. The Station administers the program. There are approximately 100,000 acres of white pine stands in Connecticut, much of this containing young trees, particularly in the eastern part of the State, where the hurricane of 1938 threw down much of the older white pine timber. The control work involves the eradication of currants and gooseberries (genus Ribes) which are considered the alternate hosts of the disease and without which the disease cannot infect white pine. This work is now on a maintenance basis.

Future plans call for remapping and the periodic inspection of pine and control areas in order to protect newly developing stands and to maintain the established control areas free of ribes. Eighteen towns are now making annual appropriations on the basis of five cents to ten cents per acres of pine in the town. The funds so appropriated are placed in town sinking funds and are allowed to build up until they are needed for ribes eradication work. They will be used to hire local laborers who will work under State direction. The administration, supervision and preliminary scouting costs will be carried by State and Federal funds.

During the past year, 41,081 acres of white pine and control area were remapped in the towns of Colebrook, Goshen, Stafford, Winchester and Woodstock, and an additional 38,892 acres were examined but not mapped because not enough pine was found to warrant the cost of protection. In these towns 38,854 wild ribes were removed from 42,017 acres of control area. Three nursery sanitation zones, aggregating 450 acres, were re-examined and 16 wild ribes were destroyed, giving protection to 250,000 young white pine destined for planting stock.

Science Works for Agriculture through:

DISEASE CONTROL



Chemotherapy, or internal treatment with chemicals, is a new approach to the problem of vascular plant disease control. Here, chemicals are watered on the soil around elm trees in Dutch elm disease control experiments. The chemicals are taken up by the roots and carried throughout the tree's internal system.

VASCULAR WILT DISEASES

Chemotherapy

For many years, the approach to problems of plant disease control has been the application of sprays or dusts to the foliage or outer portions of plants and trees. Certain diseases, however, do not respond to such methods. These include the vascular diseases of plants, those which affect the water- or sap-conducting systems. Fungi which cause such diseases are inside the plant and a spray or dust applied to the foliage cannot reach them.

A new approach to the control of such diseases is chemotherapy. Chemotherapy consists basically of applying chemicals directly to the internal portions of plants. This department has been conducting experiments using such methods for control of vascular diseases for several years. Results show considerable promise.

One of the diseases against which chemotherapy has been tried is the Dutch elm disease. During 1946, tests were conducted which confirm earlier results and show that applications of oxyquinoline benzoate applied internally to elm trees definitely reduce Dutch elm disease symptoms. The tests involved 100 elms, varying in size up to eight inches in diameter, which had been severely inoculated with the Dutch elm disease fungus.

At the same time the trees were disease-inoculated, they were treated with oxyquinoline benzoate in water solution at a concentration of 1:1000. The chemical was watered on the soil around the elms. It was taken up by the roots and carried throughout the water-conducting system of the tree. Earlier experiments had shown that applications to the soil were more effective than applications by which the chemical was injected into the tree through bore holes in the trunk. Consequently, the soil-watering method was used exclusively here. A separate group of 100 elms, also infected with the Dutch elm disease, was left untreated by the chemical as a check.

In two weeks the trees showed signs of disease. Four weeks after treatment, the percentage of the crown showing disease symptoms wes estimated for each tree in the plot. The average percentage of diseased crown was 29 per cent for the oxyquinoline benzoate-treated trees and 47 per cent for the untreated elms. It is evident that the chemotherapeutic application of oxyquinoline benzoate reduces Dutch elm disease symptoms substantially.

Four weeks after treatment, also, each tree was sampled and cultures made for recovery of the Dutch elm disease fungus. Results show that treated trees may resist infection slightly more than untreated elms. Eighty-six per cent of the treated trees became infected compared with 95 per cent of the check or untreated trees.

Further differences between the treated and untreated trees in the plot became apparent when the trees lost their leaves in the autumn. When the

check trees were almost bare of leaves, those treated still had a considerable amount of foliage.

Experiments with larger trees were also conducted. Here, again, the oxyquinoline benzoate was applied to the soil and taken up by the root systems of the trees. The tests were made on street trees and elms in landscaped areas, some healthy and some naturally infected with the Dutch elm disease. When moderately diseased trees were treated, they showed lessening of disease symptoms and the advance of the fungus through the tree was checked. In two cases where severely affected trees were treated, the infection progressed despite treatment. Since the disease causes vascular plugging, such lack of response to treatment in these advanced cases may be due to failure of the chemical to be distributed in the tree. Healthy trees under treatment remained healthy.

Action of Dutch Elm Disease Fungus

Other research on the Dutch elm disease concerned the nature of the causal fungus and the way in which it works. Some plant pathologists believe that the fungus produces toxins which affect the water-conducting tissues of the tree, causing disease. Cultures of the fungus were analyzed to see if these toxins could be detected and isolated.

Two substances of toxic nature were found. Tried on elm and tomato cuttings, the first produced symptoms similar to those of the Dutch elm disease, but did not affect the water uptake. The second produced severe curling of foliage on both elm and tomato cuttings and caused elm leaves to wilt. It also caused a decrease in the rate of water uptake of cuttings of both elms and tomatoes. The effect on the water uptake of the cuttings appeared before disease symptoms on the leaves. It seems evident that the second toxin is an important factor in the active infection of elms by the Dutch elm disease.

DEVELOPMENT OF NEW FUNGICIDES

A constant search for new and improved plant disease-fighting materials goes on in the fungicide laboratory. During the past year, one new chemical has reached the stage of commercial adoption. The chemical name of the new fungicide is zinc ethylene bisdithiocarbamate, an offspring of an earlier material, Dithane, which was developed here. The new material has not yet received a trade name. It is much more stable and, therefore, toxic over a longer period of time than the older material. It is useful against the same group of vegetable diseases as Dithane and shows particular promise on potatoes.

Two other new materials have passed through all the screening tests, including a first field test. These will now receive further testing under commercial conditions. Both materials have given successful control of celery blight and bean anthracnose and should prove useful to other plant diseases in these classes. Their chemical names are 4-nitrophenyl-2,3-dichloroisobutyl ether and 1-hydroxy-2-trichloroethyl bis-2-chloroethyl phosphite.

ROOT ROT DISEASES

Root rots of strawberries, peas, onions and other crops are serious problems of market gardening in Connecticut.

Previous studies, here and elsewhere, had shown that the kind of crop grown the previous year or the cover crop may affect the development of root rot diseases. Investigations carried on during 1946 were directed toward finding out just what this effect was.

A scheme was devised to separate the effects of the crop residue from the effects of bacterial products formed by the decaying of the crop. Using this scheme, radish seedlings were used as a test plant in the laboratory.

Extracts were made from certain suspected plants and radish seedlings were soaked in them for eight hours. Extracts from ladino clover and perennial ryegrass caused browning of the radish roots. Corn stover and soybean tops caused no injury.

Plant material was then allowed to decay for varying periods of time to determine the effects of decomposition on seedling injury. During decomposition, the injurious factor in clover and ryegrass gradually disappeared. When decomposition proceeded at high temperatures, the toxic factor disappeared much faster.

Bacteria and fungi which hasten decomposition of clover and ryegrass residues are evidently beneficial. In the case of corn stover, decomposing at a high moisture level, there was, at four to six weeks, a temporary injury. This was probably caused by a chemical produced by microbial action.

Further work along these lines will be carried on in the field next year.

APPLE SCAB

Comparisons of New Fungicides

The work of testing new fungicides for the control of apple scab in the field was continued in 1946. Six organic materials were tested against wettable sulfur (mike sulfur) as a standard. The materials tested and the concentrations follow. All amounts given are per 100 gallons of water:

Thiosan (tetramethyl thiuramdisulfide, 50% active)	2 lbs. active
Omilite (a polymeric polysulfide)	2 gals.
G4 (dihydroxy dichloro diphenyl methane)	2 lbs.
Phygon (2,3 dichloro-1, 4-napthoquinone)	2 lbs.
No. 341 (2-heptadecylglyoxalidine)	1 gal.
Wettable sulfur (mike sulfur, 95% active)	4 lbs. active
Puratized N5E (phenyl mercuric triethanol ammonium lactate)	1.65 pints

Six applications were made with all materials on small McIntosh apple trees with knapsack sprayers.

Phygon and Puratized gave good control in the early part of the season but allowed the development of considerable infection in late season. Even with this fault, they were the best of the lot. Thiosan gave fair control in the early season with no appreciable increase as the season advanced. Mike sulfur and Omilite showed rather poor control with no significant difference between them. G4 and No. 341 were scarcely better than the checks. It must be said in fairness to No. 341 that the manufacturing process was faulty and the results did not show the true value of the material as a fungicide.

Comparison of Sulfur Concentrations

A series of concentrations of sulfur were applied to bearing McIntosh apple trees for the purpose of getting data on the effect of concentration on control of apple scab. It had been noted in various experiments that lower concentrations often gave higher control than was expected. In this experiment six concentrations of actual sulfur in a wettable sulfur were used as follows: 6, 4, 2.67, 1.68, 1.19 and .79 lbs. per 100 gallons. Six applications of each concentration were made. While it is realized that this schedule was inadequate for good commercial control in the 1946 season, it was sufficient to show differences in control between the several concentrations.

The results at harvest time showed that 4, 2.67 and 1.68 pounds gave approximately the same control of scab on foliage and all were better than six pounds. Below 1.68 pounds, control fell off rapidly but remained considerably above the checks. On the fruit, four pounds gave better control than six pounds but, below four pounds, control fell much more rapidly than on the foliage. It has not been possible to get the quantitative analysis of sulfur deposit on the foliage, and a satisfactory explanation of the above results cannot be made at this time. As in previous spraying experiments, it was found that there was more scab on the outside leaves than on the inside for all treatments, including the checks, and that the difference in amount was approximately the same in all cases.

Chemotherapy

A series of chemicals, Puratized N5#, *p*-aminobenzene-sulfonamide, Dithane (disodium ethylene bisdithiocarbamate), 8-hydroxyquinoline benzoate, Isothan Q15 (lauryl isoquinolinium bromide), Hymine 1622 and 8-hydroxyquinoline sulfate, were applied to the soil around young McIntosh apple trees for scab control. None of these materials had any visible effect on the amount of scab present on the foliage. This was a first attempt to control apple scab by chemotherapy. The failure cannot be taken as necessarily meaning that scab may not be controlled by this method if suitable materials and techniques can be found.

NURSERY STOCK

At the request of the Experiment Station Committee of the Connecticut Nurserymen's Association, the problem of moulding of nursery stock in storage and the preservation of the normal winter coloration of some species of evergreens were investigated. It was found that a species of Botrytis was chiefly responsible for the moulding of the stored nursery stock. Spraying of the stock in the bins with liquid lime-sulfur 1-40 definitely retarded the development of the fungus.

In the experiment set up to test the action of several chemicals on the coloration of the evergreens, the results were negative. Some observational data on evergreens growing at different levels of nitrogen supply indicated that additional nitrogen might be helpful, and this information was passed on to the nurserymen.

SEED TESTING

In 1946 the laboratory completed the following seed tests:

	Germination	Purity
Vegetables	1400	
Field seed	189	189
Lawn mixtures	122	122
	1711	311

The above samples were submitted by the Commissioner of Agriculture as provided in the Connecticut Seed Law. In addition to these samples, 105 germination and 20 purity tests were made for State institutions and citizens.

In testing the germination of vegetable seed, a new procedure was worked out whereby several samples of the same kind of seed (from the same company and having the same or about the same germination claim) were combined as one sample. This was done by making a composite sample of an appropriate number of seeds from each lot for the test sample. If, when tested, this composite sample of seed was found to be below the average claim for the component lots, each sample of seed included in the composite sample was retested in order to find out which one or ones of the combined sample were below claim. This method did, however, save considerable time and produced accurate results.

As time permits, the laboratory has been experimenting with a chemical test of tetrazolium chloride for rapid determination of seed germination ability. The work has not progressed far enough to draw any definite conclusions.

Science Works for Agriculture through:

PLANT BREEDING

Miss Nancy Rhynedance inspects a plot of sweet-dent ensilage corn, a new type recently developed by the Genetics Department. A cross between field and sweet corn inbreds, the new hybrids are high-yielding, large and strong. They make excellent cattle fodder.

FIELD CORN

Breeding

Some years ago, crosses of field corn hybrids with one of our late sweet corn inbreds were made with the aim of finding a better type of ensilage corn for this region. The results were several unusually vigorous and high-yielding hybrids, with somewhat better quality than standard field corn varieties. Compared with U.S. 13, the most popular field corn grown for silage in this area, some of the sweet-dent ensilage hybrids withstood storms and stood erect better. Two of these hybrids will be handled by commercial seed companies on a limited basis in 1947.

To test yields of this new type of corn further, 25 of the sweet-dent crosses were grown and records of dry matter and grain yields were kept. U.S. 13 was used as a check and produced 4.48 tons of dry matter and 80 bushels of grain per acre. The highest yielding sweet-dent hybrids in these plots yielded 5.35 tons of dry matter and 95 bushels of grain. Improved crosses will probably result in even higher yields. Several of the newer experimental hybrids were grown in single row observation plots and yields here ran as high as 6.57 tons of dry matter per acre.

Yield Testing

New commercial and experimental field corn hybrids are tested for yield and other qualities each year to determine how useful they may be to the Connecticut grower. The trials are divided into three classes: early, mid-season and late.

In the early trials in 1946, 25 varieties were tested, of which six produced 125 bushels or more per acre. Two of these were experimental hybrids developed by this Station.

Mid-season yields were generally higher. Of 25 varieties planted, 11 yielded more than 150 bushels per acre. Inbreds which appeared most often in these high-yielding hybrids were Ohio 40B, B164, Wf and Conn. 35.

There was considerable lodging in the late trials following a severe storm in early August. Only nine varieties exceeded 100 bushels, with the highest producing 117 bushels.

Although no direct comparison can be made between the early and mid-season tests and the late trials, the superior yields produced by some of the earlier hybrids indicate that perhaps we should strive for earlier hybrids with high yields and place less emphasis on the very late hybrids. This may be desirable because the yield of late varieties is often reduced by frost. Also, if corn can be harvested early, the fields can be seeded to cover crops to prevent erosion during the winter and to supply much needed organic matter. More experiments are needed to determine the best spacing of early varieties to obtain maximum yields. Preliminary tests in 1946 indicated that no reduction

in yield resulted when the space between plants was reduced from 12 to 6 inches.

Cooperative Testing for the Northeast

In addition to trials to determine the best varieties of field corn for Connecticut, a cooperative trial was conducted with four other northeastern Experiment Stations to find the best late hybrids for the Northeast. Other states cooperating were Maryland, New Jersey, Delaware and Massachusetts. Seed was assembled here and distributed to the other cooperators. The results were also tabulated here.

Twenty-five varieties in the U.S. 13 maturity season which had given good results in various sections of the Northeast were tested. Among the consistently high yielders were Conn. 830, Ohio 3143 and an experimental hybrid bred here. These high yielding entries were comparable to any other variety as far as moisture content, breaking and lodging were concerned.

SWEET CORN BREEDING

One of the remarkable features of the corn plant is the wide range of maturity of different varieties. This difference in maturity has been put to good use in developing sweet corn hybrids which ripen in succession over a period of a month. Hybrid varieties are now available that ripen at three to four day intervals from the earliest to the latest. By a proper choice of varieties, a grower can have sweet corn ripening for a month from a single planting. One of the advantages of a single planting date is escape from heavy infestation of the European corn borer. The best time for planting in Connecticut is between May 10 and May 30.

Some varieties now in use are not of the best quality. In the near future, improvements in marketing sweet corn will make this essential. Consequently, work to develop top quality hybrids for the different maturity seasons is being intensified. Other varieties do not show enough resistance to disease. Another need is shortening the interval between ripening dates of certain varieties. The sweet corn program is being carried on with such improvements as important aims.

Marcross, one of the most popular market garden hybrids, is productive but should have better quality and more resistance to smut. One new hybrid, Washington, expected to be on the market in 1948, will meet these qualifications, to some extent at least.

Another need is for a hybrid maturing between Carmelcross and Lincoln. Old Hickory may meet this need as soon as seed production difficulties are overcome. Some experimental hybrids in this season also show promise. In the Lincoln-Lee season, a few new hybrids seem outstanding. One is a vigorous drought resistant hybrid that might well be tried farther south. Two others have quality suitable for processing.

In the Golden Cross Bantam season, one of the new experimental hybrids is more vigorous, produces less tillers, and more ears, and has a greater total

weight than Golden Cross. This may have a definite place as a market corn in this season.

In the late season, two yellow hybrids were outstanding. Purplecross, a hybrid with purple color in the stalk, leaves and cob, developed here a few years ago, also produced a good yield. Reports from the southern states indicate this corn may have some resistance to the corn ear worm.

TOMATOES

Tomato trials conducted during the 1946 season proved definitely that superior hybrids outyield superior standard strains of tomatoes. In the trials, the yields of twelve hybrids, some of them commercial varieties, others bred at this Station, were tested against six standard strains.

Two hybrids from the W. Atlee Burpee Seed Co., Philadelphia, Pa., outyielded all other entries both in the early season and during the entire summer. However, fruit of these two hybrids was inferior in quality and size to a hybrid developed here, Conn. No. 3 x Garden State, which produced excellent fruit. Yield in the latter was significantly higher than in such commonly grown strains as Master Marglobe and Rutgers. Hybrids which have as one parent a small fruited type of tomato such as Red Cherry or San Marsano showed a slight amount of resistance to blight.

While yields of hybrids are greater, the considerable amount of work involved in the production of hybrid seed may limit its availability and popularity. On the other hand, it is possible that the second generation hybrid may outyield standard varieties and still be sufficiently uniform to meet market demands. Such seed could be easily produced in large quantities by letting the first generation hybrid plants self-pollinate. This problem is being investigated, as is the production of blight resistant tomatoes by incorporating the resistance of the small-fruited types into salad varieties.

PEAS

Peas are an extremely difficult crop to raise in the southern section of New England along the coast, because root rot is apt to kill the vines before the pods mature. Only the very early dwarf varieties such as Laxton's Progress or World's Record can be grown with any degree of success. Accordingly, a pea breeding project has been started, the purpose of which is to produce a superior pea for this section of Connecticut. Hybrids between various early varieties have been made, and seed from promising plants in the second generation has been collected for further trials next summer.

GENETIC INVESTIGATIONS

The Cause of Hybrid Vigor

Hybrid vigor is being used to increase the yields of both sweet and field corn. Our use of hybrid vigor has surpassed our knowledge of what causes

this increased growth when two unrelated strains are crossed. Two general theories have been advanced:

1. There is a physiological stimulation when germ plasm from two unrelated strains is brought together in a hybrid.

2. Dominance of linked genes, proposed by Dr. D. F. Jones of this Station, suggests that hybrid vigor is gene controlled and that each unrelated parent supplies different genes so that the dominant allele (condition) suppresses the recessive allele of the other parent. Since the two parents contribute different hereditary units, each tends to complement the other and supply what the other lacks. Hence, a hybrid of two different parents has greater vigor than either parent.

So far, there is little critical evidence to differentiate these two theories. Consequently, more experimental evidence is needed.

In the past four or five years several degenerate or much reduced types of corn have been discovered in inbred lines of both sweet and field corn. One of these, the C30 inbred in sweet corn, gave increased vigor over the normal Purdue 39 line, from which C30 arose, when outcrossed to unrelated inbreds such as C13 and C15. It also gave hybrid vigor when crossed back on to the P39 parent. In field corn several degenerate lines were discovered that gave much vigor when crossed by the original parent from which they arose. Thus, it seemed that single genes were causing hybrid vigor. However, further analysis has proved in the case of sweet corn, and suggested in the case of the field corn lines, that more than one gene is involved in each case.

Our interpretation of these facts is as follows: Inbred lines, once considered relatively stable, continue to mutate or change as does all other living material. Consequently, if we split an inbred line in any generation of inbreeding into two separate lines, and self the two for several generations, there will be manifest hybrid vigor when the two sub lines are crossed together. Thus, we have heterosis or hybrid vigor within an inbred line. Since finding this, we have suggested that practical application be made of it. Seedsmen can use a cross of two sub lines of Purdue 39, for example, in their seed fields instead of using a single inbred line. The advantages are that the sub line cross (line cross for short) will be more vigorous than either sub line parent and greater seed yields can be obtained. Also, the seed produced on such line crosses will be slightly larger, germinate better and give a little more seedling vigor than either parent. These things are extremely important to every grower of sweet or field corn.

This method is being adopted rapidly by the seed companies. Most Golden Cross Bantam is now being produced by the line cross method and this method is also being used to some extent for hybrids using Connecticut 13 as a seed parent. It will be used more as soon as we find out which are the best line crosses to use.

It is also possible to use this method for producing field corn hybrids, thus making possible the economical production of single crosses instead of the double crosses as used at present. Thus, the methods of producing sweet and field corn hybrids will be brought closer together.

The Effect of Temperature on the Growth and Sterility of Maize

Varieties of corn grown in the Northeast and in the Middlewest at the same latitude are noticeably taller in the East. Several environmental conditions are involved in this growth difference, principally light intensity and temperature which are lower in the East.

Plants of many species, including maize, grown under tobacco shade cloth, are significantly taller and broader in leaf than plants from the same lot of seed grown in full sunlight. Under the cloth shade the temperature is the same as outside but the humidity is higher and the light intensity is lower. The same effect is noticed in the field where short stalked varieties of corn are grown in single rows between taller varieties. Where there is a wide alley between ranges, the plants at the end of the rows are shorter than those in the center of the rows, the plants graduating in height. Here, humidity and temperature are the same but light intensity varies.

Some corn seedlings started in the greenhouse and set outdoors were shorter at maturity than plants from the same seed started outdoors. This indicated that temperature in the early stages of growth had an effect. To test this, seeds of a uniform, vigorous, first generation hybrid (Wf9 x P8) were germinated in an incubator at about 30° C. until the shoots and roots were from one-fourth to one-half inch long. Three different lots of these sprouted seedlings were held at 40, 50 and 60° C. for one hour. They were then planted in pots and left in the greenhouse until it was certain the plant would grow. They were then set in the field alongside plants from the same lot of seed sown in the open ground at the same time the treated seedlings were started in the incubator. Some of the heat treated seedlings died but enough were started in each lot and later thinned to give an even stand of plants in the field.

All three lots of heat treated seedlings were shorter in height, less vigorous in growth throughout the season and later in flowering than the untreated plants. All lots grew to full maturity and were measured after growth had ceased. The results are: control, 101; 40° C., 87; 50° C., 89; 60° C., 93 inches in height. The differences between the three temperature treatments are small. All three averaged 90 compared to 101 inches in height for the control.

The result that was not anticipated was the pollen sterility in all treated lots. Normal tassels were produced with well developed florets but the anthers were small and shriveled and for the most part remained enclosed in the glumes. In view of the fact that high temperatures sterilize the male germ cells in animals from amphibians to mammals, these results are highly significant. This influence on growth is an anti-vernalization effect and may have wide usefulness in the production of hybrid seed, especially if shown by other plants as well as maize. Further experiments are in progress.

Science Works for Agriculture through:

SOIL MANAGEMENT

H. A. Lunt and H. G. M. Jacobson surveying soils in the field, the first step in the preparation of soil maps. Mr. Jacobson holds a soil auger which is used to sample soil. Soil, slope, and land use separations are made directly on the aerial photograph which Mr. Lunt holds.

SOIL TESTING

Testing of soils continues to be a popular service of the Station. This year the number of soil samples tested totaled 1,806, which is about the same number tested in 1945. Those interested in lawns, flowers and shrubs provided 31.8 per cent of the soils tested. Farmers and home gardeners were next in line with 23.6 and 20.8 per cent, respectively. Other groups of people interested in obtaining information on their soils are greenhouse and orchard people; they supplied 5.8 and 1.8 per cent, respectively, of the soils tested. The remainder of the soils came from miscellaneous sources.

The Soils Department is continually striving to improve the techniques and methods used in soil testing work. During the past year, in cooperation with the Tobacco Substation and the University of Connecticut, improvements have been made in the boron and copper tests. These new methods make possible the detection of extremely small amounts of these elements in the soil. Since only very small amounts of these elements are needed by plants for good growth, it is essential that sensitive tests be available for checking their content in soils. As pointed out in a succeeding article in this bulletin, "Nutritional Studies with Potatoes", soil tests are combined with plant tissue tests for obtaining more information on the relationships between plant growth, fertilizers and soils. Work on developing better methods for tissue testing of plants is now in progress.

SOIL MAPPING

A considerable portion of the commercial potato crop is concentrated in the eight towns lying north and east of Hartford, namely: East Hartford, South Windsor, East Windsor, Enfield, Somers, Ellington, Vernon and Manchester. Intensive cropping practices, such as growing potatoes on the same land each year, have intensified the problems of land use, fertilization and erosion in this area. As a basis for researches on these pressing soil problems, a soil survey of this area was begun in the fall of 1945 and completed in 1946. All open unforested land was mapped as to type, slope and current use.

One unexpected finding was that the soil most extensively used for potatoes is that known as Cheshire. About one-third of the area planted to potatoes has this soil. Cheshire soil has been developed from triassic sandstone glacial till on rolling land having moderate to slightly irregular slopes. The surface soil is well-drained, mellow, and light to medium brown in color. The reddish-brown firm subsoil grades into light reddish-brown firm glacial till. Other soils in these eight towns extensively used for the growing of potatoes (in percentage of the potato acreage) are the Hartford soils, 18.4 per cent; the Manchester soils, 15.3 per cent, and the Enfield soils, 11.5 per cent.

The survey also brought out that most of the potatoes are grown on soils having a fine sandy loam texture. Of the 8,500 acres of land in these eight towns cropped to potatoes, 65 per cent of the soils are fine sandy loams. Other

textures represented in order of their importance are as follows: silt loam, 18.1 per cent; loam, 6.9 per cent, and very fine sandy loam, 6.1 per cent.

ROTATIONS AND ORGANIC MATTER MAINTENANCE FOR THE MARKET GARDEN

Market gardening is an intensive form of agriculture which rapidly depletes the soil of organic matter. Because land cropped to vegetables is intensively tilled, little opportunity is afforded for the growing of crops in rotation which will add organic matter to the soil. Since nitrogen is an integral part of organic matter, a reduction in the amount of organic matter usually means less nitrogen in the soil.

The problems involved in the maintenance of soil organic matter are of the following nature: How effective are green manure crops? Which crops are best for this purpose? Will the addition of extra nitrogen increase the effectiveness of green manures or aid in other ways in maintaining soil productivity for vegetable crops?

In 1940 a field experiment was started at Windsor which included legume and non-legume crops in vegetable rotations. In order to obtain some comparison with stable manure on a relative basis with legumes and non-legumes for maintenance of soil organic matter, stable manure was substituted as a source of organic matter in one of the plot series. On some of the plots extra nitrogen was added in addition to the basic application, while on others it was omitted.

This year a three-year rotation which has been repeated twice in the field experiment at Windsor was completed. This rotation consists of: 1st year, spinach followed by the green manures, millet or soybeans, or by a cabbage crop; 2nd year, lettuce followed by beets, and onions by buckwheat as a green manure crop; 3rd year, tomatoes (no green manure). All of the plots were disced and seeded to rye for a winter cover crop. In the spring, the winter rye was turned under as a green manure. In this rotation some of the plots were top dressed with nitrogen while others received no additional nitrogen.

One interesting thing learned was that both total nitrogen and soil organic matter were lower at the end of the first rotation than at the beginning of the experiment. However, at the end of the second rotation cycle, the content of both nitrogen and organic matter in the soil had increased. For organic matter, however, the increases did not make up for the losses which occurred during the first rotation. Millet was the only crop used as a green manure and plowed under that showed a slight gain in total nitrogen over the amount originally present.

In comparison with those plots of millet not top dressed with nitrogen during the rotation, top dressing with nitrogen showed a slight increase for organic matter and a gain of 5.4 per cent of total nitrogen. The rotation which included millet top dressed with nitrogen, in comparison with millet not top dressed, showed a gain of about 5 per cent in both total nitrogen and organic carbon. In every case the millet was plowed under for green manure in the fall and the land planted to rye for a winter cover crop.

Other useful information obtained from this field experiment is as follows:

The yield for tomatoes (Pritchard) showed a 3 per cent increase in favor of extra nitrogen applications, up until the time of a blight in late August. No yields were obtained after the blight.

Onion sets (Ebenezer) produced slightly greater yields of marketable onions on the plots receiving standard nitrogen applications. Plots receiving extra nitrogen produced a higher percentage of diseased onions.

Lettuce (Imperial 847) produced 10.6 per cent greater yields when extra nitrogen was applied.

Extra nitrogen was likewise beneficial to spinach (Long Standing Savoy) resulting in a 14.16 per cent greater yield on the plots which had received extra nitrogen the two previous years.

NUTRITIONAL STUDIES WITH POTATOES

In a potato spray experiment carried on jointly by the departments of Plant Pathology and Entomology at the Mt. Carmel Farm, opportunity was afforded for studying soil and plant relationships under different rates of fertilization. The fertilizer treatments consisted of 0, 150, 450, 1,350 and 4,050 pounds of 5-10-10 fertilizer. In addition, castor pomace was applied at one-fourth these rates, or 0, 37.5, 112.5, 337.5 and 1,012.5 pounds per acre, respectively.

Plant tissue and soil tests were made on samples collected June 21, July 9, July 26 and August 15. These plant tissue tests indicated the amount of unassimilated nutrients within the main stem of the plant. Analysis of the entire plant above ground for total content of nutrients was made on all plants except for those collected on the final sampling date.

Plant top size and tuber yields increased with an increase in fertilizer application except for the 1,350-pound rate which yielded no more and, in some cases, less than the 450-pound rate.

Soil tests showed that only the highest fertilizer application (4,050 pounds) produced available nitrogen and potassium in excess of plant needs. Phosphorus availability, on the other hand, increased slightly with larger fertilizer treatments.

The stage of development of the potato plant appeared to exert an influence on its internal nitrate nitrogen concentration. Early in the season, all fertilizer treatments caused a progressive increase in unassimilated nitrate nitrogen, but by mid-summer only the highest treatment produced an increase of this plant nutrient within the plant. In the latter case, the differences were very large. For example, on August 15, nitrates averaged around 50 ppm for the first four treatments, and over 650 ppm for the fifth treatment.

Phosphorus in the plant definitely decreased with an increase in fertilizer applications, indicating that this element was a limiting factor in the experiment. Apparently, this soil (Cheshire fine sandy loam) readily fixes phosphorus, hence, it is difficult to provide adequate amounts of available phosphorus for plant needs.

The content of potassium in the plant varied less than those of nitrogen and phosphorus. No consistent relationship appeared to exist between internal plant potassium concentration, fertilizer treatment and tuber yield except for the 1,350-pound treatment on the last three sampling dates. On these dates the unassimilated potassium content of the plants for the 1,350-pound treatment was lower than for any of the other fertilizer applications. The concentration of potassium for all treatments was lower on August 15 than on any of the other preceding sampling dates.

Analyses of samples of the entire plant collected on the first three sampling dates show that seasonal factors and fertilizer treatments produce only relatively small differences in the total nutrient content of the plant as compared with the unassimilated nutrient content (plant tissue tests).

From these tests it is apparent that the larger the plant the greater the uptake of plant nutrients from the soil and, unless nutrients are available in abundance in the soil, the concentration within the plant of unassimilated nutrients will be lower.

LEACHING OF PLANT FOOD FROM THE SOIL

Since 1929, studies have been conducted at Windsor on the amount of plant food lost by leaching from the soil. The manner of cultural treatment and the effect various kinds of fertilizers have on increasing or decreasing these plant nutrients losses have been studied. Because nitrogen leaches more readily from the soil than any of the other plant nutrients, considerable attention has been given to this element. A series of cylinders, called lysimeters, 20 inches in diameter with varying depths of 8, 20 and 30 inches, have been placed in the ground and carefully filled with soils of various textures to represent as closely as possible soil profile conditions as they exist in the field. Provision is made to catch the water for each rain which produces leaching. A nitrate nitrogen analysis is made of the leachate obtained from each plot. Aliquots are also taken of each leachate and all of these leachates are composited to make one sample for each six months period of the year. At the end of each period, total chemical analyses of the leachates are made. The data from the chemical analysis of the composite samples are accumulated for the period of the experiment. They are then summarized and published in a Station bulletin.

Series "F", started in 1940, is a study of nitrogen utilization as affected by rates of application, soil reaction adjustment, and source of nitrogen.

An experiment was commenced in 1941 for studying soil residual nitrogen, soil reaction adjustment, and protection against leaching by cover crops on four soils to which nitrate of soda, sulfate of ammonia, urea and cotton-

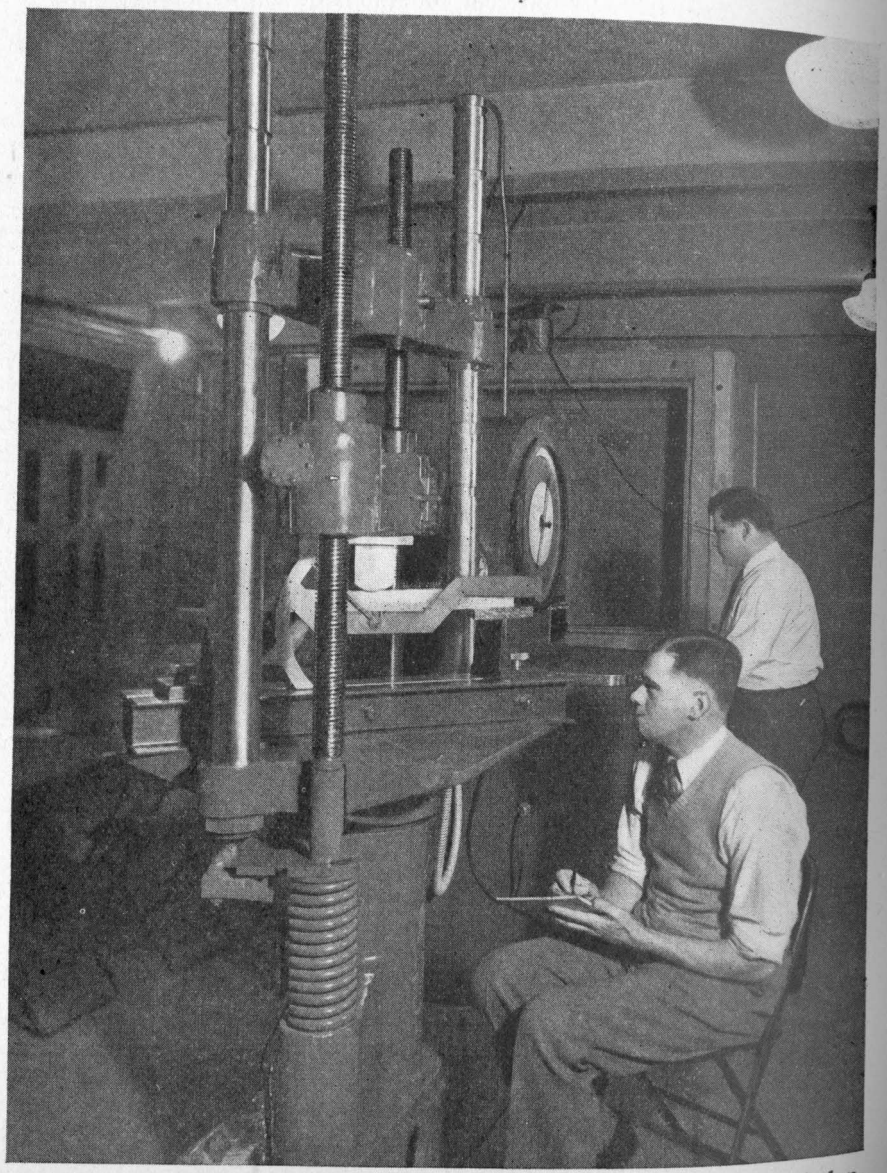
seed meal had been applied for 15 years previous to this experiment. This experiment has been designated as series "G."

Series "H", begun in 1944, is designed to furnish information on nitrogen losses from soils under different conditions of soil management. The soil management treatment involves the use of organic materials (oat straw, soybean hay and barnyard manure).

During the growing season whenever the lysimeters show that rains have produced substantial losses of plant nutrients, especially nitrogen, from the soil by leaching, growers are advised to fertilize their crops. This information is disseminated to the growers through press releases and other information dissemination methods in time for them to apply fertilizers before their crops suffer from a lack of a proper amount of plant food for optimum growth.

Science Works for Agriculture through:

FOREST UTILIZATION



A. R. Olson and N. V. Poletika of the Forestry Department test a beam of plantation-grown pine to determine strength and elasticity. This is one of a series of tests to learn how planted woods compare with those grown in natural stands.

STRENGTH PROPERTIES OF PLANTATION GROWN WOODS

The hurricane of 1938 offered the opportunity to collect wood samples for a series of standard strength tests on plantation grown white pine, red pine, Scotch pine, Austrian pine, jack pine, Norway spruce and European larch. These species have been widely used for forest planting in the northeastern United States. Mechanical properties of the wood from these species have been determined for material selected from mature natural stands but only meager data are available for wood from plantations.

Under ordinary conditions, planted trees grow with little competition for the first 15 to 20 years and produce wood at a faster rate than trees in natural stands. Wood that grows rapidly produces wider annual rings and has, consequently, low density. Therefore, it seemed advisable to test the plantation woods mechanically to determine how they compared in strength with wood of the same species obtained from more mature natural forest trees.

Some 7,000 standard tests and measurements were performed on the plantation grown woods from stands under 40 years of age. They show that for all planted species the specific gravity and the strength under all conditions of testing are lower than for wood from trees from natural stands. This should not be interpreted as a wholesale condemnation of plantation grown lumber because as the trees increase in age, competition becomes keener and the growth rate slows down. It is to be expected that as the trees grow older the wood will increase in specific gravity and in strength and will be no different from forest grown material.

From a practical standpoint, the lack of strength of material cut from stands under 40 years of age should be compensated for in construction either by increasing the size of or decreasing the spacing between such unsupported members as rafters, floor joists and columns. For studding, sub-flooring, roof boards and rough siding, little, if any, increase in dimensions appears necessary.

VOLUME TABLES FOR PLANTED WHITE PINE AND RED PINE

Considerable areas of plantation white and red pine, planted before 1920, have now reached a size where they are producing some merchantable material. In order to provide a suitable instrument for measuring the amount of wood of standing trees as a basis for estimates and sales, the Station prepared volume tables for red pine (Bulletin 413, 1938) and for white pine (Bulletin 427, 1939). These bulletins give tables for estimating the cubic feet of wood in a plantation if the height and diameter of the trees are known. It has been possible during the past year to secure data for the extension of these tables to include trees of larger sizes. Those for white pine are now being prepared and a new table will be available in the near future. The new table for red pine may be delayed for a year.

LAMINATED OAK TIMBERS

Oaks of various species form a very large part of the forest stands in southern New England. The timber cut from these stands is often of low grade due to such defects as knots, cross grain, bark pockets, etc., and does not find as ready a market as high grade structural material. Moreover, timbers more than one inch in thickness are likely to warp and twist badly in seasoning, thus causing a high percentage of cull.

If such timber is cut into boards (laminates) one inch or less in thickness, these laminates can be built up by glueing them together into timbers of larger size which are more satisfactory for construction purposes than timbers of the same size cut from native material. By laminating, it is possible to minimize the defects and to produce a built-up timber that is usually stronger than one of the same size not laminated and which also holds its shape better.

At the present time this Department is working on a lamination project to determine in detail the strength and other properties of laminated oak timbers. These will be tested for strength in various ways and will also be subjected to weathering to determine the effect of lamination on warping, twisting and checking.

MOVEMENT OF LIQUIDS THROUGH WOODY STEMS

A project has been initiated to study the movement of liquids through woody stems. The work will extend over a period of two to two and one-half years and will cover a wide field of materials and conditions.

It is anticipated that the results will be of importance in furthering two projects now underway at the Station. These are the internal therapy of living trees to immunize them against certain diseases and the preservation of wood to inhibit decay.

There are many new chemicals which show great promise either as disease immunizers or as wood preservatives but comparatively little is known of their movement through woody stems or of the factors governing this movement. The study is designed to evaluate these factors.

TREE PROTECTION EXAMINING BOARD

The secretarial work of this Board is currently handled by the Forestry Department. During the past year, certain changes have been made to promote greater efficiency in the routine office work. The 1947 General Assembly will be asked to make changes in the law under which the Board operates in order to facilitate still further the work of the Board and also to permit compliance with recommendations made by the State auditors.

PRESERVATIVE TREATMENT OF SHADE TENT POLES

(In Cooperation with Tobacco Substation)

Since the disappearance of the chestnut, once commonly used for Shade tobacco tent poles, growers have tried other native woods for this purpose, without too much success. White cedar has proved unserviceable because the wood is weak, rots rather quickly and is too soft to hold staples. Red cedar is now commonly used, but many growers find that the poles are rough and knotty and do not have enough heartwood and that staples do not hold well in the sapwood. Moreover, the supply of red cedar is inadequate.

A treatment to render non-durable woods suitable for poles would seem to be the answer.

For several years, various preservative materials and methods have been tried on such species as red maple and pine. Zinc chloride solution treatment by either the tire tube or pressure head method has given good results and seems to be the most practical cheap method. Poles of maple, birch and pine treated eight years ago and set in the tent were found to be in good condition in 1946. A new series, using poles of other species treated with zinc chloride, was begun in 1945.

Treatment with creosote has also been tried but was found to be unsatisfactory. When only the butts were treated, the untreated tops decayed. When the entire poles were treated, fumes from the creosote injured the tobacco plants.

Treatments of poles with Wolman Salts and with chromated copper sulfate were begun in 1946. The American Sumatra Tobacco Company has pitch pine posts treated seven years ago with chromated copper sulfate which are still in service and reported to be in excellent condition.

Science Works for Agriculture through:

TOBACCO RESEARCH

Miss Jeannette Lowe looks over a field of Broadleaf tobacco being grown at the Windsor Tobacco Substation for breeding purposes.

BREEDING

Better quality, higher yields and resistance to disease attack are some of the aims of the tobacco breeding project being carried on by the Tobacco Substation at Windsor. In progress since 1940, the work has already resulted in the development of three outstanding strains of Shade tobacco—Connecticut 15, Connecticut 17 and Connecticut G4. All of these are now being grown commercially on a considerable acreage. Work on improving the taste of these strains is in progress, chiefly through liming the soil at different rates to determine the effect on taste. Crosses of the new strains with standard Shade varieties are also being made, to see if the hybrid vigor resulting from such crosses of food plants, will apply in the case of tobacco.

New strains of Havana Seed tobacco are also being grown with the aim of finding better varieties for Connecticut. In 1946, five superior, root rot-resistant strains, obtained from the Wisconsin and Massachusetts experiment stations were grown and compared with two commonly grown Connecticut strains (Havana Seed 211 and Brown). Havana Seed 211 is our most widely grown root rot-resistant Havana Seed variety while Brown is a common non-resistant strain. In the preliminary tests, Wisconsin 322, Havana Seed 211 and K1 (Mass.) proved to be the best three strains. Judging from the best combination of yield, grading and quality, Wisconsin 322 was superior. The leaves of K1 had a tendency to be too narrow. Yield and grading of the Brown strain was entirely too low to be compared with the others.

Mosaic Resistance

In other states, several strains of tobacco have been developed which are resistant to the mosaic disease. Such strains are not adapted to commercial use in Connecticut. To take advantage of their resistant qualities, several such strains are being crossed with Havana Seed 211. The hope is that strains will be obtained which will combine the good qualities of both parents.

Mosaic resistance is also being sought in Broadleaf tobacco. Several highly resistant strains have been developed. Further tests will be conducted to confirm these results and determine commercial usefulness of the strains.

DISEASE

Downy Mildew

Fermate is now the established material for controlling downy mildew in Connecticut tobacco fields. Believing that some growers may find it more convenient to dust than to spray with Fermate, a comparison of the two methods was made. Dusting gave as complete control as spraying, although the method is somewhat more expensive.

Pathologists in other states have reported that certain bismuth compounds give more lasting protection than Fermate against downy mildew. To determine if bismuth applications would be practicable in Connecticut,

tests were made with two different mixtures of bismuth subsalicylate. No improvement over Fermate was noted, however, and both bismuth preparations caused some foliage burn at the rates applied.

Seedbed Sterilization

The use of chlorpicrin for sterilizing seedbeds is becoming more commonly adopted by growers. One of the problems in its use is the employment of a suitable cover or seal for the fumigated soil, in order to keep escape of gas at a minimum. Old tent cloth is commonly used, but in the past two years some growers have used commercial peat (black or brown muck, sold under various trade names) for covering the beds. In a comparison between these two types of "covers", it was found that healthier and more uniform growth of plants was obtained with peat than with cloth.

Chlorpicrin for Black Root Rot

While chlorpicrin is employed in seedbeds primarily for weed control, growers have found that in beds where it is used the incidence of black root rot is also reduced. There has been some question as to whether the material itself killed the fungus or whether weed control resulting from its use was responsible for the lack of the disease.

Positive proof was obtained that chlorpicrin itself is effective against black root rot. The use of the fumigant in a heavily infested field, three weeks before planting, resulted in perfect growth. There were very few black root rot lesions on the roots. In contrast, a part of the field left untreated produced tobacco of no commercial value and roots were badly infected with black root rot. Practically, chlorpicrin cannot be used in the field because of its high chlorine content which affects the burn of the tobacco. In the seedbeds, this factor need not be considered.

ROOT NEMATODES

Nematodes, serious pests of tobacco in the South, were found on tobacco in Connecticut for the first time in 1946. A severe infestation of the root-knot nematode (*Heterodera marioni*) caused serious stunting of Shade tobacco in one field in Windsor. On other fields two other species of nematodes were found associated with deterioration of the roots and stunted growth of the plants. One of these was identified as the meadow nematode (*Pratylenchus pratensis*). How widespread nematode infestation may be in the tobacco fields of New England is not known. No survey has yet been made and nematode damage may have been attributed to other organisms. Diseased roots that we have previously called brown root rot are now found to be infested with meadow and other species of nematodes. Whether or not they are the primary cause of the trouble has not yet been determined.

Control experiments started in the fall with treatment of field plots with chlorpicrin and DD fumigants. Other soil disinfestants will be added in the spring. Probably the same materials will be effective against all species of nematodes.

WIREWORMS

Sporadic outbreaks of wireworms have long been a problem to the tobacco grower. While this has received a good deal of attention by research men at the Tobacco Substation, no completely satisfactory solution has ever been found.

This past summer, striking results were obtained with a new chemical, benzene hexachloride (Gammexane), for wireworm control on potatoes (see page 7). This material will be tested next year on tobacco, with special attention to be given to the effect of the material on burn and quality of the tobacco.

FERTILIZATION

Ammonium Nitrate

Ammonium nitrate, which contains 32.5 per cent nitrogen, is a valuable addition to the now scant supply of nitrogenous materials in fertilization of tobacco. To determine the exact place of ammonium nitrate in the tobacco fertilization program, experiments have been carried on for the past three years.

Ammonium nitrate produced excellent results when it was used to supply a part of the nitrogen in a mixture of commercial grade. Proportions where the ammonium nitrate supplied up to 37½ per cent of the nitrogen were satisfactory. Ammonium nitrate is also an excellent material for side dressing.

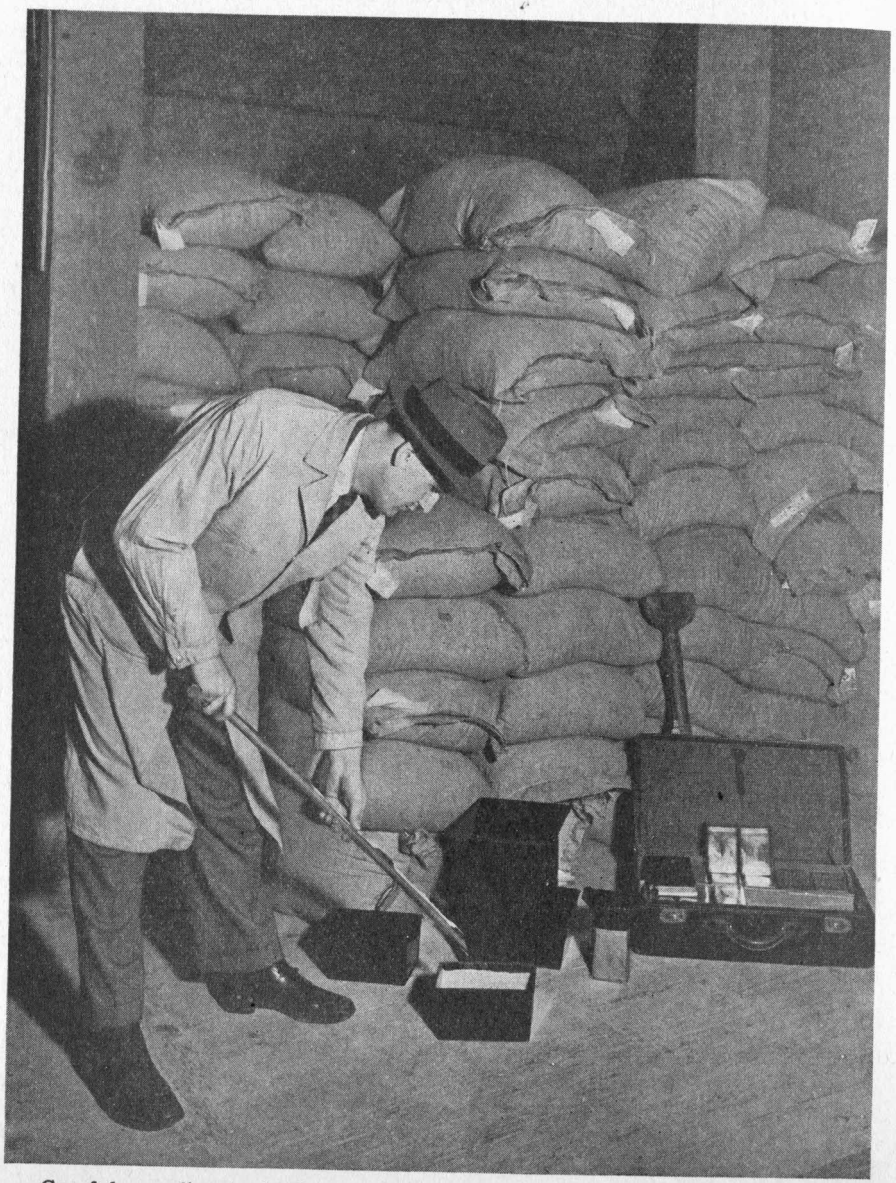
A series of experiments were also conducted, comparing ammonium nitrate with cottonseed meal as the sole source of nitrogen. Ammonium nitrate, used as the only supply of nitrogen and applied all at one time, gave results inferior to cottonseed meal. Even when applied in five fractional amounts at 10-day intervals, the results with ammonium nitrate did not quite match those obtained with cottonseed meal.

Boron

Experiments in 1946 showed nearly 12 per cent improvement in crop value with the addition of 20 pounds of borax per acre. A one-time application of not more than 20 to 25 pounds of borax per acre may be profitably made on fields in good production, but where tobacco appears to be lacking in quality. Such an application should be made only when a satisfactory lime (calcium) content of the soil has been ascertained by soil tests. For general use, borax may be included safely in commercial mixtures at the rate of five pounds per ton.

Science Works for Agriculture through:

ANALYTICAL CHEMISTRY



Careful sampling is the first step in the official inspection of such materials as livestock feeds and fertilizers. The long "tryer" goes through the entire length of the bag, thus insuring an even, accurate sample. Richard Nichols, sampling agent, has taken a sample and prepares to carry it back to the laboratory for chemical analysis.

SUMMARY OF 1946 INSPECTIONS

To a large extent the duties of the Department of Analytical Chemistry are determined by special statutes: the fertilizer, feeding stuffs, food, drug and cosmetic, dairy and insecticide laws. The Department also makes many chemical analyses required in connection with the field studies of other departments of this Station and the Storrs Experiment Station. Since it is the only State general chemical laboratory, a considerable amount of analytical and consulting service is given to other State and Federal departments and to local boards of health and police departments. These include the Commission on Domestic Animals, the State Purchasing Agent, the State Department of Health, the State Police, the U.S. Geological Survey and the State Humane Society.

In the past year analyses or other examinations have been made of 567 fertilizers; 1,289 feeding stuffs and fodder materials, including biological specimens examined for poisons; 1,406 official and other samples of foods, drugs and cosmetics; 397 miscellaneous materials and 1,373 pieces of Babcock glassware and thermometers.

INSPECTION OF FERTILIZERS

War restrictions on fertilizer grades were removed with the revocation of War Food Order No. 5 as of September 30, 1945. Since that date manufacturers have not been compelled by law to limit the number of their grades, although both manufacturers and agronomists recognize that such limitation is desirable. As yet, there has been no significant increase in the number of grades and brands sold.

Fertilizers used in Connecticut during the 1945-1946 season amounted to 80,813 tons, 1 per cent less than the previous year. This decrease is of doubtful significance; fertilizer consumption for the 1944-1945 season for the United States as a whole has been estimated at over 13 million tons, which is a 14 per cent increase over the 1943 consumption.

Fifty-six firms registered 243 commercial brands. Our analyses show that 92 per cent of all guaranties were substantially met or exceeded.

INSPECTION OF FEEDING STUFFS

For the calendar year, 1945, 204 firms registered 1,200 brands of livestock and poultry feed, including vitamin D carriers. This is a 13 per cent increase over the 1944 period in the number of both firms and brands.

The shortage of many feed ingredients, particularly those high in protein, resulted in frequent revisions of registered lists of ingredients and the reduction of protein and raising of fiber guaranties. To some extent, substitu-

tions were made without the notification to the Station that the law requires. On the whole guaranties were well maintained: 94 per cent of feed guaranties and 91 per cent of the guaranties for vitamin D carriers were substantially met. These are the same percentages found in the 1944 inspection.

In addition to the commercial feeding stuffs, 239 samples of experimental forage crops were analyzed for the Storrs Experiment Station.

INSPECTION OF FOODS AND DRUGS

Following the passage of the Federal Food, Drug and Cosmetic Act of 1938 which replaced the old "Wiley" law of 1906, this State was one of the first to adopt a law with corresponding provisions when the General Assembly passed the Connecticut Food, Drug and Cosmetic Act in 1939. Under this law it is the duty of the Station to analyze samples of foods, drugs and cosmetics submitted by the Dairy and Food Commission and report whether the samples violate the law; also to give technical information to the Commissioner. Regulations under the law are issued jointly by the Director of the Station and the Dairy and Food Commissioner. In addition to performing the analyses required in enforcing this law, the Department also examines some foods and drugs submitted by the State Purchasing Agent, local boards of health and private citizens.

During the past year, although there was no increase in the percentage of foods found adulterated or misbranded, inspection revealed a greater prevalence of grosser forms of adulteration. High prices combined with shortages of certain foodstuffs that were in great demand were probably responsible for this. Fats and oils were particularly scarce; this resulted in the substitution of other vegetable oils for olive oil and in the appearance of mineral oil in many foods.

A large number of foods were examined for contamination, decomposition and deceptive packaging. Of 165 foods suspected of being contaminated or decomposed, 78 or 47 per cent, were found to contain rodent excreta or to be insect-infested or otherwise unfit for food. Of 43 samples examined for deceptive packaging, 22 or 51 per cent were slack-filled.

Reports that horse meat was being sold for beef resulted in a survey of Connecticut markets by the State Police and the Dairy and Food Commission. Of 30 samples sold for beef, six contained horse meat, but these all came from two Norwalk markets; no substitution of horse meat for beef was found elsewhere in Connecticut.

Of the 1,225 official samples of foods, drugs and cosmetics submitted for examination, 21 per cent were found to be adulterated, misbranded or otherwise objectionable.

One special food that is regularly inspected is vitamin D milk; 104 samples were examined in 1945; 91 per cent of these met their guaranties.

CALIBRATION OF BABCOCK GLASSWARE AND THERMOMETERS

Sections 2463 and 2488 of the General Statues require that all bottles and pipettes used in determining the fat content of milk and cream, and all dairy thermometers, be certified by the Station before they may be used. Thirteen hundred and fifty-two items were calibrated in 1945.

ANALYSES OF INSECTICIDES AND FUNGICIDES

The Insecticide Law states that the Station "may" sample any commercial insecticide of fungicide and "shall annually analyze" each sample so collected. No attempt has ever been made to sample and analyze all brands of commercial insecticides and fungicides each year. In late years most attention has been paid to new insecticides, usually complex organic preparations. During 1946 a limited market survey was made, and the results of these and other analyses made since the appearance of Circular 153 will soon be published.

There is need for a new law to replace the present one which follows the old Federal Act of 1910. Provisions to require the coloring of white insecticides and fungicides and to provide for the restriction of the sale of very dangerous insecticides such as sodium fluoracetate are particularly needed as a matter of public safety. A new Federal act may pass the present Congress and, if it does, this State should revise its own law.

COLLABORATIVE STUDIES OF ANALYTICAL METHODS

The 6th edition of Methods of Analysis of the Association of Official Agricultural Chemists, prepared by a committee on which the Department head served as chairman, appeared early in 1946.

Extensive studies were made of methods for the analysis of the packing oils in canned sardines, as a result of a request from the Dairy and Food Commissioner. Admixture of natural oil from the fish with the olive oil used in packing sardines alters the constants of the oil in the can so that it no longer reacts like pure olive oil. Methods were worked out to correct for the influence of fish oil and so permit detection of the substitution of other vegetable oils for olive oil.

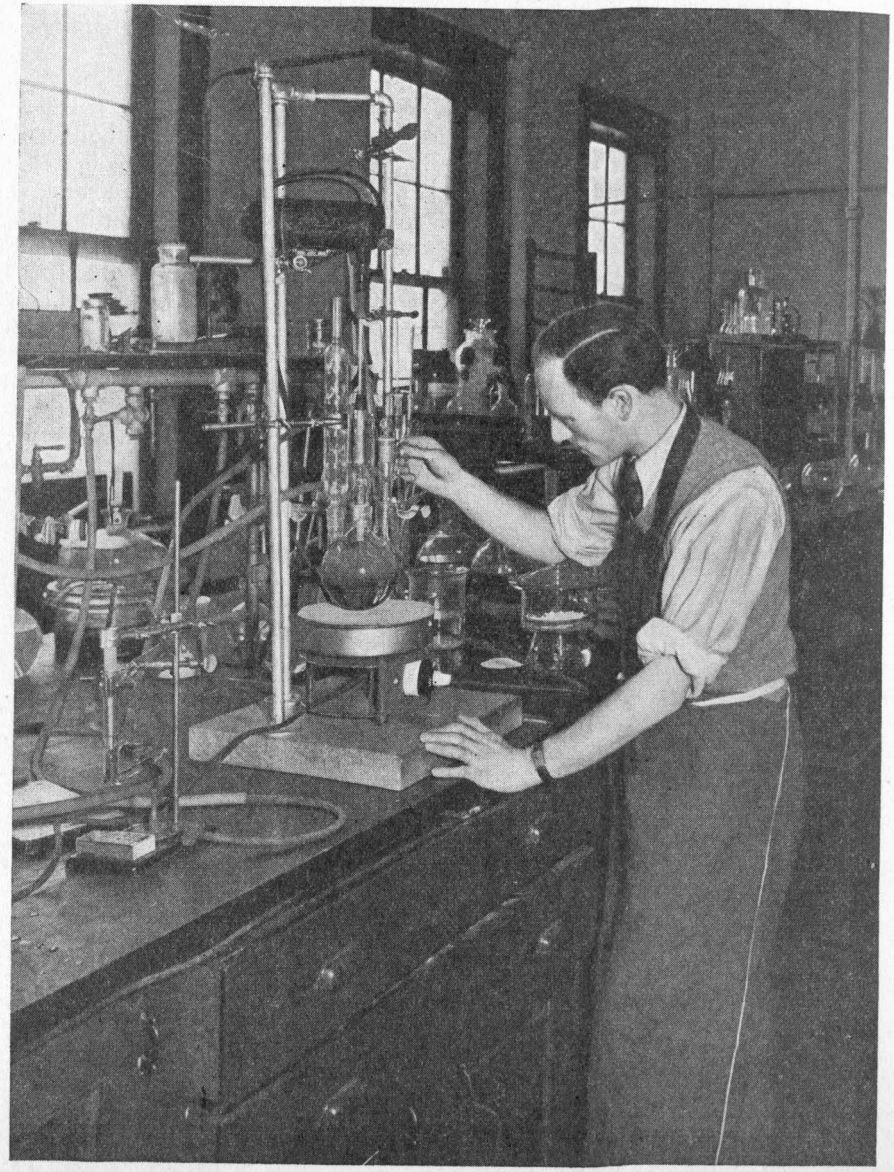
Studies have been made, and are continuing, of the use of the spectrograph in the determination of the mineral constituents of vegetable products and soils, of lead in spray residues, and of mercury, bismuth, antimony and other metals in biological specimens.

EXAMINATION OF BIOLOGICAL SPECIMENS IN CONNECTION WITH SUSPECTED POISONING OF LIVESTOCK

Ninety-six biological specimens were examined in connection with suspected poisoning of domestic animals and poultry. In 23 of these, poisonous substances were found in sufficient quantity to suggest probable or possible causes of death. The poisons found were: arsenicals, cyanide, lead, strychnine, yellow phosphorus, kerosene and yew.

Science Works for Agriculture through:

BIOCHEMISTRY



Heinrich Rinderknecht at work on the preparation of a sulfonic acid.

PLANT METABOLISM

The chemical changes that take place during the growth of plants are complex and many of them are not yet fully understood. However, the need for accurate knowledge increases as our agriculture becomes more intensive and the demand for crops of greater nutritive or commercial value grows more pressing. In our laboratory several plants, notably tobacco, have been investigated intensively.

The common organic acids of plants, such as citric and malic acid, are important components of a great many human foods and have many uses in industry. Of even greater importance to mankind, however, is the use that is made of these substances in the living plant or animal cell itself. During the past decade it has become clear that the chemical reactions to which respiration of the plant is due are reactions in which a group of organic acids undergo transformations. Accordingly, the study of the behavior of the organic acids in living tissues has assumed increasing significance.

The observation, made here, that the leaves of the common greenhouse plant *Bryophyllum calycinum* contain upwards of 11 per cent of their dry weight of isocitric acid has aroused much interest in the metabolism of this species. This plant is a member of the family *Crassulaceae* and belongs in a group frequently referred to as succulents, having thick fleshy leaves and stems. It is characteristic of most of these plants that the leaves undergo a daily variation, frequently of considerable magnitude, in their content of organic acids. The phenomenon has long been known. As early as 1815, Heyne noted that the leaves of *Bryophyllum* are intensely sour to the taste in the morning but that they lose the sour taste by evening, becoming bitter instead. This striking change in the chemical composition of the tissue has attracted the attention of physiologists and botanists ever since, and few phenomena in plant biochemistry have been more frequently studied. In spite of this, it cannot be claimed that the sequence of chemical reactions that must occur in the tissues is understood even today.

The facts are that organic acids increase in the leaves at the expense of carbohydrates when the leaves are deprived of light. The increase has long been held to arise from the synthesis of malic acid, and this seems to be essentially true, although it is only part of the picture. When the leaves are exposed to light, the concentration of the organic acids decreases, malic acid being again largely involved, and there is an increase in the concentration of the carbohydrate. To what extent these chemical events are related and what are the successive steps of the reactions that take place are matters that are still obscure.

Because the particular reactions mentioned are so pronounced and easily observed in the *Bryophyllum* plant, this species is well adapted for detailed study of the phenomena. Accordingly, during the past two years, a great deal of attention has been paid to the metabolism of this species. A preliminary study involved the chemical analysis of the tissues of *Bryophyllum* plants at stages of growth extending from the young plant up to fully grown plants apparently almost ready to pass into the reproductive phase. However, this plant only rarely blossoms under greenhouse conditions in this climate. The

composition of the plants was computed in terms of grams of each component per single plant, and curves were drawn that show the rate of accumulation of each component as the plant grew. A detailed picture of the rate of growth of the plant in terms of many of its chemical components was thus secured.

In general, it was found that growth in terms of fresh weight, organic solids, ash, water, protein, nitrate, soluble carbohydrates, crude fiber (which is chiefly cellulose), total organic acids and malic acid followed curves that were, within the limit of error, straight lines. Total nitrogen, isocitric acid and citric acid followed curves which indicated that there is a gradual slowing of the rate of accumulation of these components as the plant grew older. On the other hand, starch, which was by far the most plentiful known component of the leaves, followed a curve which showed a relatively greater capacity for the storage of starch as the leaves matured. Comparison of these data with information secured several years ago on the rate of growth of the tobacco plant shows that the tobacco plant grows much faster as measured by almost all of these criteria. The most important exception is in the rate of accumulation of organic acids; isocitric acid is formed almost as rapidly by the *Bryophyllum* plant as malic acid is by the tobacco plant. Citric acid is formed at almost equal rates in the two species. In *Bryophyllum* leaves collected at noon on sunny days, isocitric acid is the predominant organic acid just as malic acid is the predominant organic acid of the tobacco leaf. In young *Bryophyllum* leaves, isocitric acid is present to the extent of about 18 per cent of the organic solids of the dry leaf; such tissue is accordingly valuable for the preparation of this substance in quantity.

ISOCITRIC ACID

It was mentioned last year that progress had been made in the development of a method to prepare optically active isocitric acid from the *Bryophyllum* plant. During the past year, a large quantity of the leaves was worked up with the result that somewhat more than 200 grams of this rare substance have been secured in the form of the dimethyl ester of its lactone, a crystalline derivative that has favorable properties for isolation purposes. Nevertheless, this was only about one-third of the isocitric acid present in the tissue examined and further improvements in the method for isolation must be made. Study of this technically difficult problem has recently resulted in finding a means whereby increased yields can be obtained and the new method will be investigated in detail during the coming year.

There is a continuous demand from other laboratories for small samples of this substance which, so far as we can learn, is unobtainable elsewhere. The substance is needed for research in many different fields but especially in the study of respiration. The Station is thus privileged to give assistance to a wide variety of work on the part of other investigators.

DETERMINATION OF CITRIC ACID

About ten years ago, a method to determine citric acid in plant and animal tissues was developed here which has been successfully used in many

other laboratories in the study of the metabolism of citric acid. This method has been improved in detail from time to time. Each modification has permitted its use for the determination of smaller and smaller quantities of citric acid, thereby extending the range of the problems that could be solved with its aid. Recently, the method of Sendroy for the titration of halogens has been applied and found to increase the sensitivity and convenience of the procedure so that quantities of citric acid as small as one-tenth of a milligram can now be determined with accuracy and the limit of the method has been pushed to about one-fifth of even this small quantity. As a result, the determination of citric acid in, for example, a single adrenal gland of a rat is easily possible.

GLUTAMINE

Glutamine, the amide of glutamic acid, is widely distributed in plant tissues and is one of the most important of the simpler nitrogenous substances found in them. Certain tissues, such as tomato stems and beet roots, under conditions of nutrition such that a large part of the nitrogen supplied to the plant is in the form of ammonium ions, become notably enriched in this substance. As much as 5 per cent of the dry weight may consist of glutamine. The laboratory has studied the behavior of this substance in plants at intervals over a period of some 13 years and, among other things, has developed procedures whereby it can be obtained in quantity. These procedures have been used for the commercial production of glutamine by several pharmaceutical companies.

The discovery, announced not long ago at the Rockefeller Institute for Medical Research, that glutamine is an important constituent of blood, in particular that of man, has greatly increased scientific interest in glutamine and has led to a considerable demand for the substance. It has seemed desirable, therefore, to attempt to improve the method that was advocated several years ago of treating beet plants with ammonium sulfate in the field for several days so as to stimulate them to store a high proportion of glutamine. It has now been found that if freshly dug beet plants are carefully washed free from soil and placed for about a week with the roots immersed in a dilute solution of ammonium sulfate, marked storage of glutamine in the root tissue takes place. The leaves wilt badly and collapse; nevertheless, their presence seems to be essential for the reaction to take place. This procedure is much more convenient for enriching the tissue in anticipation of the laboratory or the larger scale preparation of glutamine than was that previously suggested.

HISTORY OF THE KJELDAHL METHOD

Kjeldahl first described his well-known method to determine nitrogen in 1883. Few, if any, chemical methods have had so profound an influence on agriculture. Within ten years, modifications of the original procedure rendered this method applicable to almost all nitrogenous substances. The outstanding contributions were those of Wilfarth, who first employed mercury or

copper as catalysts; Gunning, who first suggested the addition of potassium or sodium sulfate to raise the boiling point of the digestion mixture; Scovell, who developed a convenient procedure for determining the nitrogen of nitrates, and S. W. Johnson, the founder of this Station, who designed apparatus that made the technique of the method convenient and rapid and which, in modernized form, is now used universally.

Because of the close association of this Station with the early development of the Kjeldahl method it seemed desirable to trace its history. This has been done in a paper contributed to the Yale Journal of Biology and Medicine.

NOMENCLATURE OF THE NATURAL AMINO ACIDS

Considerable time has been spent by the head of the Department in committee work with the Editorial Board of the Journal of Biological Chemistry, the Editorial Board of the Biochemical Journal and the Committee on Nomenclature, Spelling and Pronunciation of the American Chemical Society on the reform of the nomenclature of the natural amino acids. The nomenclature of this group of important substances has long been in a state of confusion because of the use of several different systems that have been developed over the years. New rules have been proposed that serve to eliminate any possibility of confusion in the meaning of scientific statements regarding these substances. It is hoped that these will soon pass into general use in the fields of biochemistry and physiology.

GROWTH STUDIES IN THE RAT COLONY

The analysis of the growth of rats in relation to different stock rations has been continued in an attempt to determine the cause of the lower weaning weights that have been observed when mothers with nursing young are fed the Bills stock diet instead of the regular colony maintenance diet. As previously recorded, the two stock rations differ chiefly in that the regular colony maintenance diet includes liberal supplements to a basal mixture of grains, milk powder and inorganic salts. Because of this difference, the animals of the regular stock colony receive a ration much higher in protein than is available for the animals maintained on the Bills stock diet.

To trace the growth of the young rats during the nursing period, and to determine any possible drain on the mother, the weights of the mother and of the young have been recorded at three intervals, namely, at the end of 4, 17 and 21 days of nursing, when the young were weaned. For greater uniformity, only rats that have successfully weaned three litters of six or more young have been included in this summary. Two observations are possible at this time. The weights of the young rats nursed by mothers in the regular stock diet group (higher protein food) are uniformly higher at 17 days and at 21 days than the corresponding weights for animals in the Bills diet group. In addition, the mothers show very little change in weight while nursing, particularly during the first and second lactations. On the other hand, the mothers that

were fed the Bills diet showed about 10 per cent loss in weight during the nursing period.

Several years ago, when the first "rapid growth" studies were reported from this laboratory, comparisons were made of skeletal development and of organ size for both the "slow growth" and "rapid growth" rats. Now that the colony has become established on the "rapid growth" basis, it seems desirable to review and extend some of those early measurements. Preliminary data indicate that during the period of most rapid growth the skeletons may be somewhat lower in weight than the normal values given in the literature.

Biometry

The success of many agricultural experiments depends upon their being planned so that the investigator can recognize which results are due to his experimental treatments. He has to contend with the variation in soil fertility, weather and many other disturbing factors. The Station Biometrician is concerned with the technical problems involved in designing experiments so as to minimize these factors and in evaluating the data so that their effects can be eliminated. He aids investigators in all departments adapt the more efficient modern designs to their needs and make sense of their figures. In addition to acting as a consultant, the biometrician conducts research on new experimental designs and analytical techniques.

During the past year, particular attention was given to slope-ratio assays. These provide a new method for measuring the potency of physical and chemical agents which act upon living plants and animals. In each case the effectiveness of one chemical or other stimulus is compared with that of some familar "standard". Curves relating the response of the test organism to the dose are determined for each chemical. The ratio of the slope of one curve to that of another measures their relative potencies. Research has been directed towards systematizing the design so that many unknowns can be evaluated at one time with a minimum of effort. A paper on the mathematical procedure has been published and the method has been applied to the action of X-rays upon seedlings for measuring depth—dose of X-rays and to the microbiological assay of several vitamins.

The application of the discriminant function to biological assays has also been studied in detail. In many assays of insecticides, fungicides and drugs, the response of the animal or plant can be measured by several criteria. Sometimes much potential information is lost in combining these criteria arbitrarily, so that larger experiments are required than would otherwise be necessary. By means of the discriminant function, the information that each criterion provides on the effectiveness of the treatment can be measured objectively. Some criteria may be eliminated as of no value while others are given weights proportionate to their importance. These weights are computed so as to maximize the slope of the curve relating the composite response to the dose of poison or drug in comparison with the experimental error. The method has been applied to available data on several drug assays and is proving of value in field experiments as well.

Work upon a book describing the statistical designs and analytical methods of use in biological assay has been continued.

The Library

During the year the Station Library had approximately 232 additions. These consisted of 154 bound periodicals and bulletins and 78 single books.

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

In place of inter-library loans, 24 microfilms and photostats were purchased.

The Entomology and Soils departments' libraries were recatalogued and rearranged during 1946. The Main Library recataloguing has not yet been completed, nor the revision of author and title cards in the main catalog. All departments now have card catalogues of their books.

Accessions and library information, including articles in current journals of interest to our staff, and articles by staff members, are listed in the mimeographed "Library Notes", now issued bimonthly.

The total number of cloth and paper bound volumes on hand is now approximately 28,180.

Events at the Station

The second post-war Annual Field Day of the Station held at the Mt. Carmel Experimental Farm had an attendance of more than 1,000, made up of farmers, home gardeners, agricultural research men and others. All Connecticut counties and ten other States were represented. All field plots were open to visitors and a number of demonstrations and exhibits were set up. In addition, a series of short talks on departmental projects and activities were given by department heads.

A number of other meetings were held at the Station during the year. The Federated Garden Clubs of Connecticut held their annual meeting here on October 5. On December 4-5, the New England-New York Fruit Spray Conference met. Over-lapping this session was the meeting of the New England Division of the American Phytopathological Society held on December 5 and 6. A meeting for fruit growers of the State was held on February 14, sponsored by the Connecticut Pomological Society and New Haven County fruit growers.

The fourth annual "Day at Your Experiment Station" arranged for the Federated Garden Clubs of Connecticut was held on May 8. On May 20, county agents from all counties in the State met here for a series of talks on the work of the Station and a tour of the departments. On August 8, a tour of experimental potato plots at Mt. Carmel was conducted for Connecticut potato growers.

The Staff

The Director being on leave for the second half of the Station year, his duties were carried by Dr. Roger B. Friend. This was in addition to his task as Chief Entomologist. To Dr. Friend's untiring and efficient labors go the credit for a successful year.

Forestry Head Retires

Walter O. Filley retired as forester in charge of the Forestry Department on January 1, 1946, after 39 years of service. Mr. Filley was a member of the fifth class at the Yale School of Forestry. After completing his course in 1906, he joined the Station Forestry Department as assistant forester. He became head of his department in 1912. His duties at the Station included supervision of forest surveys, studies in forest management, control programs for blister rust, pine shoot moth and Dutch elm disease, and work with wood preservation and utilization. He was instrumental in bringing about the Station's program for distribution of forest planting stock in effect for many years. He encouraged forest plantings on the part of large landowners, including water boards and companies.

Mr. Filley's contributions to the development of Connecticut forests and parks are many and outstanding. He served as both Station and State forester from 1912 to 1921 and, in this latter capacity, he enlarged the four existing State forests and acquired a fifth in Eastford. It was largely through his efforts that the Meigs Point property was added to Hammonasset Park, and that the Mohawk State Forest was given to the State. For 20 years, he served as treasurer of the State Park and Forest Commission and for several years subsequently as secretary. He is a charter member of the Connecticut Tree Protective Association, which he was active in organizing.

Two Department Heads Appointed

Henry W. Hicock was appointed head of the Forestry Department on January 1, 1946. Mr. Hicock had been assistant forester since 1919. He is a graduate of the Sheffield Scientific School and the Yale School of Forestry, receiving his Ph.B. in 1913 and his M.F. in 1915. He has been engaged in many phases of forestry work during his Station career, particularly sylvacultural investigations, combustion of wood, methods of wood preservation and utilization.

In recent years Mr. Hicock's chief attention has been given to researches on the utilization of the low grade woods that result from improvement cuttings in Connecticut forests. The wood burning conversion unit and the portable charcoal kiln were part of this program.

Dr. C. L. W. Swanson was appointed head of the Soils Department on October 15, 1946, succeeding the late Dr. M. F. Morgan, who was killed in action while serving with the armed forces during World War II. Dr. Swanson is a graduate of Coe College, Iowa, where he received his B.S. degree in 1933. He holds the degrees of M.S. and Ph.D. from Iowa State College. He served four years with the U.S. Army during the recent war, being discharged with the rank of Major. Ten months of this period was spent in Tokyo as head of the Soils and Fertilizer Branch, Agricultural Division, of the Army's Natural Resources Section. In this capacity, he organized and supervised the first reconnaissance soil survey of the country, studied the use of fertilizers with respect to maximizing food production in Japan and Korea, and supervised a land reclamation program for Japan. Prior to his Army service, Dr. Swanson was assistant professor of Agronomy at the University of New Hampshire.

Leaves

Dr. H. B. Vickery, head of the Biochemistry Department, was granted leave to witness the atomic bomb experiments conducted on Bikini Atoll in the Marshall Islands during July. He was one of a group of 20 civilian scientists from the National Academy of Sciences invited by the Navy to be present at the demonstrations.

Dr. Raimon L. Beard, entomologist, began a year's leave of absence on March 1, 1946, to work with the National Research Council. Dr. Beard was one of the group which was responsible for the organizational and preparatory work in connection with the establishment of the Chemical-Biological Coordination Center of the Council. The purpose of the Center is to assemble and correlate information on chemical compounds and biological actions and to facilitate research on chemical compounds with the aim of finding new uses for them.

Dr. C. I. Bliss, station biometrician, was granted a two months leave to accept an invitation as visiting lecturer at the University of North Carolina during June and July.

Dr. D. F. Jones, head of the Genetics Department, began a sabbatical leave on October 15 to engage in special research at the California Institute of Technology, Pasadena, Calif. During his absence, Dr. W. Ralph Singleton was acting head of the Genetics Department.

DAVID C. WALDEN

Feb. 19, 1905—Sept. 13, 1946

David C. Walden, a chemist in the Analytical Chemistry Department at the Station, died August 15, 1946, one month after he had retired because of ill health. He had been a member of the staff for 19 years.

Mr. Walden's entire professional career was spent at this Station. Shortly after his graduation from Wesleyan University with the degree of Bachelor of Science in 1927, he joined the Station staff. His duties included analyses of foods, drugs, feeds and fertilizers. He also collaborated on investigations of livestock poisoning and was co-author of a Station bulletin "Notes on Livestock Poisoning in Connecticut".

Mr. Walden was an accurate analyst and a chemist who knew how to meet new problems as they arose. Despite the affliction of a rare malady that gave little or no hope of successful treatment, he continued his duties in his laboratory to within a few weeks of his death, compelled by his devotion to his work and his extraordinary courage.

During his career at the Station, Mr. Walden won the respect and affection of all. His sincerity, cheerfulness and spontaneous good humor pervaded all of his relations with his co-workers, who feel a deep personal loss in his death.

Retirements

W. O. Filley, Head of Forestry Department, December 31, 1945.
D. C. Walden, B.S., Chemist in Analytical Laboratory, August 16, 1946.

Resignations

Helen R. Kent, Accountant, December 15, 1945.
Frances J. Barney, M.S., Seed Tester in Plant Pathology Department, January 31, 1946.
L. C. Curtis, Ph.D., Geneticist, January 31, 1946.
Mary H. Kinnane, Stenographer, January 31, 1946.
O. E. Nelson, Jr., M.S., Research Technician in Genetics Department, February 28, 1946.
Helen A. Hulse, Secretary in Entomology Department, May 31, 1946.
Frances M. Gillespie, B.S., Laboratory Helper in Entomology Department, June 21, 1946.
Mary C. Frederiksen, Secretary in Pant Pathology Department, July 31, 1946.

Appointments

V. W. Cochrane, Ph.D., Plant Pathologist, November 1, 1945.
A. B. Pack, M.S., Plant Physiologist at Tobacco Substation, November 7, 1945.
Marjorie D. Abrahams, M.A., Research Technician in Biochemistry Department, December 1, 1945.
H. W. Hicock, Head of Forestry Department, January 1, 1946.
A. E. Dimond, Ph.D., Plant Pathologist, January 1, 1946.
Ruth Wedmore, Stenographer, January 1, 1946.
A. F. Wickroski, M.A., Chemist in Analytical Laboratory, February 1, 1946.
Dorothy M. Griffin, B.S., Seed Tester in Plant Pathology Department, February 7, 1946.
H. O'D. Hunter, M.S., Executive Secretary, March 15, 1946.
C. T. Parsons, Ph.D., Entomologist, April 1, 1946.
C. C. Esposito, Clerk, May 1, 1946.
Lloyd G. Keirstead, B.S., Chemist in Analytical Laboratory, June 24, 1946.
Celeno K. Walker, Laboratory Helper in Entomology Department, July 8, 1946.
W. H. Gabelman, B.S., Research Technician in Genetics Department, August 1, 1946.
Dorothy A. Mettler, Secretary in Plant Pathology Department, August 1, 1946.
Mary Louise Gilbert, B.S., Secretary to Director, September 1, 1946.
C. L. W. Swanson, Ph.D., Head, Soils Department, October 16, 1946.
Nancy C. Woodruff, B.A., Research Technician in Entomology Department, October 16, 1946.

Plant Improvements and New Equipment

The Pomeroy lot, adjoining the Tobacco Substation at Windsor, was purchased to be used for trial plots for tobacco and vegetable experimentation. Previously, this lot had been rented by the Tobacco Substation for several years.

A new insecticide laboratory in Jenkins Laboratory was equipped. This is being used for tests on the effect of formulations on the toxicity of insecticides and the effect of chemical structure on the toxicity of chemicals to insects.

Three sprayers for experimental work in pest control to be used at the Mt. Carmel Experimental Farm were purchased. Two of these are being

used for potato investigations and the third is an orchard sprayer used for fruit research.

Also purchased for use in potato experiments was a pick-up truck, obtained from Army surplus materials. An Army carry-all was bought for general utility purposes.

The Administration Building and Johnson Laboratory were painted, and many repairs deferred during the war, were undertaken.

LIST OF PROJECTS

Active in 1946-47

Analytical Chemistry

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

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

Biochemistry

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

Entomology

9. Insect survey of Connecticut.
17. The control of the Oriental fruit moth, including parasites. (In cooperation with the U. S. Dept. Agr.)
37. Substitutes for lead arsenate in orchard sprays—development of non-arsenical programs.
43. The spruce gall aphid.
44. Bark beetles of the elm.
45. Investigation of parasites of the Japanese beetle.
49. Adhesives for standard spray mixtures—reduction in number of sprays necessary.
51. Soil and grassland insect investigations.
52. The biology and control of the eastern field wireworm.
56. Investigation of the factors affecting the efficiency of dusts. (In cooperation with the Dept. of Plant Pathology and Botany.)
57. The biology and control of Comstock's mealybug on pears and apples.
58. Investigations of diseases affecting scarabaeid larvae.
60. The biology of the codling moth in Connecticut.
62. Control of the borers in nursery trees.
63. Investigations into the poisoning of honeybees in the control of plant pests.
64. Control of American foul brood of bees.
65. New methods for applying insecticides to orchard and shade trees.
66. Relation between chemical constitution of insecticides and toxicity to insects.
68. The biology of the European apple sawfly.

69. A study of the effect of formulations on the toxicity of DDT.
70. A study of synergism between insecticides and between insecticides and other chemicals.

Control and Service

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

Forestry

6. Studies of forest plantations.
   a. Growth and yield of several species in relation to site. (Inactive)
12. Problems in the utilization of Connecticut grown woods.
   a. Preservative treatment of species growing in Connecticut.
   b. Portable charcoal kilns. (Inactive)
   c. Strength properties of plantation grown conifers. (In cooperation with Yale Forestry School.)
   d. Lamination of native oak timber. (In cooperation with Yale Forestry School.)
13. Factors governing the natural regeneration of white pine.

Genetics (Plant Breeding)

1. A genetic and cytological study of herditary characters in plants.
2. The effects of inbreeding and crossing upon seed and vegetatively propagated plants.
3. Methods for the improvement of naturally cross-fertilized plants by selection in inbred lines.
4. Methods for the improvement of naturally self-fertilized plants.
5. Variation resulting from alteration in position or arrangement of nuclear and cytoplasmic components of the cell.

Plant Pathology and Botany

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

Control and Service

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

Soils

3. Nutrient requirements of vegetable crops on important soil types used for market gardening in Connecticut.
4b. The relation of soil conditions to growth of trees in plantations.
5. Lysimeter studies of the drainage losses and other changes that occur in soils under heavy fertilization as practised for tobacco and vegetables.
7. The improvement of the nutritional status of unproductive forest soils.
   a. Soil conditions and tree growth as affected by litter removal and liming.
   c. The effect of several methods of slash disposal on the soil and the rate of growth of young trees.
8. The agronomic application of rapid chemical tests for estimating the nutritional factors of soil fertility.
10. Nitrogen relationships in soil maintenance by green manures in vegetable cropping systems.
11. The utilization by crops of nitrogen applied at high rates.

Tobacco Substation

1. Fertilizer experiments.
   ea. Ammonium nitrate as a source of nitrogen for tobacco.
   r. Fertilizer placement.
4. Tobacco nutrition studies.
   b. The role of boron in tobacco fertilizers.
   d. Symptoms of deficiencies.
5c. Improvement of Havana seed strains.
7aa. Improvement of Shade tobacco by selection and breeding. (With Genetics Dept. and in cooperation with the Shade Tobacco Growers Agricultural Association, Inc.)
   e. Open field wrappers.
13. Preservative treatment of shade tent poles. (See Forestry No. 12.)
17aa. Study of tobacco pigments.
19. Investigation of various tobacco diseases.
   a. Damping-off.
   c. Pole rot.
   e. Breeding for mosaic resistant Broadleaf.
   f. Control of downy mildew.
   i. Sclerotinia and Botrytis diseases of tobacco.
   j. Breeding for mosaic resistant Havana seed.
20. The biology and control of insects that attack tobacco. (See Entomology No. 52.)
22. Irrigation of tobacco.
26. Sterilizing tobacco beds—tests of new materials.
32. Plowing versus discing as preparation for tobacco.
33. Effect of shade tent on conditions within the tent and their effect on the plant.
34. Nematodes on tobacco.

PUBLICATIONS

July, 1945 to July, 1946

BULLETINS OF THE STATION

Public Document No. **24.** Annual Report of the Connecticut Agricultural Experiment Station for the Year Ending October 31, 1945.

No. **485.** A Study of Stickers for Lead Arsenate Sprays on Fruit Trees. Philip Garman.

No. **486.** Commercial Feeding Stuffs. Report on Inspection. 1944. E. M. Bailey.

No. **487.** Tobacco Substation at Windsor. Report for 1944. P. J. Anderson and T. R. Swanback.

No. **488.** Connecticut State Entomologist. Forty-Fourth Report. 1944. R. B. Friend.

No. **489.** The Forty-Ninth Report on Food Products and the Thirty-Seventh Report on Drug Products. 1944. E. M. Bailey.

No. **490.** The Improvement of Naturally Cross-Pollinated Plants by Selection in Self-Fertilized Lines. IV. Combining Ability of Successive Generations of Inbred Sweet Corn. W. Ralph Singleton and O. E. Nelson, Jr.

No. **491.** Studies on the Milky Disease of Japanese Beetle Larvae. R. L. Beard.

No. **492.** Commercial Fertilizers. Report for 1945. E. M. Bailey.

No. **493.** Tobacco Substation at Windsor. Report for 1945. P. J. Anderson and T. R. Swanback.

No. **494.** A Charcoal Kiln Made of Cinder-Concrete Blocks. A. R. Olson and H. W. Hicock.

No. **495.** Some Fundamental Aspects of Control of the European Corn Borer. N. Turner.

No. **496.** Chemical Investigations of the Metabolism of Plants. I. The Nitrogen Nutrition of *Narcissus Poeticus*. H. B. Vickery, G. W. Pucher, A. J. Wakeman, and C. S. Leavenworth.

No. **497.** Commercial Feeding Stuffs. Report on Inspection. 1945. H. J. Fisher.

No. **498.** Dutch Elm Disease and Its Chemotherapy. G. A. Zentmyer, J. G. Horsfall, P. P. Wallace.

CIRCULARS OF THE STATION

No. **162.** Text of the Insecticide Law of Connecticut and Regulations for Its Enforcement.

JOURNAL PAPERS

Bailey, E. M. Review: "Official and Tentative Methods of Analysis", by Assoc. of Official Agricul. Chemists. Chemical and Engineering News, **24**:1729. 1946.

Barratt, R. W. A laboratory assay for stability of organic fungicide residues. Phytopath., **36**:679. 1946.

Beard, R. L. Competition between two entomogenous bacteria. Science, **103**:371-372. 1946.

Bliss, C. I. An experimental design for slope-ratio assays. Annals of Mathematical Statistics, **17**:232-237. 1946.

———. A revised cylinder-plate assay for penicillin. Amer. Jour. Pharm. Assn., **35**:6-12. 1946.

———. Confidence limits for biological assays. Biometrics Bulletin, 1:57-65. 1945.

BLISS, C. I. Review: "Statistical Analysis in Biology," by K. Mather. Science, **102**:161-162. 1945.

————. The combined slope in comparative tests of tibia and toe ash in the chick assay for Vitamin D. Poultry Science, **24**:535-541. 1945.

BLISS, C. I., AND BARTELS, B. L. The determination of the most efficient response for measuring drug potency (abstract). Federation Proc., **5**:167-168. 1946.

BLISS, C. I., AND LANDAUER, WALTER. Insulin-induced rumplessness of chickens: III. The relationship of dosage and development stage at time of injection to response. Jour. of Expt. Zoology, **102**:1-22. 1946.

BRIGHAM, W. T. Oriental fruit moth control. Pom. Pointers for Conn. Fruit Growers, No. **184**. 1946.

FRIEND, R. B. Entomology. The American Year Book, 1945, pp. 848-852.

————. The insecticide DDT, new weapon in the control of pests. The Yale Scientific Magazine, **20**:12-18. 1945.

————. The timing of insect control operations. Plants and Gardens. **1**:113-115. 1945.

GARMAN, PHILIP. Notes on fruit growing in Florida. Pom. Pointers for Conn. Fruit Growers, No. **184**. 1946.

HORSFALL, J. G., JACOBSON, H. G. M., AND GRIES, G. A. Polymodal dosage—Response curve between calcium-potassium ratio and potato scab. Phytopath., **36**:399. 1946.

HORSFALL, J. G., TURNER, N., AND MCDONNELL, A. D. Interactions of concentration, pressure, time, and orifice in spraying. Phytopath., **36**:680. 1946.

JACOBSON, H. G. M. Need for organic matter. Rural New Yorker, **104**:386. 1945.

————. Use your land wisely. Rural New Yorker, **105**:5611. 1946.

JOHNSON, J. P., AND STADEL, R. Sulfathiazole as a medication for American foul brood disease of honeybees. Jour. of Economic Entomology, **39**:141-144. 1946.

JONES, D. F. Heterosis resulting from degenerative changes. Genetics, **30**:527-542. 1945.

LUNT, H. A. Moisture retention by nursery packing materials. American Nurseryman, **82**:5-6. 1945.

————. Preliminary greenhouse studies of digested sludge as a fertilizer. Sewage Works Jour., **18**:46-53. 1946.

————. The fertilizer situation. Rural New Yorker, **105**:5615. 1946.

————. The value of woodashes as fertilizer in soil improvement, Proc. No. Eastern Wood Utilization Council, **7**:14-18. 1945.

NELSON, O. E., AND BURR, H. S. Growth correlates of electromotive forces in maize seeds. Proc. Nat. Academy of Sciences, **32**:73-84. 1946.

PUCHER, G. W., AND VICKERY, H. B. The synthesis of isocitric acid. Jour. Biol. Chem., **163**:169-184. 1946.

QUACKENBUSH, A. Man-made "bug" slays bugs. Esso Farm News, Nov. 1945, pp. 18-19.

————. The wonderful squash of Doctor Curtis. Saturday Evening Post, March 16, 1946.

————. What to expect from DDT. The Flower Grower, **32**:535. 1945.

SHEPARD, C. E., AND FISHER, H. J. The determination of sulfathiazole and other sulfa drugs in honey. Jour. Assoc. of Official Agric. Chemists, **29**:175-177. 1946.

SINGLETON, W. R. Inheritance of indeterminate growth in maize. Jour. of Heredity, **37**:61-64. 1946.

————. "Long Husk" sterility in maize. Jour. of Heredity, **37**:29-30. 1946.

STODDARD, E. M. Chemotherapy—a method of plant pest control. Plants and Gardens, **1**:116-118. 1945.

STODDARD, E. M. Report of the Committee on Fruit Diseases. Proc. of the 55th Annual Meeting of the Conn. Pomological Society, **48**:85-89. 1945.

————. What is new in apple disease control. Proc. of the 55th Annual Meeting of the Conn. Pomological Society, **48**:26-31. 1945.

SWANBACK, T. R. Possible role of boron in tobacco fertilization. Soil Science, **62**: 137-149. 1946.

TURNER, N. Conn. experiments with DDT for control of potato pests. Amer. Potato Jour., **23**:135-137. 1946.

————. Diatomaceous diluents for dusts. Jour. Econ. Ent., **39**:149-158. 1946.

————. New organic insecticides. Chronica Botanica, **9**:92-94. 1945.

VICKERY, H. B. Plant proteins. Nutrition Reviews, **3**:257-259. 1945.

VICKERY, H. B., AND CLARKE, H. T. The amino acid composition of proteins. Science, **102**:454-456. 1945.